

Molecular Biophysics and Biochemistry

Director of undergraduate studies: Andrew Miranker (he/him/his), 318 Bass Building on Science Hill, MBBUndergrad@yale.edu

Undergraduate registrar: Liz Vellali (she/her), 309 Klein Tower on Science Hill, MBBUndergrad@yale.edu

MB&B on one page

Members of the Department of Molecular Biophysics and Biochemistry (MB&B) are united by a common view that processes in biology are understood when molecular, chemical, kinetic and thermodynamic contributions to mechanisms have been elucidated. Faculty and students are joined by a shared fascination with biochemistry, physical chemistry, structural biology, computation, spectroscopy, macromolecular engineering, imaging and the molecular basis of disease.

The core elements of our discipline are:

Biophysics 3 credits for BA, 4 credits for BS and BS/MS

Biochemistry 3 credits

Science & Society 1/2 credit

Additional requirements in MB&B serve to:

- support the core elements as prerequisites or accompanying labs
- teach advanced topics that make use of these underpinnings
- teach the technology that enables scholarship in our discipline
- give opportunity to seniors to demonstrate mastery of the discipline in writing

Practical Skills 1 credit for BA, 2 credits for BS and 1 for BS/MS

Electives 1 credit for BA, 2 credits for BS and 6 for BS/MS

Senior Thesis 1 credit for BA and BS, 4 for BS/MS

Three quarters of MB&B graduates matriculate into PhD, MD and MD/PhD programs. Other recent graduates have joined companies specializing in finance, management consulting, biotechnology and pharma. Others have matriculated in law or business school and doctoral programs in the humanities. Still others have performed 1-2 years of public service, entered secondary education or joined the US armed forces as officers.

To directly engage students' interests and career goals, concentrations are available. These are named sets of electives, curated by the faculty, that count towards elective requirements and appear on your official Yale transcript. MB&B students may concentrate in **Medicine**, **Computational Biology & Bioinformatics**, **Biophysics and Structural Biology**, **Chemical Biology**, **Biochemistry**, or **Environment and Climate Change**.

Introductory Courses for First Years

We recommend you prioritize completing courses in the box below by the end of your first year. These courses are prerequisites for **MB&B 275 Biology at the Molecular Level**, a course open to everyone and that ~3/4 of MB&B students take as sophomores as their gateway into the major. Don't worry if you do not complete or place out of all 5 of these credits by the end of the first year! The MB&B major is still open to you.

CHEM 161	General Chemistry I
CHEM 134L	General Chemistry I lab (1/2 credit)
CHEM 165	General Chemistry II
CHEM 136L	General Chemistry II lab (1/2 credit)
MATH 112	Calculus I
BIOL 101	Biochemistry and Biophysics (taught by MB&B Profs!)*
BIOL 102	Cell Biology and Membrane Physiology*

*Can be taken concurrently in with **MB&B 275** with instructor permission.

We further recommend students complete the 2.5 credits below as soon as they are able. These are prerequisites for courses that MB&B students typically take in their junior year.

CHEM 220	Organic Chemistry I (~2/3 of MB&B students take as sophomores)
CHEM 222L	Organic Chem I Lab (~2/3 of MB&B students take as sophomores)
MATH 115 or 116	Calculus II (~1/4 of MB&B students defer this sophomore year)

The ½ credit courses below prepare students for conducting research in faculty labs across Yale and beyond, are co-taught and co-listed with Physics. Taking any two modules is also one of several ways to satisfy premedical physics lab requirements. These modules are available to both first-year and 2nd year students and are offered every semester to help students plan and balance their coursework demands across the liberal arts.

MB&B 121L	Introduction to Physics in Living Systems Lab I: Observation and Analysis I
MB&B 122L	Introduction to Physics in Living Systems Lab II: Observation and Analysis II
MB&B 123L	Introduction to Physics in Living Systems Lab III: Mechanics
MB&B 124L	Introduction to Physics in Living Systems Lab IV: Electricity, Magnetism & Radiation

First Year Advising: Students are welcome to declare MB&B as their major at anytime. Completing introductory course work is not required. We encourage declaration as it improves our ability to advise and send you pertinent information and dates. Once declared, MB&B students are assigned one academic faculty advisor through whom they may also petition to have courses waived. Declaration of major is non-binding at Yale and changing major does not require anyone's approval. If you are not a declared major, no problem! Just send questions to MBBUndergrad@yale.edu and watch your email for informational events.

Molecular Biophysics & Biochemistry

Degrees Offered	BA	BS	BS/MS
Introductory Courses	SUGGESTED INTRODUCTORY PREPARATION Dependent on concentration, placement or waiver. Typically the following: CHEM 174 or CHEM 220 with lab MATH 115+, BIOL 101 & 102, MB&B 121L		
Requirements for each degree	9.5 course credits including senior requirement	12.5 course credits including senior requirement	18.5 course credits 10 of which at 500+ including senior req
	BIOPHYSICS		
	(three terms) MB&B 275 and PHYS 170 & 171	(four terms) MB&B 275, PHYS 170 & 171 1 x 300+ in Physical Sci, MATH, CPSC or S&DS	(four terms) MB&B 275 PHYS 180/181 CHEM 332
	BIOCHEMISTRY (three terms) MB&B 300 and MB&B 301 CHEM 200+ or CHEM 175		
	SCIENCE & SOCIETY (1/2 term) MB&B 268 or MB&B 107 or others		
	PRACTICAL SKILLS		
	(1 credit) enrollment in 2 or 3 of these categories: <u>Physics Lab</u> <u>Biochem/Bio Lab</u> <u>Critical Tools</u> 1/2 credit or more from MB&B Physics Lab: e.g. PHYS 165L, MB&B 121L, 124L, 364 Biochem Lab: e.g. MB&B 470, 251L, CHEM 355L or ... Critical Tools: e.g. S&DS 100+, CPSC 100, MB&B 435 or ... many others	(2 credits)	(1 credit) MB&B 470 or 471 before end of 5th semester
SEMINAR AND LECTURE ELECTIVES			
(one term) 1 x MB&B at 200+ level	(two terms) 1 x MB&B at 200+ level 1 x STEM at 200+	(six terms) 2 x MB&B at 500+ level 4 x STEM at 500+	
Concentrations (optional)	CONCENTRATIONS Faculty curated sets of classes that fulfill the above electives. Six available: <u>Medicine</u> <u>Biochemistry</u> <u>Computational Biology & Bioinformatics</u> <u>Biophysics & Structural Biology</u> <u>Chemical Biology</u> <u>Environment & Climate Change</u> Between 0-3 additional credits. For BA & BS, one upper level elective can be taken Cr/D/F Concentration name appears on your Official Yale Transcript		
Senior Requirements	SENIOR PROJECT (1 term, fall or spring) MB&B 490 or 491		RESEARCH (4 credits) MB&B 570a and 571

Core elements of the Majors

Biophysics:

Rationale: Understanding biology requires a broad understanding of physical principles.

BA & BS majors: A two semester sequence PHYS 170/171 or higher.

BS/MS majors: A two semester sequence PHYS 180/181 or higher. If you are considering the BS/MS path, you must take physics at this level or higher.

Accompanying labs for the above classes are not required but can be used to fulfill **Practical Skills** requirements described below.

Rationale: Integral to understanding molecular mechanism in biochemistry is the formal study of thermodynamics, spectroscopy, quantitative methods for analysis and atomic structure determination. For BA students, one, and for BS and BS/MS students two lecture courses must be taken on one or more of these topics. Reading-based seminar and laboratory courses are typically excluded.

All majors: Our recommended route is to begin with the introductory class, **MB&B 275 “Biology at the Molecular Level”**. This class requires only General Chemistry and BIOL 101 as its pre-requisites and focuses strongly on biological applications. **MB&B 275** is typically taken by students in the fall of their sophomore year..

Acceptable alternatives to **MB&B 275** are formal courses in thermodynamics from other departments: CHEM 332, CENG 300, APHY 420 and MENG 211.

Note, MB&B 275 may not be taken after these courses.

BS majors: A 300+ seminar or lecture course which emphasizes thermodynamics, spectroscopy or analytical methods in physical natural sciences, physical engineering sciences, math, statistics, or computer science. Acceptable courses include: APHY 420, CENG 300, CHEM 332, 333, 406, 407, 417, 466, 472, 496 CPS 223, MB&B 330, 361, 364, 420, 435, 452 and 529, EPS 310, 323, 335, EVST 362, MENG 211, S&DS 351. Note: most courses in Biomedical Engineering and Chemical Biology are excluded from being used to fulfill this requirement.

Alternatives may be petitioned through your advisor (see **Policies and Procedures**) based on the courses commitment to the above rationale.

BS/MS: CHEM 332, CENG 300, APHY 420 or MENG 211. However, if one of these classes is taken in lieu of MB&B 275, you may follow the guidance for BS majors.

Biochemistry:

MB&B 300/301 is a two semester, comprehensive sequence that defines MB&B's perspective on biochemistry. It is required of all majors.

Course substitutions for **MB&B 300/301** are **not** permitted.

The prerequisites for MB&B 300/301 is one semester of organic chemistry with lab, BIOL 101 and BIOL 102. While we recommend this course sequence be taken in year 3, about 1/3 of majors take this course sequence in year 2. MB&B 300 may be taken concurrently with organic chemistry. There is no accompanying lab to MB&B 300 or 301.

An additional 200+ level course in Chemistry, or CHEM 175, is required of all majors to further support understanding of Biochemistry. Majors typically take a second semester of organic chemistry, or inorganic chemistry, or options specified by particular concentrations. Accompanying labs are not required.

Science & Society:

This requirement formalizes the MB&B faculty's view that the intersection of our discipline with human identity and society is critically important to the training of the next generation and the continued education of ourselves. Matters of personal and group identity underpin the history of our discipline's development, the lived experience of our field's practitioners, the achievement of excellence by diverse cultures co-working in our labs and the interaction of ourselves and our graduates with the public in its secondary schools, businesses, hospitals and government.

All majors take at least 1/2 credit of 100+ coursework in this area. One mechanism is to take the initiative and independently explore this interface by taking MB&B 268, "Society, Identity and STEM". This half-credit course meets in the second half of term and is taken simultaneously or immediately following any humanities course with significant focus on race, ethnicity, gender, sexuality, disability, veteran status, religion or any other aspect of human identity. MB&B 268 may be taken up to two times for a letter grade.

An alternative approach to fulfilling this requirement is to take one of many courses at Yale that directly address this topic. This includes AFAM 170, MB&B 107/268, HSHM 206/241/332/406/409/424/425/436/475/481, HIST 479, HLTH 140, SOCY 126/127/351, MCDB 375 or WGSS 270/457/741. Petitions for **course substitutions** (see below) are encouraged.

Additional Requirements

Practical Skills:

Many practical skills are vital to effective bench and computer-based research in biology and physics. Other practical skills benefit our ability to generate and test hypotheses and establish rigor when performing statistical analyses of data sets large and small. The juxtaposition of concepts and practical implementation in coursework results in lasting understanding.

BA majors take one credit and BS majors take two credits: across at least two of three categories: **Physics Lab**, **Biochemistry Lab** and **Critical Tools**. One or more courses (at least ½ credit) must be from MB&B. Courses that can be used to satisfy more than one category may not be double counted.

- **Physics Lab:** MB&B 121L, 124L 364, 470/471*, PHYS 165L, 166L, CHEM 355L and others with **DUS approval** (see below).
- **Biochemistry Lab:** MB&B 251L, 364, 470/471*, CHEM 355L, others including MCDB/EEB/BENG 200+ lab courses with **DUS approval**.
- **Critical Tools:** MB&B 435, 470/471*, S&DS 100+, 238, CPSC 100+ and others with **DUS approval** (see below).

BS/MS majors: Practical Skills are incorporated into the senior requirement

*This is research for credit coursework. Up to two credits may be taken for a letter grade. Categorization of the coursework into one of the three skills is dependent on your project and/or the lab in which your project is conducted.

Electives

Seminar or lecture-based coursework as follows:

BA majors: one 200+ level in MB&B

BS majors: one 200+ level in STEM and one 200+ level in MB&B

BS/MS majors: Two 500+ level* seminar or lecture credits in MB&B plus
Four 500+ level* seminar or lecture credits in natural science, math, statistics or engineering. Note, many graduate courses are ½ semester modules. It is common for more than six courses to be used to reach six credits.

IMPORTANT:

- A maximum of two of the 6 may be double counted towards fulfilling both the BS and MS degree requirements.
- Undergraduate (100-400) course that also hold graduate (500+) numbers cannot be retroactively changed. Students considering BS/MS are strongly encouraged to sign up using the graduate number.
- Most but NOT ALL graduate courses count towards fulfillment of these electives. The DUS must explicitly approve the use of any 500+ level course for fulfillment of the BS/MS elective requirements. Requests for approval should be sent to DUS by your academic advisor.

Senior Requirements

BA and BS majors: MB&B 490/491 is a one credit course that culminates in the writing of a thesis in the fall or spring term of senior year.

BS/MS majors: Completion of 5 credits of research for credit. All 5 credits of research are expected to take place within the same lab and culminate in a 50-page thesis and a public oral defense during reading period of your final semester.

- **MB&B 470 or 471** is required by the end of fall semester of junior year as a prerequisite for application to the program.
- **MB&B 570 and 571** is taken during senior year.

Concentrations

Concentrations in MB&B are sets of electives, curated by faculty, designed to focus attention onto specific subfields of Molecular Biophysics and Biochemistry. Concentrations appear on a student's official Yale transcript and are currently available in **Biophysics and Structural Biology**, **Chemical Biology**, **Computational Biology and Bioinformatics**, **Medicine**, **Biochemistry** and **Environment & Climate Change**.

Electives for concentrations can be used to fulfill the total of 3.5 elective credits for BA majors and 6.5 elective credits for the BS major. In other words, electives for concentrations can be freely double counted with electives for the BA or BS degrees. For example, a BS major concentrating in **Medicine** must fulfill one course in statistics. S&DS 220 can fulfill the concentration's requirement and also count as a 200+ level STEM elective for the major.

For BS/MS majors, electives for the concentration apply only to the BS. A maximum of two electives may be double counted towards fulfilling both the BS and MS portions of the degree:

The complete space of electives for BA and BS majors can be summarized as follows:

- CHEM 200+ or CHEM 175
1 credit BA, BS
- 300+ in physical sci, physical engineering, math, statistics, or computer sci.
1 credit BS
- Science and Society
½ credit BA, BS
- Practical Skills
2 credit BS, 1 credit BA (1/2 credit of which must be in MB&B)
- STEM elective at 200+
1 credit BS
- MB&B elective at 200+
1 credit BA, BS

Placement exams and acceleration credits **do not** count towards completion of concentration-specific requirements. E.g. A BS Major who places out of 100-level statistics and is pursuing a concentration in **Computational Biology and Bioinformatics** is still expected to complete the concentration's requirement for 3 courses in MATH/S&DS/COMP.

Concentration in **Medicine**

The MB&B concentration in **Medicine** is designed for students with strong interests in the molecular basis of physiology and disease. MB&B offers a unique lens on these subjects as it was formed as a merger of the Yale Medical School Department of Biochemistry and the Yale College Department of Molecular Biophysics. MB&B faculty maintain labs in both schools (as well as West Campus) and instructs both Yale undergraduates and Yale medical school students. Majors aspiring to graduate studies in biomedical sciences, work in biotechnology or enter medical school are particularly encouraged to fulfill this concentration:

Requirements

Genetics and Development and Ecology and Evolution (1 credit): BIOL 103/104 or higher

Organic Chemistry (1 credit): Second term organic chemistry, CHEM 175 or CHEM 221
Accompanying lab is not required.

Statistics (1 credit): S&DS 100+ or (MATH 200+ in these subjects: linear algebra, probability, statistics or stochastic processes)

Psychology (1 credit): PSYC 110 or higher

Physics lab (2 courses totaling 1 credit or more): **MB&B 101L**, PHYS 165L, PHYS 166L or **MB&B 364** and others

Research (1 credit): Research for credit on a project focused on basic biological or biomedical research, **MB&B 470 or 471**. Alternatively, course-based undergraduate biomedical research experience (CURE), **MB&B 251L**, **MCDB 291L** and others. See **course substitutions** policy below.

Advanced (300+) Biomedical Lecture or Seminar (1 credit):

MB&B 449 Medical Impact of Basic Science
MB&B 445 Methods and Logic in Molecular Biology
MB&B 452 Biomedical Data Science, Mining and Modeling
BENG 350 Physiological Systems
MCDB 315 Pathobiology
MCDB 450 The Human Genome

Other choices for the above are encouraged and possible by petition.
See **course substitutions** policy below.

Note: The core BS major requires 12.5 credits while the core BA major requires 9.5 credits. For students with no advanced preparation in STEM, the concentration in **Medicine** (see sample schedules) can be completed with 2 additional credits over the core BS major and 3 additional credits over the core BA requirements.

Computational Biology & Bioinformatics

The MB&B concentration in **Computational Biology & Bioinformatics** is designed for students with a combination of strong interests in computer science, data science, statistics and biology. Majors aspiring to graduate studies in computational biology, bioinformatics, medical informatics or biotechnology are particularly encouraged to fulfill this concentration:

Requirements

Genetics and Evolutionary Biol (1 credit, BA): BIOL 103 and 104, or follow the BS guideline.

Genetics and Evolutionary Biol (1 credit, BS): A 200+ elective in genetics, molecular biology or evolutionary biology. This elective may be used in place of MB&B's requirement for a 200+ elective in Chemistry: MCDB 200, MCDB 202, MCDB 310, **MB&B 330** and others.

Computer Sci, Math, Stats (2 credits, BA): CPSC 201 and S&DS 100+

Computer Sci, Math, Stats (3 credits, BS): CPSC 201 and (S&DS 238 or S&DS 241) and (CPSC 223 or S&DS 265). CPSC 223 may be used to fulfill the 300+ elective requirement in physical sci, physical engineering, math, statistics, or computer sci.

Advanced (300+) Computational Biology & Bioinformatics (1 credit):

MB&B 452 Biomedical Data Science, Mining and Modeling

CPSC 453 Unsupervised Learning for Big Data

Other choices for the above are encouraged and possible by petition.
See **course substitutions** policy below.

Note: The core BS major requires 12.5 credits while the core BA major requires 9.5 credits. For students with no advanced preparation in STEM, the **Computational Biology & Bioinformatics** concentration (see sample schedules) can be completed with 3 additional credits over the core BS major and 3 additional credits over the core BA requirements.

Chemical Biology

Chemical Biology leverages the tools and concepts of chemistry to understand, leverage and/or manipulate biological processes. Students' interested in the MB&B concentration in **Chemical Biology** select electives from organic and inorganic chemistry as well as advanced courses in cell biology. Majors interested in additional studies in chemical biology, drug-development and/or biotechnology after graduation are particularly encouraged to fulfill this concentration:

Requirements

Organic Chemistry II (1.5 credits):

Second semester of organic chemistry with accompanying ½ credit lab.

Cell Biology and Chemistry (3 credits for BS):

2 x 200+ and 1 x 300+ electives in Chemistry or Cell Biology.

At least one of the credits must come from Cell Biology or Chemistry.

Cell Biology (1 credit for BA):

1 x 200+ electives in Cell-based biology

Research in Chemical Biology (1 credit): Research for credit on a Chemical Biology project (broadly interpreted), **MB&B 470 or 471**. Alternatively, **MB&B 364** or course-based undergraduate chemical biology research experience (CURE) by petition to DUS. See **course substitutions** policy below.

Advanced (300+) Chemical Biology Lecture or Seminar (1 credit):

MB&B 443 Advanced Eukaryotic Cell Biology

CHEM 419/424 Foundations of Chemical Biology I / II

Other choices for the above are encouraged and possible by petition.

See **course substitutions** policy below.

Note: The core BS major requires 12.5 credits while the core BA major requires 9.5 credits. The concentration in **Chemical Biology** (see sample schedules) can be completed with one additional credit requirement over the core BS major and two additional credits over the core BA requirements.

Biochemistry

The MB&B concentration in Biochemistry is geared towards students seeking robust training in structure and function of nucleic acids and proteins in the context of life processes. Molecular length scale biochemistry is foundational to the mechanisms by which dynamic networks of molecular machines enable everything from cellular function to whole organism physiology. Failures in these networks are responsible for pathology in plants and animals, agriculture and medicine. MB&B majors interested in working in these fields directly after graduation, or who hope to pursue graduate studies including PhD and MD/PhD are particularly encouraged to fulfill this concentration:

Requirements

Genetics and Development and Ecology and Evolution (1 credit): BIOL 103/104 or above.

Molecular, Cellular or Organismal Biology 200+ (1 credit): MCDB 205, MCDB 202 and others

Research in Biochemistry (1 credit): Research for credit on a project with biochemical emphasis (broadly interpreted), **MB&B 470 or 471**. Alternatively, course-based undergraduate research experience (CURE) in biochemistry by petition to DUS.

Advanced (300+) Biochemistry Lecture or Seminar (2 credits for BS, 1 credit for BA):

- MB&B 365** Biochemistry and our Changing Climate
- MB&B 330** Modeling Biological Systems
- MB&B 445** Methods & Logic in Molecular Biology
- MB&B 449** Medical Impact of Basic Research
- MB&B 443** Advanced Eukaryotic Cell Biology

Other choices for the above are encouraged and possible by petition.
See **course substitutions** policy below.

Note: The core BS major requires 12.5 credits while the core BA major requires 9.5 credits. For students with no advanced preparation in STEM, the concentration in **Biochemistry** (see sample schedules) can be completed with two additional credit requirements over the core BS major and 3 additional credits over the core BA requirements.

Environment and Climate Change

The MB&B concentration in Environment and Climate Change is geared towards students seeking robust training in life processes as they affect, and are affected by the environment, human activity and climate change. MB&B majors interested in working in these fields directly after graduation, or who hope to pursue graduate studies including PhD are particularly encouraged to fulfill this concentration:

Requirements

Physical Environmental Science 300+ (1 credit for BS and BS/MS)

May be used to fulfill 300+ requirement in physical/engineering sciences.

EVST 362	Observing Earth from Space	EPS 335	Physical Oceanography
EPS 310	Isotope Geochemistry	CHEM 332	Thermodynamics
EPS 323	Climate Dynamics	CHEM 333	Quantum Mechanics

Environmental Chemistry 200+ (1 credit for BA, BS and BS/MS)

May be used to fulfill 200+ elective requirement in Chemistry

EVST 307	Organic Pollutants in the Env.	CHEM 252	Inorganic Chemistry
EPS 310	Isotope Geochemistry	ENVE 438	Environmental Org Chemistry

Math, Statistics and/or Computer Science (1 credit for BA, BS and BS/MS)

May be used to fulfill one credit of practical skills requirement for BA and BS

Math 120/121/222 or higher, S&DS 100+ or CPSC 100+
--

Ecology and Evolution 100+ (1 credit for BA, BS and BS/MS)

Courses at 200+ may be used to fulfill 200+ STEM requirement for BS

BIOL 104	Principles of Ecology and Evolutionary Biology
E&EB 225	Evolutionary Biology
ANTH 267	Human Evolution

Environmental Sciences 100+ (1 credit for BA, BS and BS/MS)

Courses at 200+ may be used to fulfill 200+ STEM requirement for BS

CENG 120	Intro to Environmental Engineering	EPS 101	Climate Change
EPS 140	Atmosphere, Ocean & Climate Change	EVST 223	General Ecology
EVST 265	Environmental Geomicrobiology	EPS 125	History of Life
EPS 232	Earth Surface Processes	EPS 261	Minerals & Human Health

Advanced (300+) Environment Lecture or Seminar (2 credits for BS and BS/MS, 1 credit for BA)

MB&B 365 may be used to fulfill 200+ MB&B requirement for all degrees

MB&B 365	Biochemistry & our Changing Climate	ENVE 441	Bio Processes in Environmental Engineering
ENVE 464	Engineering Solutions to Climate Change	EPS 323	Climate dynamics
EVST 415	Biotechnology & Developing World	ENVE 360	Green Engineering and Sustainability
EPS 355	Extraordinary Glimpses of Past Life	ENVE 438	Environ. Organic Chem.

Other choices for the above are encouraged and possible by petition.

See **course substitutions** policy below.

Note: The core BS major requires 12.5 credits while the core BA major requires 9.5 credits. For students with no advanced preparation in STEM, the concentration in **Environment and Climate Change** (see sample schedules) can be completed with one additional credit requirements over the core BS and core BA requirements.

Biophysics and Structural Biology

The MB&B concentration in **Biophysics and Structural Biology** is designed for students with strong interests in life processes on the molecular length scale. Majors aspiring to graduate studies in biophysics, molecular medicine and biotechnology are particularly encouraged to fulfill this concentration.

Biophysics and Structural Biology are made possible by fundamental quantitative and physical tools such as linear algebra, Fourier analysis, x-ray diffraction, imaging and optical spectroscopy to measure biomolecular dynamics and atomic resolution structure. Seminar courses applicable to this area focus on the basic biology enabled by exquisitely specific macromolecular interactions, the molecular basis of disease and drug-design.

Requirements

Comp. Sci, Math, Statistics (1 credits, BS): MATH 120 or 121 or 225 or S&DS 238 or CPSC 112

Comp. Sci, Math, Statistics (1 credits, BA): MATH 120 or 121 or 225 or S&DS 100+ or CPSC 112

Biophysical Chemistry (1 credit, BS): CHEM 332 or **MB&B 431** or any 300+ elective in thermodynamics, statistical mech, quantum mechanics or spectroscopy.

Research in Biophysics and Structural Biology (1 credit): Research for credit on a solution biophysical or structural biology project (broadly interpreted), **MB&B 470 or 471**. Alternatively, CHEM 355, or course-based undergraduate biophysical or structural biology research experience (CURE) by petition. See **course substitutions** policy below.

Tools and Quantitative Analysis (1 credits, BS): 200+ course with emphasis on measurement and/or modeling of energy, kinetics, or structure relevant to the molecular length scale. **MB&B 330/420/431/435** , CHEM 333/406/492 and others

Advanced Biophysics and Structural Biology Lecture or Seminar (1 credit):

MB&B 420 Macromolecular Structure and Biophysical Analysis

MB&B 431 Illuminating Biomolecular Mechanism with Structure

MB&B 529 Structural Biology and Drug Discovery

Other choices for the above are encouraged and possible by petition.
See **course substitutions** policy below.

Note: The core BS major requires 12.5 credits while the core BA major requires 9.5 credits. For students with no advanced preparation in STEM, the concentration in **Biophysics and Structural Biology** (see sample schedules) can be completed with one additional credit requirements over the core BS major and 2 additional credits over the core BA requirements.

Policies and Procedures

Course Substitutions: Students may petition for course substitutions by assembling the relevant syllabi, writing a short justification (<300 words) and sending to their **MB&B academic advisor**. Requests in line with MB&Bs goals described above are always welcome.

Credit/D/Fail: To encourage BA and BS majors to explore more challenging coursework, students are welcome to complete one credit requirement as Credit/D/Fail. This will not affect your ability to graduate with distinction, but does count against Yale's limit of 6 total Credit/D/Fail courses. Qualifying courses must be 400+ in MB&B, and 300+ in any other STEM subject. For BS/MS students, all required coursework must be taken for a letter grade.

MB&B Academic Advisors: Students are assigned a member of MB&B faculty for academic advising as soon as they declare their major. Requests for change in advisor should be sent to the registrar via direct email (elizabeth.vellali@yale.edu). Justification is not required

DUS Approvals: DUS approvals for waivers, course substitutions, endorsement of petitions to the Committee on Honors and Academic Standing, applications to the BS/MS program etc, are initiated by an email of support from students' assigned **MB&B academic advisor**. The academic advisor functions as the student's advocate on requests to the DUS with the MB&B registrar giving oversight and interfacing with the University registrar. Very important: one-on-one meetings by majors with their **MB&B academic advisor** during every registration period are logged. Failures to schedule meetings and missed meetings are factored into the DUS approval process.

BS/MS Program: Students considering the BS/MS program are urged to follow its course requirements throughout their time at Yale. Entry to the program requires application to the department via a form downloadable from the MB&B web site and is due to the DUS by December 1st of your junior year. Factors affecting the success of your application are as follows:

1. A well-established relationship with a Yale research lab as evidenced by successful completion of MB&B 470 and/or MBB 471 by no later than fall term of junior year.
2. One or more of the following:
 - a. Completion of a summer (10-weeks) of full-time research in your intended dissertation lab, i.e. the lab in which you took or will take MB&B 470/471
 - b. Completion of a summer (10-weeks) of full-time research at any University, industry or govt research lab during a summer after matriculating at Yale
 - c. Intent to work in your Yale-based dissertation lab during the summer of your junior year, endorsed explicitly by your research supervisor.
3. Written personal motivation for pursuing the dual degree and at least one meeting to discuss this with your MB&B academic advisor.
4. Endorsement of your application by your MB&B academic advisor.
5. Endorsement of your application by your research supervisor.
6. Endorsement of your application by the instructor in charge of MBB 470/471

Successful applicants will be invited by the DUS to apply directly to the Yale Graduate School in

Sample Schedules

Available below and online are sample student schedules for hypothetical students who arrive at Yale with no advanced preparation. For perspective:

About 1/3 of MB&B students place out of General Chemistry

About 4/5 of MB&B students place out of Calculus I.

Bachelor of Science (BA) in Molecular Biophysics & Biochemistry

Sample schedule without concentration				Credits							Additional Elements			
				Core Elements				Additional Requirements			Practical Skills			
				Introductory	Biophysics (4)	Biochemistry (3)	Science & Society (0.5)	Practical Skills (2)	Electives at 200+ (1+1)	Senior Req. (1)	2+ categories, (P,B,C) ?	≥ 0.5 credit in MB&B?	Cr/D/F (0 or 1 only)	
Term	Dept	#	Name											
Fall	CHEM	161	<i>General Chemistry I</i>	1										
	CHEM	134L	<i>General Chemistry I Lab</i>	0.5										
	MATH	112	<i>Calculus I</i>	1										
	BIOL	101	<i>Biochemistry and Biophysics</i>	0.5										
	BIOL	102	<i>Cell Bio & Membrane Physiology</i>	0.5										
				Credit Load: 3.5										
Spring	CHEM	165	<i>General Chemistry II</i>	1										
	CHEM	136L	<i>General Chemistry II Lab</i>	0.5										
	MB&B	121L	Physics in Living Systems Lab I				0.5		P	0.5				
	MB&B	124L	Physics in Living Systems Lab IV				0.5		P	0.5				
				Credit Load: 2.5										
Fall	CHEM	220	Organic Chemistry	1										
	CHEM	222L	Lab for Organic Chemistry I	0.5										
	MB&B	275	Biology at the Molecular Level		1									
	MATH	115	<i>Calculus II</i>	1										
			Credit Load: 2.5											
Spring	CHEM	221	Organic Chemistry of Life Processes			1								
	MB&B	268	Identity, Society, and STEM			0.5								
			Credit Load: 1.5											
Fall	PHYS	170	University Physics: Life Sciences		1									
	MB&B	300	Principles of Biochemistry I			1								
			Credit Load: 2											
Spring	PHYS	171	University Physics: Life Sciences		1									
	MB&B	301	Principles of Biochemistry II			1								
			Credit Load: 2											
	MB&B	449	Medical Impact of Basic Research (Credit/D eligible)					1						
			Credit Load: 1											
Spring	MB&B	490	Senior Project						1					
			Credit Load: 1											

Italicized courses have placement exams or other mechanisms for placing out depending on prior knowledge.

Bachelor of Science (BS) in Molecular Biophysics & Biochemistry

Sample schedule without concentration				Credits							Additional Elements			
				Core Elements				Additional Requirements			Practical Skills			
				Introductory	Biophysics (4)	Biochemistry (3)	Science & Society (0.5)	Practical Skills (2)	Electives at 200+ (1+1)	Senior Req. (1)	2+ categories, (P,B,C) ?	≥ 0.5 credit in MB&B?		
Term	Dept	#	Name											
Fall	CHEM	161	<i>General Chemistry I</i>	1										
	CHEM	134L	<i>General Chemistry I Lab</i>	0.5										
	MATH	112	<i>Calculus I</i>	1										
	BIOL	101	<i>Biochemistry and Biophysics</i>	0.5										
	BIOL	102	<i>Cell Bio & Membrane Physiology</i>	0.5										
	Credit Load: 3.5													
Spring	CHEM	165	<i>General Chemistry II</i>	1										
	CHEM	136L	<i>General Chemistry II Lab</i>	0.5										
	MB&B	121L	Physics in Living Systems Lab I				0.5		P	0.5				
	MB&B	124L	Physics in Living Systems Lab IV				0.5		P	0.5				
	Credit Load: 3.5													
Fall	CHEM	220	Organic Chemistry	1										
	CHEM	222L	Lab for Organic Chemistry I	0.5										
	MB&B	275	Biology at the Molecular Level		1									
	MATH	115	<i>Calculus II</i>	1										
	Credit Load: 3.5													
Spring	CHEM	221	Organic Chemistry of Life Processes			1								
	MB&B	268	Identity, Society, and STEM				0.5							
	MB&B	470	Research in Biochem & Biophys				1		B	1				
	Credit Load: 3.5													
Fall	PHYS	170	University Physics: Life Sciences		1									
	MB&B	300	Principles of Biochemistry I			1								
	Credit Load: 3													
Spring	PHYS	171	University Physics: Life Sciences		1									
	MB&B	301	Principles of Biochemistry II			1								
	Credit Load: 2													
Fall	CHEM	332	Physical Chemistry I (Credit/D eligible)		1							1		
	MB&B	449	Medical Impact of Basic Research (Credit/D eligible)					1						
	Credit Load: 2													
Spring	MB&B	490	Senior Project						1					
	MB&B	445	Methods & Logic in Molecular Biology (Credit/D eligible)					1						
	Credit Load: 2													

Italicized courses have placement exams or other mechanisms for placing out depending on prior knowledge.

Bachelor of Arts (BA) in Molecular Biophysics & Biochemistry

Sample Schedule for Concentration in:				Credits						Additional Elements					
				Core Elements				Additional Requirements		Practical Skills		Concentration Specific			
				Introductory	Biophysics (3)	Biochemistry (3)	Science & Society (0.5)	Practical Skills (1)	MB&B 200+ Elective (1)	Senior Req. (1)	2+ categories, (P,B,C) ?	≥ 0.5 credit in MB&B?	Gen Dev Eco Evo Bio (1)	Molecular, Cell or Organismal Bio (1)	Research or CURE (1)
Term	Dept	#	Name												
Fall	CHEM	161	<i>General Chemistry I</i>	1											
	CHEM	134L	<i>General Chemistry I Lab</i>	0.5											
	MATH	112	<i>Calculus I</i>	1											
	BIOL	101	<i>Biochemistry and Biophysics</i>	0.5											
	BIOL	102	<i>Cell Bio & Membrane Physiology</i>	0.5											
				Credit Load: 3.5											
Spring	CHEM	165	<i>General Chemistry II</i>	1											
	CHEM	136L	<i>General Chemistry II Lab</i>	0.5											
	BIOL	103	<i>Genetics & Development</i>							0.5					
	BIOL	104	<i>Ecology & Evolution</i>							0.5					
	MB&B	121L	Physics in Living Systems Lab I				0.5		P	0.5					
	MB&B	124L	Physics in Living Systems Lab IV				0.5		P	0.5					
			Credit Load: 3.5												
Fall	CHEM	220	Organic Chemistry	1											
	CHEM	222L	Lab for Organic Chemistry I	0.5											
	MB&B	275	Biology at the Molecular Level		1										
	MATH	115	<i>Calculus II</i>	1											
			Credit Load: 3.5												
Spring	MB&B	268	Identity, Society, and STEM			0.5									
	MB&B	470	Research in Biochem & Biophys				1		B	1		1			
			Credit Load: 1.5												
Fall	PHYS	170	University Physics: Life Sciences		1										
	MB&B	300	Principles of Biochemistry I			1									
	CHEM	252	Introductory Inorganic Chemistry			1									
			Credit Load: 3												
Spring	PHYS	171	University Physics: Life Sciences		1										
	MCDB	205	Cell Biology								1				
	MB&B	301	Principles of Biochemistry II			1									
			Credit Load: 3												
Fall	MB&B	365	Biochemistry and our Changing Climate					1					1		
			Credit Load: 1												
Spring	MB&B	490	Senior Project						1						
			Credit Load: 1												

Italicized courses have placement exams or other mechanisms for placing out depending on prior knowledge.

Bachelor of Science (BS) in Molecular Biophysics & Biochemistry

Sample Schedule for Concentration in: Biochemistry				Credits						Additional Elements				
				Core Elements				Additional Requirements		Practical Skills		Concentration Specific		
				Introductory	Biophysics (4)	Biochemistry (3)	Science & Society (0.5)	Practical Skills (2)	Electives at 200+ (1+1)	Senior Req. (1)	2+ categories, (P,B,C) ?	≥ 0.5 credit in MB&B?	Gen Dev Eco Evo Bio (1)	Molecular, Cell or Organismal Bio (1)
Term	Dept	#	Name											
Fall	CHEM	161	<i>General Chemistry I</i>	1										
	CHEM	134L	<i>General Chemistry I Lab</i>	0.5										
	MATH	112	<i>Calculus I</i>	1										
	BIOL	101	<i>Biochemistry and Biophysics</i>	0.5										
	BIOL	102	<i>Cell Bio & Membrane Physiology</i>	0.5										
			Credit Load: 3.5											
Spring	CHEM	165	<i>General Chemistry II</i>	1										
	CHEM	136L	<i>General Chemistry II Lab</i>	0.5										
	BIOL	103	<i>Genetics & Development</i>							0.5				
	BIOL	104	<i>Ecology & Evolution</i>							0.5				
	MB&B	121L	Physics in Living Systems Lab I				0.5		P	0.5				
	MB&B	124L	Physics in Living Systems Lab IV				0.5		P	0.5				
			Credit Load: 3.5											
Fall	CHEM	220	Organic Chemistry	1										
	CHEM	222L	Lab for Organic Chemistry I	0.5										
	MB&B	275	Biology at the Molecular Level		1									
	MATH	115	<i>Calculus II</i>	1										
			Credit Load: 2.5											
Spring	MB&B	268	Identity, Society, and STEM			0.5								
	MB&B	470	Research in Biochem & Biophys				1		B	1		1		
			Credit Load: 1.5											
Fall	PHYS	170	University Physics: Life Sciences		1									
	MB&B	300	Principles of Biochemistry I			1								
	CHEM	252	Introductory Inorganic Chemistry			1								
			Credit Load: 3											
Spring	PHYS	171	University Physics: Life Sciences		1									
	MCDB	205	Cell Biology								1			
	MB&B	301	Principles of Biochemistry II			1								
			Credit Load: 3											
Fall	MB&B	365	Biochemistry and our Changing Climate					1					1	
	CHEM	332	Physical Chemistry I (Credit/D eligible)*		1									1
			Credit Load: 2											
Spring	MB&B	490	Senior Project						1					
	MB&B	445	Methods & Logic in Molecular Biology (Credit/D eligible)*					1					1	
			Credit Load: 2											

Italicized courses have placement exams or other mechanisms for placing out depending on prior knowledge.

Bachelor of Science (BA) in Molecular Biophysics & Biochemistry

Sample Schedule for Concentration in: Biophysics and Structural Biology				Credits						Additional Elements					
				Core Elements				Additional Requirements		Practical Skills		Concentration Specific			
				Introductory	Biophysics (3)	Biochemistry (3)	Science & Society (0.5)	Practical Skills (1)	MB&B 200+ Elective (1)	Senior Req. (1)	2+ categories, (P,B,C) ?	≥ 0.5 credit in MB&B?	Comp Sci Math Stats (1)	Research or CURE (1)	Advanced Biophysics Lecture or Seminar (1)
Term	Dept	#	Name												
Fall	CHEM	161	<i>General Chemistry I</i>	1											
	CHEM	134L	<i>General Chemistry I Lab</i>	0.5											
	MATH	112	<i>Calculus I</i>	1											
	BIOL	101	<i>Biochemistry and Biophysics</i>	0.5											
	BIOL	102	<i>Cell Bio & Membrane Physiology</i>	0.5											
				Credit Load: 3.5											
Spring	CHEM	165	<i>General Chemistry II</i>	1											
	CHEM	136L	<i>General Chemistry II Lab</i>	0.5											
	MATH	115	<i>Calculus II</i>	1											
	MB&B	121L	Physics in Living Systems Lab I				0.5		P	0.5					
	MB&B	124L	Physics in Living Systems Lab IV				0.5		P	0.5					
				Credit Load: 3.5											
Fall	CHEM	220	Organic Chemistry	1											
	CHEM	222L	Lab for Organic Chemistry I	0.5											
	MB&B	275	Biology at the Molecular Level		1										
	MATH	115	<i>Calculus II</i>	1											
				Credit Load: 3.5											
Spring	MB&B	268	Identity, Society, and STEM			0.5									
	MATH	225	Linear Algebra				1			1					
	MB&B	470	Research in Biochem & Biophys				1		B	1	1				
				Credit Load: 2.5											
Fall	PHYS	170	University Physics: Life Sciences		1										
	MB&B	300	Principles of Biochemistry I			1									
			Credit Load: 2												
Spring	PHYS	171	University Physics: Life Sciences		1										
	MB&B	301	Principles of Biochemistry II			1									
			Credit Load: 2												
Fall	CHEM	252	Introductory Inorganic Chemistry			1									
			Credit Load: 1												
Spring	MB&B	490	Senior Project					1							
	MB&B	529	Structural Biology and Drug Discovery (Credit/D eligible)*					1				1			
			Credit Load: 2												

Italicized courses have placement exams or other mechanisms for placing out depending on prior knowledge.

Bachelor of Science (BS) in Molecular Biophysics & Biochemistry

Sample Schedule for Concentration in: Biophysics and Structural Biology				Credits						Additional Elements							
				Core Elements				Additional Requirements		Practical Skills		Concentration Specific					
				Introductory	Biophysics (4)	Biochemistry (3)	Science & Society (0.5)	Practical Skills (2)	Electives at 200+ (1+1)	Senior Req. (1)	2+ categories, (P,B,C) ?	≥ 0.5 credit in MB&B?	Comp Sci Math Stats (1)	Adv Tools & Quant Analysis (1)	Biophysical Chemistry (1)	Research or CURE (1)	Advanced Biophysics Lecture or Seminar (1)
Term	Dept	#	Name														
Fall	CHEM	161	<i>General Chemistry I</i>	1													
	CHEM	134L	<i>General Chemistry I Lab</i>	0.5													
	MATH	112	<i>Calculus I</i>	1													
	BIOL	101	<i>Biochemistry and Biophysics</i>	0.5													
	BIOL	102	<i>Cell Bio & Membrane Physiology</i>	0.5													
			Credit Load: 3.5														
Spring	CHEM	165	<i>General Chemistry II</i>	1													
	CHEM	136L	<i>General Chemistry II Lab</i>	0.5													
	MATH	115	<i>Calculus II</i>	1													
	MB&B	121L	Physics in Living Systems Lab I				0.5		P	0.5							
	MB&B	124L	Physics in Living Systems Lab IV				0.5		P	0.5							
			Credit Load: 3.5														
Fall	CHEM	220	Organic Chemistry	1													
	CHEM	222L	Lab for Organic Chemistry I	0.5													
	MB&B	275	Biology at the Molecular Level		1												
	MATH	115	<i>Calculus II</i>	1													
			Credit Load: 2.5														
Spring	MB&B	268	Identity, Society, and STEM			0.5											
	MATH	225	Linear Algebra				1			1							
	MB&B	470	Research in Biochem & Biophys				1		B	1			1				
			Credit Load: 2.5														
Fall	PHYS	170	University Physics: Life Sciences		1												
	MB&B	300	Principles of Biochemistry I			1											
	CHEM	252	Introductory Inorganic Chemistry			1											
			Credit Load: 3														
Spring	PHYS	171	University Physics: Life Sciences		1												
	MB&B	301	Principles of Biochemistry II			1											
			Credit Load: 2														
Fall	MB&B	435	Quantitative Approaches in Biophysics and Biochemistry (Credit/D eligible)*				1		C	1		1					
	CHEM	332	Physical Chemistry I (Credit/D eligible)*		1							1			1		
			Credit Load: 2														
Spring	MB&B	490	Senior Project					1									
	MB&B	529	Structural Biology and Drug Discovery (Credit/D eligible)*					1						1			
			Credit Load: 2														

Italicized courses have placement exams or other mechanisms for placing out depending on prior knowledge.

Bachelor of Arts (BA) in Molecular Biophysics & Biochemistry

Sample Schedule for Concentration in:				Credits							Additional Elements									
				Core Elements				Additional Requirements			Practical Skills		Concentration Specific							
				Introductory	Biophysics (3)	Biochemistry (3)	Science & Society (0.5)	Practical Skills (1)	MB&B 200+ Elective (1)	Senior Req. (1)	2+ categories, (P,B,C) ?	≥ 0.5 credit in MB&B?	Cell Biol (1)	Orgo II with Lab (1.5)	Research or CURE (1)	Chemical Biol Seminar (1)	Cr/D/F (0 or 1 only)			
Chemical Biology																				
Term	Dept	#	Name																	
Fall	CHEM	161	<i>General Chemistry I</i>	1																
	CHEM	134L	<i>General Chemistry I Lab</i>	0.5																
	MATH	112	<i>Calculus I</i>	1																
	BIOL	101	<i>Biochemistry and Biophysics</i>	0.5																
	BIOL	102	<i>Cell Bio & Membrane Physiology</i>	0.5																
				Credit Load: 3.5																
Spring	CHEM	165	<i>General Chemistry II</i>	1																
	CHEM	136L	<i>General Chemistry II Lab</i>	0.5																
	MCDB	205	Cell Biology										1							
				Credit Load: 2.5																
Fall	CHEM	220	Organic Chemistry	1																
	CHEM	222L	Lab for Organic Chemistry I	0.5																
	MB&B	275	Biology at the Molecular Level		1															
				Credit Load: 2.5																
Spring	CHEM	221	Organic Chemistry of Life Processes			1									1					
	CHEM	223L	Lab for Organic Chemistry II				0.5				P				0.5					
	MB&B	268	Identity, Society, and STEM				0.5													
	MATH	115	<i>Calculus II</i>	1																
				Credit Load: 3																
Fall	PHYS	170	University Physics: Life Sciences		1															
	MB&B	300	Principles of Biochemistry I			1														
	MB&B	364	Light Microscopy					1								1				
				Credit Load: 3																
Spring	PHYS	171	University Physics: Life Sciences		1															
	MB&B	251L	Laboratory for Biochemistry				0.5				B	0.5								
	MB&B	301	Principles of Biochemistry II			1														
				Credit Load: 2.5																
Fall	CHEM	419	Foundations of Chemical Biology I (Credit/D eligible)*			1													1	
			Credit Load: 1																	
Spring	MB&B	490	Senior Project							1										
			Credit Load: 1																	

Italicized courses have placement exams or other mechanisms for placing out depending on prior knowledge.

Bachelor of Science (BS) in Molecular Biophysics & Biochemistry

Sample Schedule for Concentration in: Chemical Biology				Credits						Additional Elements				
				Core Elements			Additional Requirements			Practical Skills		Concentration Specific		
				Introductory	Biophysics (4)	Biochemistry (3)	Science & Society (0.5)	Practical Skills (2)	Electives at 200+ (1+1)	Senior Req. (1)	2+ categories, (P,B,C) ?	≥ 0.5 credit in MB&B?	Chemistry and Cell Biol (3)	Orgo II with Lab (1.5)
Term	Dept	#	Name											
Fall	CHEM	161	<i>General Chemistry I</i>	1										
	CHEM	134L	<i>General Chemistry I Lab</i>	0.5										
	MATH	112	<i>Calculus I</i>	1										
	BIOL	101	<i>Biochemistry and Biophysics</i>	0.5										
	BIOL	102	<i>Cell Bio & Membrane Physiology</i>	0.5										
				Credit Load: 3.5										
Spring	CHEM	165	<i>General Chemistry II</i>	1										
	CHEM	136L	<i>General Chemistry II Lab</i>	0.5										
	MCDB	205	Cell Biology					1			1			
				Credit Load: 2.5										
Fall	CHEM	220	Organic Chemistry	1										
	CHEM	222L	Lab for Organic Chemistry I	0.5										
	MB&B	275	Biology at the Molecular Level		1									
	MATH	115	<i>Calculus II</i>	1										
				Credit Load: 2.5										
Spring	CHEM	221	Organic Chemistry of Life Processes			1						1		
	CHEM	223L	Lab for Organic Chemistry II				0.5			P		0.5		
	MB&B	268	Identity, Society, and STEM			0.5								
	MB&B	470	Research in Biochem & Biophys				1			B	1		1	
				Credit Load: 3										
Fall	PHYS	170	University Physics: Life Sciences		1									
	MB&B	300	Principles of Biochemistry I			1								
	CHEM	252	Introductory Inorganic Chemistry					1			1			
				Credit Load: 3										
Spring	PHYS	171	University Physics: Life Sciences		1									
	MCDB	345L	Exp. Techniques in Cell Biology				0.5			B				
	MB&B	301	Principles of Biochemistry II			1								
				Credit Load: 2.5										
Fall	CHEM	419	Foundations of Chemical Biology I (Credit/D eligible)*		1									1
				Credit Load: 1										
Spring	MB&B	490	Senior Project						1					
	MB&B	443	Adv Eukaryotic Molecular Biology (Credit/D eligible)*					1			1			
				Credit Load: 2										

Italicized courses have placement exams or other mechanisms for placing out depending on prior knowledge.

Bachelor of Arts (BA) in Molecular Biophysics & Biochemistry

Sample Schedule for Concentration in:				Credits							Additional Elements							
				Core Elements				Additional Requirements			Practical Skills							
				Introductory	Biophysics (3)	Biochemistry (3)	Science & Society (0.5)	Practical Skills (1)	MB&B 200+ Elective (1)	Senior Req. (1)	2+ categories, (P,B,C) ?	≥ 0.5 credit in MB&B?	Environ Chem 200+ (1)	Math/CPSC/S&DS (1)	Ecology/Evolution 100+ (1)	Intro Env Sci 100+ (1)	Adv Env Sci 300+ (1)	Cr/DF (0 or 1 only)
Term	Dept	#	Name															
Fall	CHEM	161	<i>General Chemistry I</i>	1														
	CHEM	134L	<i>General Chemistry I Lab</i>	0.5														
	MATH	112	<i>Calculus I</i>	1														
	BIOL	101	<i>Biochemistry and Biophysics</i>	0.5														
	BIOL	102	<i>Cell Bio & Membrane Physiology</i>	0.5														
				Credit Load: 3.5														
Spring	CHEM	165	<i>General Chemistry II</i>	1														
	CHEM	136L	<i>General Chemistry II Lab</i>	0.5														
	MATH	115	<i>Calculus II</i>	1														
	MB&B	124L	Physics in Living Systems Lab IV				0.5		P	0.5								
				Credit Load: 3														
Fall	CHEM	220	Organic Chemistry	1														
	CHEM	222L	Lab for Organic Chemistry I	0.5														
	MB&B	275	Biology at the Molecular Level		1													
	BIOL	103	<i>Genetics & Development</i>									0.5						
	BIOL	104	<i>Ecology & Evolution</i>									0.5						
				Credit Load: 3.5														
Spring	MB&B	268	Identity, Society, and STEM				0.5											
	S&DS	100+	Intro to Statistics					1		C			1					
	EPS	140	Atmosphere Ocean & Climate Change											1				
				Credit Load: 2.5														
Fall	PHYS	170	University Physics: Life Sciences		1													
	MB&B	300	Principles of Biochemistry I			1												
	CHEM	252	Introductory Inorganic Chemistry			1						1						
				Credit Load: 3														
Spring	PHYS	171	University Physics: Life Sciences		1													
	MB&B	365	Biochemistry & Our Changing Climate							1					1			
	MB&B	301	Principles of Biochemistry II			1												
				Credit Load: 3														
Fall			Credit Load: 0															
Spring	MB&B	490	Senior Project							1								
			Credit Load: 1															

Italicized courses have placement exams or other mechanisms for placing out depending on prior knowledge.

Bachelor of Science (BS) in Molecular Biophysics & Biochemistry

Sample Schedule for Concentration in: Environment & Climate Change				Credits						Additional Elements							
				Core Elements				Additional Requirements		Practical Skills		Concentration Specific					
				Introductory	Biophysics (4)	Biochemistry (3)	Science & Society (0.5)	Practical Skills (2)	Electives at 200+ (1+1)	Senior Req. (1)	2+ categories, (P,B,C) ?	≥ 0.5 credit in MB&B?	Phys Environ Sci 300+ (1)	Environ Chem 200+ (1)	Math/CPSC/S&DS (1)	Ecology/Evolution 100+ (1)	Intro Env Sci 100+ (1)
Term	Dept	#	Name														
Fall	CHEM	161	<i>General Chemistry I</i>	1													
	CHEM	134L	<i>General Chemistry I Lab</i>	0.5													
	MATH	112	<i>Calculus I</i>	1													
	BIOL	101	<i>Biochemistry and Biophysics</i>	0.5													
	BIOL	102	<i>Cell Bio & Membrane Physiology</i>	0.5													
	Credit Load: 3.5																
Spring	CHEM	165	<i>General Chemistry II</i>	1													
	CHEM	136L	<i>General Chemistry II Lab</i>	0.5													
	MATH	115	<i>Calculus II</i>	1													
	MB&B	121L	Physics in Living Systems Lab I				0.5		P	0.5							
	MB&B	124L	Physics in Living Systems Lab IV				0.5		P	0.5							
	Credit Load: 3.5																
Fall	CHEM	220	Organic Chemistry	1													
	CHEM	222L	Lab for Organic Chemistry I	0.5													
	MB&B	275	Biology at the Molecular Level		1												
	BIOL	103	<i>Genetics & Development</i>									0.5					
	BIOL	104	<i>Ecology & Evolution</i>									0.5					
	Credit Load: 3.5																
Spring	MB&B	268	Identity, Society, and STEM				0.5										
	MATH	225	Linear Algebra				1		C			1					
	EPS	140	Athmosphere Ocean & Climate Change										1				
	Credit Load: 2.5																
Fall	PHYS	170	University Physics: Life Sciences		1												
	MB&B	300	Principles of Biochemistry I			1											
	CHEM	252	Introductory Inorganic Chemistry			1					1						
	Credit Load: 3																
Spring	PHYS	171	University Physics: Life Sciences		1												
	MB&B	365	Biochemistry & Our Changing Climate					1							1		
	MB&B	301	Principles of Biochemistry II			1											
	Credit Load: 3																
Fall	ENV	441	Biological Processes in Environmental Engineering (Credit/D eligible)					1							1		
	Credit Load: 1																
Spring	MB&B	490	Senior Project							1							
	EVST	362	Observing Earth from Space (Credit/D eligible)		1						1						
	Credit Load: 2																

Italicized courses have placement exams or other mechanisms for placing out depending on prior knowledge.

Bachelor of Arts (BA) in Molecular Biophysics & Biochemistry

Sample Schedule for Concentration in: Computational Biology & Bioinformatics				Credits						Additional Elements					
				Core Elements				Additional Requirements		Practical Skills		Concentration Specific			
				Introductory	Biophysics (3)	Biochemistry (3)	Science & Society (0.5)	Practical Skills (1)	MB&B 200+ Elective (1)	Senior Req. (1)	2+ categories, (P,B,C) ?	≥ 0.5 credit in MB&B?	Genetics & Evolution (1)	MATH / S&DS / CPSC (2)	Adv. Computational Biology (1)
Term	Dept	#	Name												
Fall	CHEM	161	<i>General Chemistry I</i>	1											
	CHEM	134L	<i>General Chemistry I Lab</i>	0.5											
	MATH	112	<i>Calculus I</i>	1											
	BIOL	101	<i>Biochemistry and Biophysics</i>	0.5											
	BIOL	102	<i>Cell Bio & Membrane Physiology</i>	0.5											
				Credit Load: 3.5											
Spring	CHEM	165	<i>General Chemistry II</i>	1											
	CHEM	136L	<i>General Chemistry II Lab</i>	0.5											
	MATH	115	<i>Calculus II</i>	1											
	CPSC	112	<i>Introduction to Programming</i>												
				Credit Load: 3.5											
Fall	CHEM	220	Organic Chemistry	1											
	CHEM	222L	Lab for Organic Chemistry I	0.5											
	MB&B	275	Biology at the Molecular Level		1										
	S&DS	105	Intro to Statistics: Medicine				1		C		1				
				Credit Load: 3.5											
Spring	MB&B	268	Identity, Society, and STEM			0.5									
	BIOL	103	Genetics & Development							0.5					
	BIOL	104	Ecology & Evolution							0.5					
	CPSC	201	Introduction to Computer Science								1				
				Credit Load: 2.5											
Fall	PHYS	170	University Physics: Life Sciences		1										
	MB&B	300	Principles of Biochemistry I			1									
			Credit Load: 2												
Spring	PHYS	171	University Physics: Life Sciences		1										
	MB&B	301	Principles of Biochemistry II			1									
			Credit Load: 2												
Fall	CHEM	252	Introductory Inorganic Chemistry			1									
	MB&B	251L	Laboratory for Biochemistry				0.5		B	0.5					
			Credit Load: 1.5												
Spring	MB&B	490	Senior Project						1						
	MB&B	452	Biomed Data Sci, Mining & Modeling (Credit/D eligible)*					1				1			
			Credit Load: 2												

Italicized courses have placement exams or other mechanisms for placing out depending on prior knowledge.

Bachelor of Science (BS) in Molecular Biophysics & Biochemistry

Sample Schedule for Concentration in:				Credits						Additional Elements					
				Core Elements				Additional Requirements		Practical Skills		Concentration Specific			
				Introductory	Biophysics (4)	Biochemistry (3)	Science & Society (0.5)	Practical Skills (2)	Electives at 200+ (1+1)	Senior Req. (1)	2+ categories, (P,B,C) ?	≥ 0.5 credit in MB&B?	Genetics & Evolution (1)	MATH / S&DS / CPSC (3)	Adv. Computational Biology (1)
Computational Biology & Bioinformatics															
Term	Dept	#	Name												
Fall	CHEM	161	<i>General Chemistry I</i>	1											
	CHEM	134L	<i>General Chemistry I Lab</i>	0.5											
	MATH	112	<i>Calculus I</i>	1											
	BIOL	101	<i>Biochemistry and Biophysics</i>	0.5											
	BIOL	102	<i>Cell Bio & Membrane Physiology</i>	0.5											
				Credit Load: 3.5											
Spring	CHEM	165	<i>General Chemistry II</i>	1											
	CHEM	136L	<i>General Chemistry II Lab</i>	0.5											
	MATH	115	<i>Calculus II</i>	1											
	CPSC	112	<i>Introduction to Programming</i>	1											
				Credit Load: 3.5											
Fall	CHEM	220	<i>Organic Chemistry</i>	1											
	CHEM	222L	<i>Lab for Organic Chemistry I</i>	0.5											
	MB&B	275	<i>Biology at the Molecular Level</i>		1										
	BIOL	103	<i>Genetics & Development</i>	0.5											
	BIOL	104	<i>Ecology & Evolution</i>	0.5											
				Credit Load: 3.5											
Spring	MB&B	268	<i>Identity, Society, and STEM</i>			0.5									
	MCDB	200	<i>Molecular Biology</i>		1						1				
	MATH	120	<i>Multivariate Calculus</i>	1											
	CPSC	201	<i>Introduction to Computer Science</i>					1				1			
				Credit Load: 3.5											
Fall	PHYS	170	<i>University Physics: Life Sciences</i>		1										
	MB&B	300	<i>Principles of Biochemistry I</i>		1										
	S&DS	238	<i>Probability and Statistics</i>				1			C		1			
				Credit Load: 3											
Spring	PHYS	171	<i>University Physics: Life Sciences</i>		1										
	MB&B	301	<i>Principles of Biochemistry II</i>		1										
				Credit Load: 2											
Fall	CPSC	223	<i>Data Structures and Programming Techniques</i>		1							1			
	MB&B	251L	<i>Laboratory for Biochemistry</i>				0.5			B	0.5				
				Credit Load: 1.5											
Spring	MB&B	490	<i>Senior Project</i>						1						
	MCDB	291L	<i>Laboratory for Microbiology</i>				0.5			B					
	MB&B	452	<i>Biomed Data Sci, Mining & Modeling (Credit/D eligible)*</i>					1					1		
				Credit Load: 2.5											

Italicized courses have placement exams or other mechanisms for placing out depending on prior knowledge.

Bachelor of Arts (BA) in Molecular Biophysics & Biochemistry

Sample Schedule for Concentration in:				Credits							Additional Elements										
				Medicine				Core Elements			Additional Requirements				Practical Skills	Concentration Specific					
								Introductory	Biophysics (3)	Biochemistry (3)	Science & Society (0.5)	Practical Skills (1)	MB&B 200+ Elective (1)	Senior Req. (1)	2+ categories, (P,B,C) ?	≥ 0.5 credit in MB&B?	Gen Dev Eco Evo Bio (1)	Organic Chemistry II (1)	Statistics (1)	Psychology (1)	Physics lab (1)
Term	Dept	#	Name																		
Fall	CHEM	161	<i>General Chemistry I</i>	1																	
	CHEM	134L	<i>General Chemistry I Lab</i>	0.5																	
	MATH	112	<i>Calculus I</i>	1																	
	BIOL	101	<i>Biochemistry and Biophysics</i>	0.5																	
	BIOL	102	<i>Cell Bio & Membrane Physiology</i>	0.5																	
				Credit Load: 3.5																	
Spring	CHEM	165	<i>General Chemistry II</i>	1																	
	CHEM	136L	<i>General Chemistry II Lab</i>	0.5																	
	BIOL	103	<i>Genetics & Development</i>									0.5									
	BIOL	104	<i>Ecology & Evolution</i>									0.5									
	MB&B	121L	Physics in Living Systems Lab I					0.5		P	0.5					0.5					
	MB&B	124L	Physics in Living Systems Lab IV					0.5		P	0.5					0.5					
			Credit Load: 3.5																		
Fall	CHEM	220	<i>Organic Chemistry</i>	1																	
	CHEM	222L	<i>Lab for Organic Chemistry I</i>	0.5																	
	MB&B	275	Biology at the Molecular Level		1																
	MATH	115	<i>Calculus II</i>	1																	
				Credit Load: 2.5																	
Spring	CHEM	221	Organic Chemistry of Life Processes			1							1								
	MB&B	268	Identity, Society, and STEM				0.5														
	MB&B	470	Research in Biochem & Biophys					1		B	1						1				
	S&DS	105	Intro to Statistics: Medicine					1		C				1							
				Credit Load: 3.5																	
Fall	PHYS	170	University Physics: Life Sciences		1																
	MB&B	300	Principles of Biochemistry I			1															
	PSYC	110	Introduction to Psychology											1							
				Credit Load: 3																	
Spring	PHYS	171	University Physics: Life Sciences		1																
	MB&B	301	Principles of Biochemistry II			1															
				Credit Load: 2																	
Fall	MB&B	449	Medical Impact of Basic Research (Credit/D eligible)*								1							1			
				Credit Load: 1																	
Spring	MB&B	490	Senior Project								1										
				Credit Load: 1																	

Italicized courses have placement exams or other mechanisms for placing out depending on prior knowledge.

Bachelor of Science (BS) in Molecular Biophysics & Biochemistry

Sample Schedule for Concentration in: Medicine				Credits						Additional Elements									
				Core Elements				Additional Requirements		Practical Skills		Concentration Specific							
				Introductory	Biophysics (4)	Biochemistry (3)	Science & Society (0.5)	Practical Skills (2)	Electives at 200+ (1+1)	Senior Req. (1)	2+ categories, (P,B,C) ?	≥ 0.5 credit in MB&B?	Gen Dev Eco Evo Bio (1)	Organic Chemistry II (1)	Statistics (1)	Psychology (1)	Physics lab (1)	Research or CURE (1)	Biomedical Seminar (1)
Term	Dept	#	Name																
Fall	CHEM	161	<i>General Chemistry I</i>	1															
	CHEM	134L	<i>General Chemistry I Lab</i>	0.5															
	BIOL	101	<i>Biochemistry and Biophysics</i>	0.5															
	BIOL	102	<i>Cell Bio & Membrane Physiology</i>	0.5															
	MATH	112	<i>Calculus I</i>	1															
			Credit Load: 3.5																
Spring	CHEM	165	<i>General Chemistry II</i>	1															
	CHEM	136L	<i>General Chemistry II Lab</i>	0.5															
	MB&B	121L	Physics in Living Systems Lab I			0.5		P	0.5					0.5					
	MB&B	124L	Physics in Living Systems Lab IV			0.5		P	0.5					0.5					
			Credit Load: 2.5																
Fall	CHEM	220	Organic Chemistry	1															
	CHEM	222L	Lab for Organic Chemistry I	0.5															
	MB&B	275	Biology at the Molecular Level		1														
	MATH	116	<i>Math Models in the Biosciences I</i>	1															
			Credit Load: 3.5																
Spring	CHEM	221	Organic Chemistry of Life Processes			1					1								
	MB&B	268	Identity, Society, and STEM			0.5													
	MB&B	471	Research in Biochem & Biophys				1		B	1					1				
	BIOL	103	<i>Genetics & Development</i>								0.5								
	BIOL	104	<i>Ecology & Evolution</i>								0.5								
			Credit Load: 2.5																
Fall	PHYS	170	University Physics: Life Sciences		1														
	MB&B	300	Principles of Biochemistry I			1													
	S&DS	105	Intro to Statistics: Medicine				1		C			1							
			Credit Load: 3																
Spring	PHYS	171	University Physics: Life Sciences		1														
	MB&B	301	Principles of Biochemistry II			1													
			Credit Load: 2																
Fall	CHEM	332	Physical Chemistry I (Credit/D eligible)*		1												1		
	PSYC	110	Introduction to Psychology									1							
	MB&B	449	Medical Impact of Basic Research (Credit/D eligible)*					1								1			
			Credit Load: 3																
Spring	MB&B	490	Senior Project						1										
	MB&B	445	Methods & Logic in Molecular Biology (Credit/D eligible)*					1											
			Credit Load: 2																

Italicized courses have placement exams or other mechanisms for placing out depending on prior knowledge.