

# CHEMISTRY

## Overview and Contact Information

Chemistry is the study of the composition, synthesis, physical properties, and transformations of materials, including biological substances, technological materials, and natural products. The goals of the chemistry major are to give students a firm foundation in the fundamental principles of chemistry, its subdisciplines, and their interrelationships; to develop a proficiency in experimental technique, design, and interpretation; and to expose students to contemporary research questions and applications. This is accomplished through hands-on experience with modern instrumentation throughout the curriculum, a broad array of advanced course work, and engagement in active discussion and collaboration with the chemistry faculty.

## See Also

- Biochemistry (<http://catalog.mtholyoke.edu/areas-study/biochemistry>)
- Engineering (<http://catalog.mtholyoke.edu/areas-study/engineering>)
- Dual-Degree in Engineering (<http://catalog.mtholyoke.edu/other-programs/other-degree-certificate-programs>)

## Contact Information

Donald Cotter, Chair

Dina Bevivino, Academic Department Coordinator

G04 Carr Laboratory

413-538-2214

<https://www.mtholyoke.edu/acad/chemistry>

## Faculty

**This area of study is administered by the Department of Chemistry:**

Wei Chen, Marilyn Dawson Sarles, M.D. Professor of Life Sciences and Professor of Chemistry

Maria Gomez, Elizabeth Page Greenawalt Professor of Chemistry

Darren Hamilton, Professor of Chemistry, Teaching Fall Only

Donald Cotter, Associate Professor of Chemistry

Alan Van Giessen, Associate Professor of Chemistry

Katie Berry, Clare Boothe Luce Assistant Professor of Biochemistry

Kyle Broaders, Assistant Professor of Chemistry, On Leave 2017-2018

Kathryn McMenimen, Assistant Professor of Chemistry

Jonathan Ashby, Mount Holyoke Fellow; Visiting Lecturer in Chemistry

## Requirements for the Major

Recognizing that the physical sciences in general, and chemistry in particular, can be the starting point for a broad variety of career trajectories, the department offers two tracks to the chemistry major, sharing a common disciplinary core.

- Track A is a specialist track, designed as preparation for doctoral study.
- Students who want to focus their undergraduate education on the chemical sciences, but who are considering professions that

do not necessarily require a doctorate in the discipline—such as science studies, secondary school science teaching, science writing/journalism—may wish to consider Track B, a generalist track that encourages them to locate their subject-matter expertise in multiple contexts: within the sciences, within the current social matrix, and within the historical scope of human knowledge.

These courses of study are not mutually exclusive, and students following either as their principal route to the major are encouraged to consider incorporating some of the spirit of the other track into their educational program.

For advising purposes, a typical Plan of Study (p. 2), showing a recommended sequence of course-taking to complete the major is provided.

Independent work is encouraged and usually takes the form of work on a problem allied to the research interests of a faculty member, details of which are available from the chemistry department office and website (<https://www.mtholyoke.edu/acad/chemistry>). A number of Mount Holyoke College students participate in the department's summer research program (eight-ten weeks of paid, full-time research), a valuable addition to their education. Students may pursue independent work at any time in their Mount Holyoke careers. The department is extremely well equipped for research, including one high-field nuclear magnetic resonance (NMR) spectrometer, two atomic force microscopes (AFM), several gas (GC) and high performance liquid (HPLC) chromatographs, numerous infrared (IR), ultra-violet/visible (UV-Vis) and fluorescence spectrometers (XRF), in addition to specialized equipment for microwave promoted synthesis of peptides and organic molecules, calorimetry, dynamic light scattering, optical microscopy, electrochemistry and computational molecular modeling.

## Track A (Predoctoral)

A minimum of 48 credits:

MATH-101	Calculus I	4
MATH-102	Calculus II	4
PHYS-110	Force, Motion, and Energy	4
PHYS-201	Electromagnetism	4
<b>Core Courses in Chemistry</b>		
CHEM-101	General Chemistry I	4
or CHEM-160	Integrated Introduction to Biology and Chemistry	
CHEM-201	General Chemistry II	4
CHEM-202	Organic Chemistry I	4
CHEM-302	Organic Chemistry II	4
CHEM-308	Chemical Thermodynamics with Lab	4
CHEM-325	Atomic and Molecular Structure with Lab	4
8 or 12 credits in elective courses, at least four of which must be at the 300 level <sup>1</sup>		8-12
Total Credits		48-52

<sup>1</sup> PHYS-205, Introduction to Mathematical Methods for Scientists, can be counted as a chemistry elective

## Other Requirements for Track A

- Senior Symposium. An individual oral presentation at the annual Senior Symposium for those seniors taking CHEM-395.

## Additional Specifications for Track A

- Students planning graduate study in chemistry should be aware that some programs require additional background in mathematics and physics. Given the current emphasis on molecular biology in chemical research, students may also find course work in biology particularly valuable.

## Track B (Generalist/State of Massachusetts Secondary Teaching Licensure)

A minimum of 48 credits:

MATH-101	Calculus I	4
MATH-102	Calculus II	4
PHYS-110	Force, Motion, and Energy	4

### Core Courses in Chemistry

CHEM-101	General Chemistry I	4
or CHEM-160	Integrated Introduction to Biology and Chemistry	
CHEM-201	General Chemistry II	4
CHEM-202	Organic Chemistry I	4
CHEM-302	Organic Chemistry II	4
CHEM-308	Chemical Thermodynamics with Lab	4

Four additional courses which must include at least one from each of the following four categories: <sup>1</sup>

#### 1. Biochemistry:

CHEM-212	Chemistry of Biomolecules
CHEM-311	Protein Biochemistry and Cellular Metabolism
BIOCH-314	Nucleic Acids Biochemistry and Molecular Biology

#### 2. History and Philosophy of Science:

CST-248	Science, Revolution, and Modernity
---------	------------------------------------

#### 3. Earth and Environment:

ENVST-100	Introduction to Environmental Studies
Any 4-credit geology course	

#### 4. Biology:

BIOL-145	Introductory Biology <sup>2</sup>
BIOL-200	Introductory Biology II: How Organisms Develop

Total Credits 48

<sup>1</sup> Permission to use a course other than those listed here must be obtained from the department chair

<sup>2</sup> BIOL-145 or any of its offerings; for example BIOL-145AB, BIOL-145GW, etc.

## Other Requirements for Track B

- Senior Symposium. An individual oral presentation at the annual Senior Symposium for those seniors taking CHEM-395. This requirement may be waived for a student enrolled in EDUC-331, Student Teaching during the second semester of her senior year.

## ACS Certification of an Undergraduate Degree in Chemistry

The Department of Chemistry is approved by the American Chemical Society. The Committee on Professional Training of the American Chemical Society sets the criteria for approval of a chemistry program;

the chair of the approved program certifies annually those students who have met the curricular guidelines.

## Plan of Study for the Chemistry Major

The chemistry major can be pursued at several levels of intensity. To get to the junior and senior years and enjoy the greatest opportunity for advanced courses and independent work, the department recommends the following schedule for students entering the major at 101 and pursuing Track A.

### First Year

Fall	Credits Spring	Credits
CHEM-101 or 160	4 CHEM-201	4
MATH-101	4 MATH-102	4
		8

### Sophomore

Fall	Credits Spring	Credits
CHEM-202	4 CHEM-302	4
PHYS-110	4 PHYS-201	4
		8

### Junior

Fall	Credits Spring	Credits
CHEM-308	4 CHEM-325	4
		4

### Senior

Fall	Credits Spring	Credits
Additional electives and independent work	4-8 Additional electives and independent work	4-8
		4-8

Total Credits 48-56

- Students entering the major at CHEM-201 or CHEM-202 gain additional flexibility in planning their course work.
- Students who would like a chemistry major with a biochemical emphasis should consider including some or all of the following courses in their programs: CHEM-212, CHEM-311, and BIOCH-314. These students should note the biology prerequisites for CHEM-311 and BIOCH-314.

## Requirements for the Minor

A minimum of 16 credits:

At least 12 credits in chemistry at the 200 level or above	12
At least 4 credits in chemistry at the 300 level	4
Total Credits	16

Students interested in pursuing licensure in the field of chemistry can combine their course work in chemistry with a minor in education. In some instances course work in the major coincides with course work required for licensure; in other cases, it does not. For specific course requirements for licensure within the major of chemistry, please consult your advisor or the chair of the chemistry department. See further information in the catalog about the minor in education (<http://catalog.mtholyoke.edu/areas-study/psychology-education/#minortext>) and Teacher Licensure (<http://catalog.mtholyoke.edu/areas-study/>)

psychology-education/#teacherlicensuretextcontainer) and consult Ms. Lawrence in the psychology and education department.

Licensure requires a formal application as well as passing scores on the Massachusetts Test of Educator Licensure (MTEL) in both the literacy component and the subject matter component. Copies of the test objectives for the MTEL are available in the chemistry department and in the Department of Psychology and Education.

Additional information about the Licensure Program, including application materials, can be found on the Teacher Licensure Program website (<https://www.mtholyoke.edu/acad/teach>).

## Course Advice

### Choosing a First Chemistry Course

The chemistry department offers three points of entry into the curriculum. CHEM-101, General Chemistry I, is usually the first course for an entering Mount Holyoke student who has taken fewer than two years of high school chemistry. CHEM-101 provides such a student with an opportunity to develop her understanding of the foundations of reaction chemistry, thermochemistry, electronic structure, chemical bonding, and acid-base chemistry.

Students interested in studying biochemistry, or interested in satisfying pre-health requirements, may find it helpful to take both introductory biology and introductory chemistry in their first semester. BIOL-160 Integrated Introduction to Biology and Chemistry and CHEM-160 integrate topics from biology and chemistry to give an introduction to both disciplines. The 8-credit course has about six hours of lecture/discussion and one four-hour lab per week. The course prepares students to continue in both second semester chemistry (CHEM-201) and second semester biology (BIOL-200) in the spring semester.

Many students enter Mount Holyoke College with a substantial background in chemical principles. These students should strongly consider one of the chemistry department's 200-level courses. Such students include those who have taken two years of high school chemistry, completed A-level chemistry or the International Baccalaureate, taken the Advanced Placement examination in chemistry with a score of 4 or 5, or taken the Achievement Test in chemistry with a score of 650 or higher. CHEM-201, General Chemistry II, is usually the appropriate choice. In addition, one year of high school calculus with a grade of B or better is required for the fall version of CHEM-201. In this course, students extend their understanding of electronic structure, kinetics, equilibrium, spontaneity and electrochemistry. Special topics based on faculty interests and expertise are also introduced to provide context for discussion.

## Course Offerings

### CHEM-101 General Chemistry I

*Fall. Credits: 4*

This course provides introduction and development of fundamental concepts including stoichiometry, reactions in aqueous solutions, thermochemistry, atomic structure, chemical bonding, and acid-base reactions. The laboratory emphasizes basic skills, quantitative chemical measurements, and principles discussed in lectures.

*Applies to requirement(s): Math Sciences*

*J. Ashby, W. Chen, M. Gomez*

*Coreq: CHEM-101L.*

### CHEM-160 Integrated Introduction to Biology and Chemistry

*Fall. Credits: 4*

This 8-credit course serves as a gateway to both the biology and chemistry core curricula. The course introduces and develops fundamental concepts in chemistry while also exploring the diverse range of strategies adopted by living systems to survive in different environments. This course prepares students for further study in chemistry (Chemistry 201) and/or biology (Biology 200). Students must register for both Biology 160 and Chemistry 160 as well as a single lab section (listed under Chemistry 160). Recommended for students interested in completing pre-health requirements or advanced study in biochemistry or neuroscience.

*Applies to requirement(s): Math Sciences*

*A. van Giessen*

*Restrictions: This course is limited to first-year students.*

*Coreq: BIOL-160 and CHEM-160L.*

*Notes: Students must co-enroll in Biology 160 and Chemistry 160 for a total of 8 credits; three 50 minute lectures, three 75 minute lectures, and one three-hour laboratory per week.*

### CHEM-199 Introduction to Research

*Spring. Credits: 4*

This seminar is for first-year students who have a strong interest in the chemical sciences and will help to prepare them for scientific research. Students will be exposed to various research topics through reading, discussing, presenting, and writing about primary literature and attending selected department seminars. Throughout the semester students will carry out one research-style project in order to gain experience with the multifaceted nature of scientific inquiry. To jump start their research career on campus, each student will arrange meetings with at least two science faculty followed by a presentation and a written description on the faculty members' research topics.

*Applies to requirement(s): Meets No Distribution Requirement*

*W. Chen*

*Restrictions: This course is limited to first-year students.*

*Instructor permission required.*

*Prereq: MATH-101.*

*Advisory: Students must take Chemistry 201 concurrently.*

### CHEM-201 General Chemistry II

*Spring. Credits: 4*

This course provides background in basic principles of physical, analytical, and inorganic chemistry essential to the study of all chemical phenomena. Topics include elementary principles of molecular electronic structure, quantitative treatment of chemical equilibrium with applications to solubility, acid-base, and electron transfer reactions, introduction to chemical kinetics and thermodynamics, and the chemistry of coordination compounds. Laboratory experiments will include classical analytical and kinetic techniques, preparation of inorganic compounds, and an introduction to ab initio electronic structure calculations.

*Applies to requirement(s): Math Sciences*

*M. Gomez, A. van Giessen*

*Restrictions: This course is limited to First-year and Sophomore students.*

*Prereq: CHEM-101 or CHEM-160 with C or better grade. Coreq: CHEM-201L.*

**CHEM-202 Organic Chemistry I***Fall. Credits: 4*

Introduces organic chemistry, emphasizing the principles governing broad classes of reactions. Topics include stereochemistry, nucleophilic substitution and elimination reactions, the chemistry of alkanes, alkenes, alkynes, alcohols, and ethers, and an introduction to infrared and nuclear magnetic resonance spectroscopy. Laboratory work includes synthesis, practice in the techniques of distillation, crystallization, chromatography, molecular modeling, and identifying unknown organic compounds by chemical and spectroscopic means.

*Applies to requirement(s): Math Sciences**D. Hamilton, K. McMenimen**Prereq: CHEM-201 with grade of C or better. Coreq: CHEM-202L.***CHEM-208 Introduction to Materials***Not Scheduled for This Year. Credits: 4*

This course provides an introduction to different types of materials, including metals, ceramics, polymers and composites, emphasizing structure and property relationships. The principles behind the design and implementation of materials as well as advances in materials in the areas of nano-, bio- and electronic technology will be presented. Class time is split among lecture, discussion and laboratory.

*Applies to requirement(s): Math Sciences**W. Chen**Prereq: CHEM-201, PHYS-110, and MATH-101. Coreq: CHEM-208L.***CHEM-212 Chemistry of Biomolecules***Spring. Credits: 4*

An examination of the major ideas of biochemistry from the point of view of the chemical sciences rather than the life sciences. Structures of important biomolecules. The role of energetics and reaction dynamics in biochemical processes. Major metabolic pathways are considered, including those of proteins, carbohydrates, lipids, and nucleic acids.

*Applies to requirement(s): Math Sciences**K. McMenimen**Prereq: CHEM-202.**Notes: This course is not intended for Biochemistry majors, who must complete Biochemistry 311 and 314. First priority will be given to sophomores and juniors.***CHEM-213 Chemistry of Biomolecules with Lab***Not Scheduled for This Year. Credits: 4*

An examination of the major ideas of biochemistry from the point of view of the chemical sciences rather than the life sciences. Structures of important biomolecules. The role of energetics and reaction dynamics in biochemical processes. Major metabolic pathways are considered, including those of proteins, carbohydrates, lipids, and nucleic acids.

*Applies to requirement(s): Math Sciences**K. McMenimen**Prereq: CHEM-202. Coreq: CHEM-213L.**Notes: This course is not intended for Biochemistry majors, who must complete Biochemistry 311 and 314. First priority will be given to sophomores and juniors.***CHEM-223 Analytical Chemistry***Spring. Credits: 4*

This course serves as an introduction to quantitative analytical chemistry, with a combined emphasis on both classical analysis tools and fundamental instrumentation for the analytical chemist. Topics to be covered include figures of merit, statistical and error analysis, volumetric and gravimetric titrations, as well as commonly used sample preparation and analyte separation methods. In the laboratory, students will apply techniques covered in lecture to quantitation of analytes commonly seen in pharmaceutical, forensic, chemical and biological settings, as well as learn the fundamentals of method development and optimization.

*Applies to requirement(s): Math Sciences**J. Ashby**Prereq: CHEM-201. Coreq: CHEM-223L.***CHEM-224 Lab in Analytical Chemistry****CHEM-224AR Lab in Analytical Chemistry: 'Art Analysis'***Not Scheduled for This Year. Credits: 1*

This course introduces concepts of analytical chemistry under the theme of 'Chemistry in Art'. The topics of quantitative chemical analysis and instrumental analysis are discussed through hands-on observation based experiments in collaboration with the Mount Holyoke College art museum. Experimental techniques – such as gas chromatography, mass spectrometry, X-ray fluorescence, UV visible spectroscopy, infrared spectroscopy, and scanning electron microscopy – are incorporated for the analysis of paintings and art objects.

*Applies to requirement(s): Meets No Distribution Requirement**H. Jayathilake**Instructor permission required.**Prereq: CHEM-201 or 202 previously or concurrently.***CHEM-226 Poisons: Death by Chemistry***Fall. Credits: 4*

This course will look at the effect of poisons at the molecular, cellular, and physiological levels from the chemistry and biochemistry perspective. We will discuss: the classification of poisons and the common structural elements of the molecules within each class; the interaction of toxic molecules with proteins and nucleic acids present in the cell; the physiologic effect of toxins on different systems of the body; dosage effects and pharmacokinetics; the mechanisms by which antidotes work; and the analytical techniques that toxicologists use to determine which poisons are present in the body. The different classes of proteins will be discussed in the context of historical case studies.

*Applies to requirement(s): Math Sciences**A. van Giessen**Instructor permission required.**Prereq: CHEM-201 with grade of C or better.**Advisory: When emailing the instructor to request permission for this class, be sure to include your class year.***CHEM-231 Inorganic Chemistry***Fall. Credits: 4*

An introduction to the chemistry of elements. Topics include atomic structure and periodicity, symmetry, bonding theory, chemistry of the main-group elements and coordination chemistry. Laboratory introduces computational, preparative, and spectroscopic techniques.

*Applies to requirement(s): Math Sciences**D. Cotter**Prereq: CHEM-201. Coreq: CHEM-231L.*

**CHEM-295 Independent Study**

Fall and Spring. Credits: 1 - 4

The department

Instructor permission required.

Notes: Note: Students conducting an independent laboratory research project for course credit in a department, program, or laboratory covered by the College's chemical hygiene plan must participate in a safety training session before beginning research. Cou

**CHEM-302 Organic Chemistry II**

Spring. Credits: 4

A continuation of Chemistry 202 that addresses the chemistry of aromatic compounds, the carbonyl group, and a number of other functional groups. Examples drawn from compounds of biological interest. The laboratory includes organic synthesis and the identification of unknown compounds by chemical and spectroscopic means.

Applies to requirement(s): Math Sciences

D. Cotter, K. McMenimen

Prereq: CHEM-202 with grade of C or better. Coreq: CHEM-302L.

**CHEM-304 Advanced Organic Chemistry Laboratory**

Not Scheduled for This Year. Credits: 1

This half-semester course, starting after spring break, applies and builds upon the techniques and tools of synthetic organic chemistry acquired during previous laboratory classes. Experiments will be selected to provide exposure to contemporary synthetic methods, to offer examples of the application of sophisticated reagents, to afford practice in modern separation and purification approaches, and provide scope for hands-on acquisition of Nuclear Magnetic Resonance (NMR) spectra.

Applies to requirement(s): Meets No Distribution Requirement

The department

Instructor permission required.

Coreq: CHEM-302.

Notes: Second half of semester

**CHEM-307 Chemical Thermodynamics**

Not Scheduled for This Year. Credits: 4

A consideration of the contribution of thermodynamics to the understanding of 'driving forces' for the physical chemical changes and the nature of the equilibrium state.

Applies to requirement(s): Math Sciences

W. Chen

Prereq: MATH-102, PHYS-110, and CHEM-202 with grade of C or better.

**CHEM-308 Chemical Thermodynamics with Lab**

Fall. Credits: 4

A consideration of the contribution of thermodynamics to the understanding of the 'driving forces' for physical chemical changes and the nature of the equilibrium state.

Applies to requirement(s): Math Sciences

M. Gomez

Prereq: MATH-102, PHYS-110, and CHEM-202 with grade of C or better. Coreq: CHEM-308L.

**CHEM-311 Protein Biochemistry and Cellular Metabolism**

Fall. Credits: 4

This course is a rigorous introduction to the study of protein molecules and their role as catalysts of the cell. Topics include general principles of protein folding, protein structure-function correlation, enzyme kinetics and mechanism, carbohydrate and lipid biochemistry, and metabolic pathways (catabolic and anabolic) and their interaction and cross-regulation. Biological transformation of energy is considered in light of the principle of thermodynamics.

Crosslisted as: BIOCH-311, BIOL-311

Applies to requirement(s): Math Sciences

K. Berry

Restrictions: This course is limited to Biochemistry majors only.

Prereq: BIOL-230 (or BIOL-210) and CHEM-302. Coreq: CHEM-311L.

Advisory: Biological Sciences 230 can be taken concurrently

**CHEM-314 Nucleic Acids Biochemistry and Molecular Biology**

Spring. Credits: 4

This course is an in-depth examination of DNA and RNA structures and how these structures support their respective functions during replication, transcription, and translation of the genetic material. Emphasis is on the detailed mechanisms associated with each step of gene expression. Discussions incorporate many recent advances brought about by recombinant DNA technology.

Crosslisted as: BIOCH-314, BIOL-314

Applies to requirement(s): Math Sciences

K. Berry

Restrictions: This course is limited to Biochemistry majors only.

Prereq: BIOCH-311, BIOL-311, or CHEM-311. Coreq: CHEM-314L.

Advisory: Chemistry 302 can be taken concurrently

**CHEM-316 Chemical Biology**

Not Scheduled for This Year. Credits: 4

The field of chemical biology applies chemical perspectives and tools to the study of biological systems. In this course, we will examine the ways that synthetic chemistry has provided techniques that support, complement, and expand on those used in biochemistry, drug discovery, and molecular and cell biology. Topics may include solid phase biomolecule synthesis, combinatorial chemistry, bioconjugation, molecular probes, protein engineering, drug delivery, and synthetic biology.

Applies to requirement(s): Math Sciences

K. Broaders

Prereq: CHEM-302 and any other 300-level chemistry or biochemistry course.

**CHEM-317 Principles of Polymer Chemistry**

Spring. Credits: 4

An introduction to the study of molecules of high molecular weights with emphasis on synthetic rather than naturally occurring polymers. Topics include polymerization, structures, molecular weight determination, molecular weight distribution, chain configurations, rubber elasticity, and thermodynamics and statistical mechanics of polymer solutions.

Applies to requirement(s): Math Sciences

W. Chen

Prereq: CHEM-302.

Notes: offered once every three years

**CHEM-325 Atomic and Molecular Structure with Lab***Spring. Credits: 4*

This course is an introduction to experimental and theoretical approaches to the determination of the structure of atoms, molecules, and chemical bonds. Classroom work provides background in the theory of atomic and molecular structure and an introduction to quantum mechanics and spectroscopy.

*Applies to requirement(s): Math Sciences**H. Jayathilake**Prereq: MATH-102, CHEM-202, and PHYS-201, all with grade of C or better.**Coreq: CHEM-325L.**Advisory: Mathematics 203 is recommended.***CHEM-328 From Lilliput to Brobdingnag: Bridging the Scales Between Science and Engineering***Not Scheduled for This Year. Credits: 4*

The performance of many engineered devices is dependent on macroscopic factors (pressure, temperature, flow, conductivity). As a result, engineers often model devices macroscopically considering atomistic level details only through fixed parameters. These parameters do not always capture the full atomistic level picture. More accurate multi-scale approaches for modeling macroscopic properties use basic atomistic level chemistry at key points in larger scale simulations. This course is an introduction to such approaches focusing on fuel cells as a concrete example. Basic scientific principles will be developed along side of basic engineering principles through project/case studies.

*Crosslisted as: PHYS-328**Applies to requirement(s): Meets No Distribution Requirement**Other Attribute(s): Writing-Intensive**M. Gomez**Prereq: MATH-102 and PHYS-201.***CHEM-334 Advanced Inorganic Chemistry***Not Scheduled for This Year. Credits: 4*

The implications of molecular symmetry as expressed in the language of group theory are explored in some depth. Group theory provides the context for a discussion of the structural and spectroscopic properties of inorganic compounds, particularly those of the transition metals.

*Applies to requirement(s): Math Sciences**D. Cotter**Prereq: CHEM-302 and CHEM-325. (CHEM-325 may be taken concurrently with this course. Apply for instructor permission in this case.)**Notes: offered every other year***CHEM-336 Organic Synthesis***Fall. Credits: 4*

This course emphasizes recent developments in synthetic organic chemistry and deals with general synthetic methods and specific examples of natural product synthesis. It covers such topics as new methods of oxidation and reduction, stereospecific olefin formation, ring-forming reactions, and methods of carbon-carbon bond formation. The application of these reactions to the synthesis of naturally occurring compounds is examined. A general strategy for the synthesis of complex molecules is also presented.

*Applies to requirement(s): Meets No Distribution Requirement**D. Hamilton**Prereq: CHEM-302.***CHEM-337 Physical Organic Chemistry***Not Scheduled for This Year. Credits: 4*

An introduction to the concepts and methods of physical organic chemistry. An examination of the mechanistic principles underlying free radical, ionic, pericyclic, and photochemical reactions, and the experimental and theoretical support for mechanistic postulates. Topics will include qualitative molecular orbital concepts, reaction kinetics, thermodynamics, and an introduction to computational methods.

*Applies to requirement(s): Math Sciences**G. Snyder**Prereq: CHEM-302.***CHEM-339 The Organic Chemistry of Biological Pathways***Not Scheduled for This Year. Credits: 4*

This course explores the underlying organic chemistry of biological pathways and thereby seeks to build a framework for understanding biological transformations from the perspective of mechanistic organic chemistry. Beginning with common biological mechanisms, and drawing parallels with their sophomore organic chemistry counterparts, a broad overview will be constructed of the pathways by which the key classes of biological molecules—lipids, carbohydrates, amino acids, nucleotides—are manufactured, modified, and consumed. Several specific biosyntheses will also be dissected from a mechanistic perspective. These case studies will include antibiotics, an alkaloid, and heme.

*Applies to requirement(s): Math Sciences**D. Hamilton**Instructor permission required.**Prereq: CHEM-302.***CHEM-344 Physical Chemistry of Biochemical Systems***Not Scheduled for This Year. Credits: 4*

This course provides an overview of the fundamental principles of physical chemistry with an emphasis on their application to the study of biological molecules and processes. Topics will include quantum mechanics, statistical mechanics and thermodynamics. Discussion of applications will relate commonly used experimental techniques – such as spectroscopy and calorimetry – to the fundamental principles on which they are based. In addition, students will gain experience and confidence in the use of mathematical models to describe biochemical systems.

*Applies to requirement(s): Math Sciences**A. van Giessen**Prereq: CHEM-202, MATH-102 and PHYS-110 with a grade of C or better.***CHEM-346 Physical Chemistry of Biochemical Systems With Lab***Not Scheduled for This Year. Credits: 4*

This course provides an overview of the fundamental principles of physical chemistry with an emphasis on their application to the study of biological molecules and processes. Topics will include quantum mechanics, statistical mechanics and thermodynamics. Discussion of applications will relate commonly used experimental techniques – such as spectroscopy and calorimetry – to the fundamental principles on which they are based. In addition, students will gain experience and confidence in the use of mathematical models to describe biochemical systems.

*Applies to requirement(s): Math Sciences**A. van Giessen**Prereq: CHEM-202, MATH-102 and PHYS-110 with a grade of C or better.**Coreq: CHEM-346L.*

**CHEM-395 Independent Study**

*Fall and Spring. Credits: 1 - 8*

*The department*

*Instructor permission required.*

*Notes: Note: See safety training restrictions in description of Chemistry 295*