Department of Chemistry

Alan F. Heyduk, Department Chair
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Chemistry is the science of molecules and materials. Chemistry plays a role in virtually all facets of life: whether you are interested in solar cells, medicines, food, personal care products, the atmosphere, minerals, your body, or even the origin of your own emotions, there is chemistry behind it. The Department of Chemistry at UCI is home to world-class faculty who engage in cutting edge research in diverse areas of chemistry, from atmospheric chemistry, to the biochemistry of cancer, to the development of new solar cell materials.

This broad perspective is also reflected in the courses offered through the Department of Chemistry, which range from general chemistry, to organic chemistry, to advanced topics such as molecular spectroscopy, nuclear chemistry, and chemical biology. On the undergraduate level, the Department offers various concentrations and tracks to majors, including programs in computational chemistry, biochemistry, chemical physics, synthesis, and chemistry education. Similarly, the Chemistry Graduate Program offers degrees and courses in all major sub-disciplines of chemistry including atmospheric chemistry, chemical biology, inorganic chemistry, organic chemistry, physical chemistry, and theoretical chemistry.

- Chemistry, B.S.
- Chemistry, Ph.D.

Faculty

Ioan Andricioaei, Ph.D. Boston University, *Professor of Chemistry; Physics and Astronomy* (chemical biology, physical chemistry and chemical physics, theoretical and computational)

Ara Apkarian, Ph.D. Northwestern University, *UCI Distinguished Professor Emeritus of Chemistry* (physical chemistry and chemical physics)

Ramesh D. Arasasingham, Ph.D. University of California, Davis, *Professor of Teaching of Chemistry* (chemical education and inorganic chemistry)

Shane Ardo, Ph.D. Johns Hopkins University, *Professor of Chemistry; Chemical and Biomolecular Engineering; Materials Science and Engineering* (inorganic and organometallic, physical chemistry and chemical physics, polymer, materials, nanoscience)

Herdeline Ann Ardoña, Ph.D. John Hopkins University, *Assistant Professor of Chemical and Biomolecular Engineering; Biomedical Engineering; Chemistry* (biomaterials, self-assembly, optoelectronics, stimuli-responsive materials, in vitro tissue models, biosensors)

Maxx Arguilla, Ph.D. The Ohio State University, *Assistant Professor of Chemistry* (inorganic and organometallic, physical chemistry and chemical physics, polymer, materials, nanoscience)

Elizabeth Bess, Ph.D. University of Utah, *Assistant Professor of Chemistry; Molecular Biology and Biochemistry* (chemical biology)

Donald R. Blake, Ph.D. University of California, Irvine, *UCI Distinguished Professor of Chemistry* (analytical, atmospheric, environmental)

Suzanne A. Blum, Ph.D. University of California, Berkeley, *Professor of Chemistry* (inorganic and organometallic, organic and synthetic, physical chemistry and chemical physics, polymer, materials, nanoscience)

Andrew Borovik, Ph.D. University of North Carolina at Chapel Hill, *UCI Distinguished Professor of Chemistry* (chemical biology, inorganic and organometallic, organic and synthetic)

David A. Brant, Ph.D. University of Wisconsin-Madison, *Professor Emeritus of Chemistry* (biophysical)

Kieron Burke, Ph.D. University of California, Santa Barbara, *School of Physical Sciences Associate Dean and Distinguished Professor of Chemistry; Physics and Astronomy* (physical chemistry and chemical physics, theoretical and computational)

Ann Marie Carlton, Ph.D. Rutgers University, *Department Vice Chair and Professor of Chemistry* (atmospheric and environmental, physical chemistry and chemical physics, theoretical and computational)

John Charles Chaput, Ph.D. University of California, Riverside, *Professor of Pharmaceutical Sciences; Chemical and Biomolecular Engineering; Chemistry; Molecular Biology and Biochemistry* (chemical and synthetic biology)

Robert Corn, Ph.D. University of California, Berkeley, *UCI Distinguished Professor Emeritus of Chemistry* (analytical, chemical biology, physical chemistry and chemical physics, polymer, materials, nanoscience)

Robert J. Doedens, Ph.D. University of Wisconsin-Madison, *Professor Emeritus of Chemistry* (inorganic and organometallic)

Vy M. Dong, Ph.D. California Institute of Technology, *Professor of Chemistry* (organic and synthetic)

Kimberly D. Edwards, Ph.D. University of California, Irvine, *Professor of Teaching of Chemistry* (general chemistry, chemical education)

William J. Evans, Ph.D. University of California, Los Angeles, *UCI Distinguished Professor Emeritus of Chemistry* (inorganic and organometallic)

Celia Faiola, Ph.D. Washington State University, *Associate Professor of Ecology and Evolutionary Biology; Chemistry*

Sarah Finkeldei, Ph.D. RWTH Aachen University, *Assistant Professor of Chemistry; Chemical and Biomolecular Engineering; Materials Science and Engineering* (nuclear chemistry)

Barbara J. Finlayson-Pitts, Ph.D. University of California, Riverside, *Director of AirUCI and UCI Distinguished Professor Emeritus of Chemistry* (analytical, atmospheric and environmental, physical chemistry and chemical physics)

Fillmore Freeman, Ph.D. Michigan State University, *Professor Emeritus of Chemistry* (organic and synthetic, theoretical and computational)

Filipp Furche, Ph.D. University of Karlsruhe, *Professor of Chemistry* (physical chemistry and chemical physics, theoretical and computational)

Nien-Hui Ge, Ph.D. University of California, Berkeley, *Professor of Chemistry* (analytical, chemical biology, physical chemistry and chemical physics, polymer, materials, nanoscience)

Robert B. Gerber, Ph.D. Oxford University, *Professor Emeritus of Chemistry* (atmospheric and environmental, physical chemistry and chemical physics, theoretical and computational)

Michael T. Green, Ph.D. University of Chicago, *Vice Chair and Professor of Molecular Biology and Biochemistry; Chemistry* (chemical, biology, inorganic and organometallic, physical chemistry and chemical physics, theoretical and computational)

Matthew E. Griffin, Ph.D. California Institute of Technology, *Assistant Professor of Chemistry; Pharmaceutical Sciences* (chemical biology)

Zhibin Guan, Ph.D. University of North Carolina at Chapel Hill, *Professor of Chemistry; Biomedical Engineering; Chemical and Biomolecular Engineering; Materials Science and Engineering* (chemical biology, organic and synthetic, polymer, materials, nanoscience)

Stephen Hanessian, Ph.D. Ohio State University, *Distinguished Professor of Pharmaceutical Sciences; Chemistry* (organic chemistry, medicinal chemistry)

John C. Hemminger, Ph.D. Harvard University, *UCI Distinguished Professor Emeritus of Chemistry* (analytical, atmospheric and environmental, physical chemistry and chemical physics, polymer, materials, nanoscience)

Alan F. Heyduk, Ph.D. Massachusetts Institute of Technology, *Department Chair and Professor of Chemistry* (inorganic and organometallic)

Wilson Ho, Ph.D. University of Pennsylvania, *Donald Bren Professor and Professor of Physics and Astronomy; Chemistry*

Allon Hochbaum, Ph.D. University of California, Berkeley, *Associate Professor of Materials Science and Engineering; Chemical and Biomolecular Engineering; Chemistry; Molecular Biology and Biochemistry* (biological materials, protein materials, electronic conductivity in proteins, materials and methods to study microbes and microbial communities)

Amanda J. Holton, Ph.D. University of California, Irvine, *Professor of Teaching of Chemistry* (chemistry, chemical education)

Kenneth C. Janda, Ph.D. Harvard University, *Professor Emeritus of Chemistry* (physical chemistry and chemical physics)

Elizabeth R. Jarvo, Ph.D. Boston College, *Professor of Chemistry* (inorganic and organometallic, organic and synthetic)

Susan M. King, Ph.D. Massachusetts Institute of Technology, *Professor of Teaching of Chemistry* (organic chemistry, chemical education)

Matthew Law, Ph.D. University of California, Berkeley, *Department Vice Chair and Professor of Chemistry; Chemical and Biomolecular Engineering; Materials Science and Engineering* (inorganic and organometallic, physical chemistry and chemical physics, polymer, materials, nanoscience)

Renee Link, Ph.D. University of California, Irvine, *Professor of Teaching of Chemistry* (organic chemistry, chemical education)

Chang C. Liu, Ph.D. Scripps Research Institute, *Professor of Biomedical Engineering; Chemistry; Molecular Biology and Biochemistry* (genetic engineering, directed evolution, synthetic biology, chemical biology)

Andrej Luptak, Ph.D. Yale University, *Department Chair and Professor of Pharmaceutical Sciences; Chemistry; Molecular Biology and Biochemistry* (chemical biology)

Vladimir A. Mandelshtam, Ph.D. Institute of Spectroscopy, Russian Academy of Sciences, *Professor of Chemistry* (physical chemistry and chemical physics, theoretical and computational)

Stephen Mang, Ph.D. University of California, Irvine, *Department Vice Chair and Associate Professor of Teaching of Chemistry* (chemical education, advanced laboratories)

Craig C. Martens, Ph.D. Cornell University, *Professor of Chemistry* (physical chemistry and chemical physics, polymer, materials, nanoscience, theoretical and computational)

Rachel Martin, Ph.D. Yale University, *Professor of Chemistry; Molecular Biology and Biochemistry* (analytical, chemical biology, physical chemistry and chemical physics)

George E. Miller, Ph.D. Oxford University, *Professor of Teaching Emeritus of Chemistry* (analytical and radioanalytical chemistry and chemical education)

David L. Mobley, Ph.D. University of California, Davis, *Vice Chair and Professor of Pharmaceutical Sciences; Chemistry* (chemical biology, physical chemistry and chemical physics, theoretical and computational)

Shaul Mukamel, Ph.D. Tel Aviv University, *UCI Distinguished Professor of Chemistry; Physics and Astronomy* (physical chemistry and chemical physics, polymer, materials, nanoscience, theoretical and computational)

Craig Murray, Ph.D. University of Edinburgh, *Associate Professor of Chemistry* (atmospheric and environmental, physical chemistry and chemical physics)

Sergey Nizkorodov, Ph.D. University of Basel, *Co-Director, AirUCI and Professor of Chemistry* (analytical, atmospheric and environmental, physical chemistry and chemical physics)

James S. Nowick, Ph.D. Massachusetts Institute of Technology, *UCI Distinguished Professor of Chemistry; Pharmaceutical Sciences* (chemical biology, organic and synthetic, polymer, materials, nanoscience)

Larry E. Overman, Ph.D. University of Wisconsin-Madison, *UCI Distinguished Professor of Chemistry* (inorganic and organometallic, organic and synthetic)

Brian Paegel, Ph.D. University of California, Berkeley, *Associate Dean of Research and Professor of Pharmaceutical Sciences; Biomedical Engineering; Chemistry* (chemical biology, drug discovery, drug discovery, miniaturization, evolution)

Krzysztof Palczewski, Ph.D. Wroclaw University of Science and Technology, *Irving H. Leopold Endowed Chair of Ophthalmology and Donald Bren and Distinguished Professor of Ophthalmology; Chemistry; Physiology and Biophysics*

Joseph Patterson, Ph.D. University of Warwick, *Assistant Professor of Chemistry; Materials Science and Engineering* (polymer, materials, nanoscience)

Reginald M. Penner, Ph.D. Texas A&M University, *Associate Dean of the School of Physical Sciences and UCI Chancellor's Professor of Chemistry* (analytical, physical chemistry and chemical physics, polymer, materials, nanoscience)

Eric Potma, Ph.D. University of Groningen, *Professor of Chemistry; Biomedical Engineering; Electrical Engineering and Computer Science* (analytical, chemical biology, physical chemistry and chemical physics)

Thomas L. Poulos, Ph.D. University of California, San Diego, *Professor Emeritus of Molecular Biology and Biochemistry; Chemistry; Pharmaceutical Sciences* (chemical biology)

Jennifer A. Prescher, Ph.D. University of California, Berkeley, *Professor of Chemistry; Molecular Biology and Biochemistry; Pharmaceutical Sciences* (chemical biology, organic and synthetic)

Sergey V. Pronin, Ph.D. University of Chicago, *Associate Professor of Chemistry* (organic and synthetic chemistry)

Markus W. Ribbe, Ph.D. University of Bayreuth, *UCI Chancellor's Professor of Molecular Biology and Biochemistry; Chemistry* (chemical biology, inorganic and organometallic)

Scott D. Rychnovsky, Ph.D. Columbia University, *UCI Distinguished Professor of Chemistry* (chemical biology, organic and synthetic)

Eric S. Saltzman, Ph.D. University of Miami, *UCI Distinguished Professor of Earth System Science; Chemistry*

A. J. Shaka, Ph.D. Oxford University, *Professor of Chemistry* (chemical biology, physical chemistry and chemical physics)

Kenneth J. Shea, Ph.D. Pennsylvania State University, *UCI Distinguished Professor Emeritus of Chemistry* (analytical, chemical biology, organic and synthetic, polymer, materials, nanoscience)

Matthew Sheldon, Ph.D. University of California, Berkeley, *Associate Professor of Chemistry* (analytical and materials chemistry)

Xiaoyu Shi, Ph.D. University of California, Davis, *Assistant Professor of Chemistry; Biomedical Engineering; Developmental and Cell Biology* (super-resolution microscopy)

Manabu Shiraiwa, Ph.D. Max Planck Institute for Chemistry, *Professor of Chemistry* (atmospheric and environmental, chemical biology, physical chemistry and chemical physics, theoretical and computational)

Seunghyun Sim, Ph.D. The University of Tokyo, Japan, *Assistant Professor of Chemistry; Biomedical Engineering; Chemical and Biomolecular Engineering* (chemical biology, organic and synthetic, polymer, materials and nanoscience)

Zuzanna S. Siwy, Ph.D. Silesian University of Technology, *Professor of Physics and Astronomy; Biomedical Engineering; Chemistry*

James N. Smith, Ph.D. California Institute of Technology, *Professor of Chemistry* (analytical, atmospheric and environmental, physical chemistry and chemical physics)

Vojislav Stamenkovic, Ph.D. University of Belgrade, *Professor of Chemical and Biomolecular Engineering; Chemistry* (energy conversion and storage, surface modifications, thin films, nanoscale synthesis, electrochemical interfaces, fuel cells, electrolyzers and batteries)

Douglas J. Tobias, Ph.D. Carnegie Mellon University, *UCI Distinguished Professor of Chemistry* (atmospheric and environmental, chemical biology, physical chemistry and chemical physics, theoretical and computational)

Shiou-Chuan (Sheryl) Tsai, Ph.D. University of California, Berkeley, *Professor of Molecular Biology and Biochemistry; Chemistry; Pharmaceutical Sciences*

Christopher Vanderwal, Ph.D. Scripps Research Institute, *Department Vice Chair and Professor of Chemistry; Pharmaceutical Sciences* (organic and synthetic)

David Van Vranken, Ph.D. Stanford University, *Associate Dean of the School of Physical Sciences and Professor of Chemistry* (organic and synthetic)

Gregory A. Weiss, Ph.D. Harvard University, *Professor of Chemistry; Molecular Biology and Biochemistry; Pharmaceutical Sciences* (analytical, chemical biology, organic and synthetic, polymer, materials, nanoscience)

Jenny Y. Yang, Ph.D. Massachusetts Institute of Technology, *Professor of Chemistry* (inorganic and organometallic, organic and synthetic, polymer, materials, nanoscience)

Jin Yu, Ph.D. University of Illinois at Urbana-Champaign, *Assistant Professor of Physics and Astronomy; Chemistry*

Courses

CHEM 1A. General Chemistry. 4 Units.
General chemistry with applications to life sciences, physical sciences, and engineering. Atomic structure; general properties of the elements; covalent, ionic, and metallic bonding; mass relationships.

Prerequisite: MATH 5A or MATH 2A or PHYS 7C or CHEM 1X or CHEM 1P or SAT Mathematics or ACT Mathematics or SAT Subject Chemistry or AP Chemistry or AP Calculus AB or AP Calculus BC. CHEM 1P with a grade of C- or better. SAT Mathematics with a minimum score of 600. ACT Mathematics with a minimum score of 27. SAT Subject Chemistry with a minimum score of 700. AP Chemistry with a minimum score of 3. AP Calculus AB with a minimum score of 3. AP Calculus BC with a minimum score of 3. Placement via a passing score on the UCI placement exam or a passing score on the ALEKS placement exam is also accepted.

Overlaps with CHEM H2A, ENGR 1A, CHEM M2A.

Restriction: Undeclared Majors have first consideration for enrollment. School of Biological Sciences students have first consideration for enrollment. School of Physical Sciences students have first consideration for enrollment. School of Engineering students have first consideration for enrollment. Program in Nursing Science students have first consideration for enrollment. Dept Pharmaceutical Sciences students have first consideration for enrollment. Program in Public Health students have first consideration for enrollment.

(II and VA).

CHEM 1B. General Chemistry. 4 Units.
General chemistry with applications to life sciences, physical sciences, and engineering. Properties of gases, liquids, solids; intermolecular forces; changes of state; properties of solutions; stoichiometry; thermochemistry; and thermodynamics. Course may be offered online.

Prerequisite: CHEM 1A or ENGR 1A or CHEM H2A or AP Chemistry or CHEM M2A. CHEM 1A with a grade of C- or better. ENGR 1A with a grade of C- or better. CHEM H2A with a grade of C- or better. AP Chemistry with a minimum score of 4. CHEM M2A with a grade of C- or better

Overlaps with CHEM H2B, CHEM M2B.

Restriction: School of Biological Sciences students have first consideration for enrollment. School of Physical Sciences students have first consideration for enrollment. School of Engineering students have first consideration for enrollment. Program in Nursing Science students have first consideration for enrollment. Dept Pharmaceutical Sciences students have first consideration for enrollment. Program in Public Health students have first consideration for enrollment. Undeclared Majors have first consideration for enrollment.

(II and Va).

CHEM 1C. General Chemistry . 4 Units.
General chemistry with applications to life sciences, physical sciences, and engineering. Equilibria, aqueous acid-base equilibria, solubility equilibria, oxidation reduction reactions, electrochemistry; kinetics; special topics.

Corequisite: CHEM 1LC
Prerequisite: CHEM 1B. CHEM 1B with a grade of C- or better

Overlaps with CHEM H2C, CHEM M2C.

Restriction: School of Biological Sciences students have first consideration for enrollment. School of Physical Sciences students have first consideration for enrollment. School of Engineering students have first consideration for enrollment. Program in Nursing Science students have first consideration for enrollment. Dept Pharmaceutical Sciences students have first consideration for enrollment. Program in Public Health students have first consideration for enrollment. Undeclared Majors have first consideration for enrollment.

(II and VA).

CHEM 1LC. General Chemistry Laboratory. 3 Units.
Training and experience in basic laboratory techniques. Chemical practice and principles illustrated through experiments related to lecture topics of CHEM 1A-B-C. Materials fee.

Corequisite: CHEM 1C
Prerequisite: CHEM 1B. CHEM 1B with a grade of C- or better

Overlaps with CHEM H2LA, CHEM M2LA.

Restriction: Div of Undergraduate Education students have first consideration for enrollment. School of Biological Sciences students have first consideration for enrollment. School of Physical Sciences students have first consideration for enrollment. School of Engineering students have first consideration for enrollment. Nursing Science Majors have first consideration for enrollment. Pharmaceutical Sciences Majors have first consideration for enrollment. Public Health Sciences Majors have first consideration for enrollment.

CHEM 1LD. General Chemistry Laboratory. 3 Units.
Training and experience in basic laboratory techniques. Chemical practice and principles illustrated through experiments related to lecture topics in CHEM 1A-B-C. Materials fee.

Prerequisite: (CHEM 1C and CHEM 1LC) or CHEM 1LE. CHEM 1C with a grade of C- or better. CHEM 1LC with a grade of C- or better. CHEM 1LE with a grade of C- or better

Overlaps with CHEM H2LB, CHEM M2LB.

Restriction: School of Biological Sciences students have first consideration for enrollment. School of Physical Sciences students have first consideration for enrollment. School of Engineering students have first consideration for enrollment. Program in Nursing Science students have first consideration for enrollment. Pharmaceutical Sciences Majors have first consideration for enrollment. Public Health Sciences Majors have first consideration for enrollment. Undecided/Undeclared students also have first consideration for enrollment.

CHEM 1LE. Accelerated General Chemistry Lab. 3 Units.
Lecture and experiments covering chemical concepts for accelerated students who do not plan to take organic chemistry. Properties of gases, liquids, solutions, and solids; chemical equilibrium and chemical thermodynamics; atomic and molecular structure; chemical kinetics; electrochemistry. Materials fee.

Corequisite: CHEM 1A or ENGR 1A.
Prerequisite: CHEM 1A or ENGR 1A or AP Chemistry. CHEM 1A with a grade of C- or better. ENGR 1A with a grade of C- or better. AP Chemistry with a minimum score of 3

Overlaps with CHEM 1LC.

Restriction: School of Engineering students have first consideration for enrollment.

CHEM 1P. Preparation for General Chemistry . 4 Units.
Units of measurement, dimensional analysis, significant figures; elementary concepts of volume, mass, force, pressure, energy, density, temperature, heat, work; fundamentals of atomic and molecular structure; the mole concept, stoichiometry; properties of the states of matter; gas laws; solutions concentrations.

Restriction: Undeclared Majors have first consideration for enrollment. School of Biological Sciences students have first consideration for enrollment. School of Physical Sciences students have first consideration for enrollment. School of Engineering students have first consideration for enrollment. Program in Nursing Science students have first consideration for enrollment. Dept Pharmaceutical Sciences students have first consideration for enrollment. Program in Public Health students have first consideration for enrollment.

CHEM 1X. General Chemistry Plus. 2 Units.
Units of chemical measurements, dimensional analysis, significant figures; elementary physicochemical concepts; fundamentals of atomic and molecular structure; molar amounts and stoichiometry; properties of the states of matter; solutions concentrations.

Prerequisite: Students who meet the requirements for taking Chem 1A through their SAT, ACT, or AP test scores are not eligible for enrollment in Chem 1X. Specifically, the students must have ALL of the following advisory prerequisites (the inverse of the Chem 1A prerequisites): S02<600 (score below 600 on the SAT Mathematics Reasoning test) A02<27 (score below 27 on the ACT Mathematics test) Z43<700 (score below 700 on the SAT Chemistry subject exam) AP25<3 (score below 3 on the AP Chemistry exam) AP66<3 (score below 3 on the AP Calculus AB Exam) AP68<3 (score below 3 on the AP Calculus BC Exam) Students who meet Chem 1A eligibility through ALEKS-based training are permitted to enroll in Chem 1X. Chem 1X is open to interested BioEASE students.

Grading Option: Pass/no pass only.

CHEM H2A. Honors General Chemistry. 4 Units.
Covers the same material as CHEM 1A-CHEM 1B-CHEM M3C but in greater depth. Additional topics will also be included as time permits.

Corequisite: CHEM H2LA
Prerequisite: AP Chemistry or SAT Subject Chemistry. AP Chemistry with a minimum score of 4. SAT Subject Chemistry with a minimum score of 700

Overlaps with CHEM 1A, CHEM M2A, ENGR 1A.

Restriction: Campuswide Honors Collegium students only.

(II and Va).

CHEM H2B. Honors General Chemistry. 4 Units.
Covers the same material as CHEM 1A-CHEM 1B-CHEM M3C but in greater depth. Additional topics are also included as time permits.

Corequisite: CHEM H2LB
Prerequisite: CHEM H2A and (CHEM H2LA or CHEM M2LA). CHEM H2A with a grade of C- or better. CHEM H2LA with a grade of C- or better. CHEM M2LA with a grade of C- or better

Overlaps with CHEM 1B, CHEM M2B.

Restriction: Campuswide Honors Collegium students only.

(II and VA).

CHEM H2C. Honors General Chemistry. 4 Units.
Covers the same material as CHEM 1A-CHEM 1B-CHEM M3C but in greater depth. Additional topics are also included as time permits.

Prerequisite: CHEM H2B and (CHEM H2LB or CHEM M2LB). CHEM H2B with a grade of C- or better. CHEM H2LB with a grade of C- or better. CHEM M2LB with a grade of C- or better

Overlaps with CHEM 1C, CHEM M2C.

Restriction: Campuswide Honors Collegium students only.

(II and VA).

CHEM H2LA. Honors General Chemistry Laboratory. 3 Units.
Training and experience in fundamental and analytical laboratory techniques through experiments related to lecture topics in CHEM H2A-CHEM H2B-CHEM H2C. Materials fee.

Corequisite: CHEM H2A
Prerequisite: AP Chemistry or SAT Subject Chemistry. AP Chemistry with a minimum score of 4. SAT Subject Chemistry with a minimum score of 700

Overlaps with CHEM M2LA, CHEM 1LC.

Restriction: Campuswide Honors Collegium students only.

CHEM H2LB. Honors General Chemistry Laboratory. 3 Units.
Training and experience in fundamental and analytical laboratory techniques through experiments related to lecture topics in CHEM H2A-CHEM H2B-CHEM H2C. Materials fee.

Corequisite: CHEM H2B
Prerequisite: CHEM H2A and (CHEM H2LA or CHEM M2LA). CHEM H2A with a grade of B or better. CHEM H2LA with a grade of B or better. CHEM M2LA with a grade of B or better

Overlaps with CHEM M2LB, CHEM 1LD.

Restriction: No credit for CHEM 1LC if taken after CHEM H2LB or CHEM M2LB.

CHEM H2LC. Honors General Chemistry Laboratory. 3 Units.
Training and experience in fundamental and analytical laboratory techniques through experiments related to lecture topics in CHEM H2A-CHEM H2B-CHEM H2C. Materials fee.

Corequisite: CHEM H2C
Prerequisite: CHEM H2B and (CHEM H2LB or CHEM M2LB). CHEM H2B with a grade of B or better. CHEM H2LB with a grade of B or better. CHEM M2LB with a grade of B or better

CHEM M2A. Majors General Chemistry Lecture. 4 Units.
Covers the same material as CHEM 1A but in greater depth. Additional topics are included as time permits.

Corequisite: MATH 5A or MATH 2A or PHYS 7C or CHEM 1X
Prerequisite: MATH 5A or MATH 2A or PHYS 7C or CHEM 1X or CHEM 1P or SAT Mathematics or ACT Mathematics or SAT Subject Chemistry or AP Chemistry or AP Calculus AB or AP Calculus BC. CHEM 1P with a grade of C- or better. SAT Mathematics with a minimum score of 600. ACT Mathematics with a minimum score of 27. SAT Subject Chemistry with a minimum score of 700. AP Chemistry with a minimum score of 3. AP Calculus AB with a minimum score of 3. AP Calculus BC with a minimum score of 3. Placement via a passing score on the ALEKS placement exam is also accepted.

Overlaps with CHEM 1A, CHEM H2A, ENGR 1A.

Restriction: Chemistry Majors have first consideration for enrollment.

(II and Va).

CHEM M2B. Majors General Chemistry Lecture. 4 Units.
Covers the same material as CHEM 1B but in greater depth. Additional topics will also be included as time permits.

Prerequisite: CHEM M2A and CHEM M2LA. CHEM M2A with a grade of C- or better. CHEM M2LA with a grade of C- or better

Overlaps with CHEM H2B, CHEM 1B.

Restriction: Chemistry Majors have first consideration for enrollment.

(II and Va).

CHEM M2C. Majors General Chemistry Lecture. 4 Units.
Covers the same material as CHEM 1C but in greater depth. Additional topics are also included as time permits.

Prerequisite: CHEM M2B and CHEM M2LB. CHEM M2B with a grade of C- or better. CHEM M2LB with a grade of C- or better

Overlaps with CHEM 1C, CHEM H2C.

Restriction: Chemistry Majors have first consideration for enrollment.

(II and Va).

CHEM M2LA. Majors General Chemistry Laboratory. 3 Units.
Training and experience in basic laboratory techniques through experiments related to lecture topics in CHEM 1A-CHEM 1B-CHEM M3C. Materials fee.

Prerequisite or corequisite: CHEM M2A. CHEM M2A with a grade of C- or better. High school chemistry.

Overlaps with CHEM H2LA, CHEM 1LC.

Restriction: Chemistry Majors only.

CHEM M2LB. Majors General Chemistry Laboratory. 3 Units.
Training and experience in basic laboratory techniques through experiments related to lecture topics in CHEM 1A-CHEM 1B-CHEM M3C. Materials fee.

Corequisite: CHEM 1B or CHEM H2B or CHEM M2B
Prerequisite: (CHEM 1B or CHEM H2B or CHEM M2B) and (CHEM M2A or CHEM H2A) and (CHEM M2LA or CHEM H2LA). CHEM 1B with a grade of C- or better. CHEM H2B with a grade of C- or better. CHEM M2B with a grade of C- or better. CHEM M2A with a grade of C- or better. CHEM H2A with a grade of C- or better. CHEM M2LA with a grade of C- or better. CHEM H2LA with a grade of C- or better

Overlaps with CHEM H2LB, CHEM 1LD.

Restriction: Chemistry Majors only.

CHEM M3C. Majors Quantitative Analytical Chemistry. 4 Units.
Topics include equilibria, aqueous acid-base equilibria, solubility equilibria, oxidation reduction reactions, electrochemistry, and kinetics with a special emphasis on the statistical treatment of data and analytical methods of chemical analysis.

Corequisite: CHEM M3LC
Prerequisite: (CHEM 1B or CHEM H2B or CHEM M2B) and (CHEM M2LB or CHEM H2LB). CHEM 1B with a grade of C- or better. CHEM H2B with a grade of C- or better. CHEM M2B with a grade of C- or better. CHEM M2LB with a grade of C- or better. CHEM H2LB with a grade of C- or better

Restriction: Chemistry Majors only.

(II and VA).

CHEM M3LC. Majors Quantitative Analytical Chemistry Laboratory. 4 Units.
Foundational principles of analytical chemistry and experimental methods for quantitative analysis of real samples. Materials fee.

Prerequisite: (CHEM 1B or CHEM H2B or CHEM M2B) and (CHEM M2LB or CHEM H2LB). CHEM 1B with a grade of C- or better. CHEM H2B with a grade of C- or better. CHEM M2B with a grade of C- or better. CHEM M2LB with a grade of C- or better. CHEM H2LB with a grade of C- or better

Restriction: Chemistry Majors only.

CHEM 5. Scientific Mathematical and Computing Skills. 4 Units.
Introduces students to mathematical skills, including complex numbers, linear algebra, differential equations, multivariable calculus, infinite series, Fourier series, and integral transforms; and computing skills, including plotting, data analysis (statistics and curve fitting), linear algebra, symbolic mathematics, and spectral analysis.

Prerequisite or corequisite: (CHEM 1C or CHEM H2C or CHEM M3C or CHEM M2C) and MATH 2D. CHEM 1C with a grade of C- or better. CHEM H2C with a grade of C- or better. CHEM M3C with a grade of C- or better. CHEM M2C with a grade of C- or better

Restriction: Chemistry Majors have first consideration for enrollment.

CHEM 11. New Chemistry Student Seminar. 1 Workload Unit.
Seminar for students who recently joined the chemistry major. Addresses available tracks in the major, research opportunities in the chemistry department, careers in chemistry, and relevant programs and resources for students.

Grading Option: Workload Credit P/NP Only.

Restriction: Freshmen students, transfer students, and students who recently changed their major to Chemistry have first consideration for enrollment.

CHEM 14. Sense and Sensibility in Science. 4 Units.
Gives an overview of scientific methods and heuristics through group exercises and discussion. Discusses the benefits and limitations of applying rational scientific approaches to real-world examples from philosophy, cognitive and social psychology, game theory, economics, political science, law, and negotiation.

(II and V.A.).

CHEM 51A. Organic Chemistry. 4 Units.
Fundamental concepts relating to carbon compounds with emphasis on structural theory and the nature of chemical bonding, stereochemistry, reaction mechanisms, and stereoscopic, physical, and chemical properties of the principal classes of carbon compounds.

Corequisite: CHEM 1LD
Prerequisite: (CHEM 1C or CHEM H2C or CHEM M2C or CHEM M3C) and (CHEM 1LD or CHEM H2LB or CHEM M2LB). CHEM 1C with a grade of C- or better. CHEM H2C with a grade of C- or better. CHEM M2C with a grade of C- or better. CHEM M3C with a grade of C- or better. CHEM 1LD with a grade of C- or better. CHEM H2LB with a grade of C- or better. CHEM M2LB with a grade of C- or better

Restriction: Undeclared Majors have first consideration for enrollment. School of Biological Sciences students have first consideration for enrollment. School of Physical Sciences students have first consideration for enrollment. School of Engineering students have first consideration for enrollment. Program in Nursing Science students have first consideration for enrollment. Dept Pharmaceutical Sciences students have first consideration for enrollment. Program in Public Health students have first consideration for enrollment.

CHEM 51B. Organic Chemistry. 4 Units.
Fundamental concepts relating to carbon compounds with emphasis on structural theory and the nature of chemical bonding, stereochemistry, reaction mechanisms, and stereoscopic, physical, and chemical properties of the principal classes of carbon compounds.

Prerequisite: CHEM 51A and (CHEM 1LD or CHEM M52LA or CHEM H52LA). CHEM 51A with a grade of C- or better. CHEM 1LD with a grade of C- or better. CHEM M52LA with a grade of C- or better. CHEM H52LA with a grade of C- or better

Overlaps with CHEM H52B.

Restriction: Undeclared Majors have first consideration for enrollment. School of Physical Sciences students have first consideration for enrollment. School of Biological Sciences students have first consideration for enrollment. School of Engineering students have first consideration for enrollment. Program in Nursing Science students have first consideration for enrollment. Dept Pharmaceutical Sciences students have first consideration for enrollment. Program in Public Health students have first consideration for enrollment.

CHEM 51C. Organic Chemistry. 4 Units.
Fundamental concepts relating to carbon compounds with emphasis on structural theory and the nature of chemical bonding, stereochemistry, reaction mechanisms, and stereoscopic, physical, and chemical properties of the principal classes of carbon compounds.

Prerequisite: CHEM 51B and (CHEM 51LB or CHEM M52LB or CHEM H52LB). CHEM 51B with a grade of C- or better. CHEM 51LB with a grade of C- or better. CHEM M52LB with a grade of C- or better. CHEM H52LB with a grade of C- or better

Overlaps with CHEM H52C.

Restriction: Undeclared Majors have first consideration for enrollment. School of Physical Sciences students have first consideration for enrollment. School of Biological Sciences students have first consideration for enrollment. School of Engineering students have first consideration for enrollment. Program in Nursing Science students have first consideration for enrollment. Dept Pharmaceutical Sciences students have first consideration for enrollment. Program in Public Health students have first consideration for enrollment.

CHEM 51LB. Organic Chemistry Laboratory. 3 Units.
Modern techniques of organic chemistry, using selected experiments to illustrate topics introduced in CHEM 51A-CHEM 51B-CHEM 51C. Materials fee.

Corequisite: CHEM 51B
Prerequisite: CHEM 51A and (CHEM 1LD or CHEM H2LB or CHEM M2LB). CHEM 51A with a grade of C- or better. CHEM 1LD with a grade of C- or better. CHEM H2LB with a grade of C- or better. CHEM M2LB with a grade of C- or better

Overlaps with CHEM H52LA, CHEM M52LA.

Restriction: School of Biological Sciences students have first consideration for enrollment. School of Physical Sciences students have first consideration for enrollment. School of Engineering students have first consideration for enrollment. Program in Nursing Science students have first consideration for enrollment. Dept Pharmaceutical Sciences students have first consideration for enrollment. Program in Public Health students have first consideration for enrollment. Undeclared Majors have first consideration for enrollment.

CHEM 51LC. Organic Chemistry Laboratory. 3 Units.
Modern techniques of organic chemistry, using selected experiments to illustrate topics introduced in CHEM 51A-B-C. Materials fee.

Corequisite: CHEM 51C
Prerequisite: CHEM 51B and CHEM 51LB. CHEM 51B with a grade of C- or better. CHEM 51LB with a grade of C- or better

Overlaps with CHEM H52LB, CHEM M52LB.

Restriction: School of Biological Sciences students have first consideration for enrollment. School of Physical Sciences students have first consideration for enrollment. School of Engineering students have first consideration for enrollment. Program in Nursing Science students have first consideration for enrollment. Dept Pharmaceutical Sciences students have first consideration for enrollment. Program in Public Health students have first consideration for enrollment. Undeclared Majors have first consideration for enrollment.

CHEM 51LD. Organic Chemistry Laboratory. 3 Units.
Modern techniques of organic chemistry using selected experiments to illustrate topics introduced in CHEM 51A-CHEM 51B-CHEM 51C. Materials fee.

Prerequisite: CHEM 51C and CHEM 51LC. CHEM 51C with a grade of C- or better. CHEM 51LC with a grade of C- or better

Overlaps with CHEM H52LC, CHEM M52LC.

Restriction: School of Biological Sciences students have first consideration for enrollment. School of Physical Sciences students have first consideration for enrollment. School of Engineering students have first consideration for enrollment. Program in Nursing Science students have first consideration for enrollment. Dept Pharmaceutical Sciences students have first consideration for enrollment. Program in Public Health students have first consideration for enrollment. Undeclared Majors have first consideration for enrollment.

CHEM H52LA. Honors Organic Chemistry Laboratory. 3 Units.
Fundamental techniques of modern experimental organic chemistry. Materials fee.

Corequisite: CHEM 51A
Prerequisite: (CHEM 1C or CHEM H2C or CHEM M2C or CHEM M3C) and (CHEM M2LB or CHEM H2LB or CHEM 1LD). CHEM 1C with a grade of C- or better. CHEM H2C with a grade of C- or better. CHEM M2C with a grade of C- or better. CHEM M3C with a grade of C- or better. CHEM M2LB with a grade of C- or better. CHEM H2LB with a grade of C- or better. CHEM 1LD with a grade of C- or better

Overlaps with CHEM 51LB, CHEM M52LA.

Restriction: Campuswide Honors Collegium students only.

CHEM H52LB. Honors Organic Chemistry Laboratory. 3 Units.
Fundamental techniques of modern experimental organic chemistry. Materials fee.

Corequisite: CHEM 51B
Prerequisite: CHEM 51A and CHEM H52LA. CHEM 51A with a grade of C- or better. CHEM H52LA with a grade of C- or better

Overlaps with CHEM M52LB, CHEM 51LC.

CHEM H52LC. Honors Organic Chemistry Laboratory. 3 Units.
Fundamental techniques of modern experimental organic chemistry. Materials fee.

Prerequisite: CHEM 51B and CHEM H52LB. CHEM 51B with a grade of C- or better. CHEM H52LB with a grade of C- or better

Overlaps with CHEM 51LD, CHEM M52LC.

CHEM M52LA. Majors Organic Chemistry Laboratory. 3 Units.
Modern techniques of organic chemistry, using selected experiments to illustrate topics introduced in CHEM 51A-B-C. Materials fee.

Corequisite: CHEM 51A
Prerequisite: (CHEM 1C or CHEM H2C or CHEM M2C or CHEM M3C) and (CHEM H2LB or CHEM M2LB or CHEM 1LD). CHEM 1C with a grade of C- or better. CHEM H2C with a grade of C- or better. CHEM M2C with a grade of C- or better. CHEM M3C with a grade of C- or better. CHEM H2LB with a grade of C- or better. CHEM M2LB with a grade of C- or better. CHEM 1LD with a grade of C- or better

Overlaps with CHEM H52LA, CHEM 51LB.

Restriction: Chemistry Majors only.

CHEM M52LB. Majors Organic Chemistry Laboratory. 3 Units.
Modern techniques of organic chemistry, using selected experiments to illustrate topics introduced in CHEM 51A-B-C. Materials fee.

Corequisite: CHEM 51B
Prerequisite: CHEM 51A and CHEM M52LA. CHEM 51A with a grade of C- or better. CHEM M52LA with a grade of C- or better

Overlaps with CHEM H52LB, CHEM 51LC.

Restriction: Chemistry Majors only.

CHEM M52LC. Majors Organic Chemistry Laboratory. 3 Units.
Modern techniques of organic chemistry, using selected experiments to illustrate topics introduced in CHEM 51A-B-C. Materials fee.

Corequisite: CHEM 51C
Prerequisite: CHEM 51B and (CHEM M52LB or CHEM H52LB). CHEM 51B with a grade of C- or better. CHEM M52LB with a grade of C- or better. CHEM H52LB with a grade of C- or better

Overlaps with CHEM H52LC, CHEM 51LD.

Restriction: Chemistry Majors only.

CHEM H90. The Idiom and Practice of Science. 4 Units.
A series of fundamental and applied problems in the chemical sciences are addressed. Topics may include the periodic table, electronic structure of atoms, chemical bonding, molecular structure, thermodynamics, and kinetics, with applications to energy and the environment, and/or biochemistry.

Restriction: Campuswide Honors Collegium students only.

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CHEM 100. Special Topics in Chemistry. 4 Units.
Devoted to current topics in the advanced fields of chemical sciences. Topics addressed vary each quarter.

Prerequisite: (CHEM 51C or CHEM H52C) and (CHEM M3C or CHEM M2C or CHEM 1C or CHEM H2C)

Repeatability: May be taken for credit 3 times as topics vary.

Restriction: Chemistry Honors students only. Chemistry Majors have first consideration for enrollment.

CHEM 100S. Laboratory Safety for Chemists.
Provide students with the fundamentals of safety involved in chemical laboratory work.

Prerequisite or corequisite: CHEM 51C

Grading Option: Pass/no pass only.

Restriction: Chemistry Majors have first consideration for enrollment.

CHEM 101W. Writing in Chemical Sciences. 4 Units.
Students receive guidance on preparing research papers, proposals, reports, and other forms of scientific writing in chemistry-related fields, on effectively searching for and using chemical information, and on communicating data in poster and platform presentations.

Prerequisite: Satisfactory completion of the Lower-Division Writing requirement.

Restriction: Upper-division students only. Chemistry Majors have first consideration for enrollment.

(Ib)

CHEM 107. Inorganic Chemistry. 4 Units.
Introduction to modern inorganic chemistry. Principles of structure, bonding, and chemical reactivity with application to compounds of the main group and transition elements, including organometallic chemistry.

Prerequisite: CHEM 51C or CHEM H52C

Restriction: Chemistry Majors have first consideration for enrollment.

CHEM 107L. Inorganic Chemistry Laboratory. 3 Units.
Modern techniques of inorganic and organometallic chemistry, including experience with glove box, Schlenk line, and vacuum line methods. Materials fee.

Corequisite: CHEM 100S
Prerequisite: CHEM 107 and CHEM 100S

Restriction: Chemistry Majors have first consideration for enrollment.

CHEM 125. Advanced Organic Chemistry. 4 Units.
Rapid-paced comprehensive treatment of organic chemistry. Focuses on molecular structure, reactivity, stability, scope and mechanisms of organic reactions. Topics include: structure and bonding; theoretical organic chemistry; acidity and basicity; reactive intermediates; pericyclic reactions; stereochemistry; organic synthesis; natural products; organic photochemistry.

Prerequisite: CHEM 51C

Restriction: Chemistry Majors have first consideration for enrollment.

CHEM 127. Inorganic Chemistry II. 4 Units.
Advanced treatment of selected fundamental topics in inorganic chemistry, building on material presented in Chemistry 107. Molecular symmetry with applications to electronic structure and spectroscopy. Reaction kinetics and mechanisms; inorganic synthesis and catalysis; bioinorganic chemistry.

Prerequisite: CHEM 107

Restriction: Chemistry Majors have first consideration for enrollment.

CHEM 128. Introduction to Chemical Biology. 4 Units.
Introduction to the basic principles of chemical biology: structures and reactivity; chemical mechanisms of enzyme catalysis; chemistry of signalling, biosynthesis, and metabolic pathways.

Corequisite: CHEM 128L
Prerequisite: (CHEM 51C or CHEM H52C)

Restriction: Chemistry Majors have first consideration for enrollment.

CHEM 128L. Introduction to Chemical Biology Laboratory Techniques. 3 Units.
Introduction to the basic laboratory techniques of chemical biology: electrophoresis, plasmid preparation, PCR, protein expression, isolation, and kinetics. Materials fee.

Corequisite: CHEM 128

Restriction: Chemistry Majors have first consideration for enrollment.

CHEM 132A. Chemical Thermodynamics, Kinetics, and Dynamics. 4 Units.
Energy, entropy, and the thermodynamic potentials. Chemical equilibrium. Chemical kinetics.

Corequisite: CHEM 5 or MATH 3D
Prerequisite: MATH 2D and (PHYS 7D or PHYS 7E) and (CHEM 5 or (MATH 3D and (EECS 10 or EECS 12 or MAE 10 or ICS 31)))

Overlaps with CHEM 131C.

Restriction: Chemistry Majors have first consideration for enrollment.

CHEM 132B. Quantum Principles, Spectroscopy, and Bonding. 4 Units.
Principles of quantum chemistry with applications to the elements of atomic structure, energy levels, and spectroscopy.

Prerequisite: (CHEM 132A or CBE 40C) and (PHYS 7D or PHYS 7E). CHEM 132A with a grade of C- or better

Restriction: Chemistry Majors have first consideration for enrollment.

CHEM 132C. Molecular Structure and Elementary Statistical Mechanics. 4 Units.
Principles of quantum mechanics with applications to molecular spectroscopy and structure determination, and chemical bonding in simple molecules. Elements of statistical mechanics.

Prerequisite: CHEM 132B

Overlaps with CHEM 131B.

Restriction: Chemistry Majors have first consideration for enrollment.

CHEM 133. Nuclear and Radiochemistry. 4 Units.
Advanced treatment of nuclear structure, nuclear reactions, and radioactive-decay processes. Introduction to nuclear activation analysis, isotope effects, radiation chemistry, hot-atom chemistry, nuclear age-dating methods, nuclear reactors, and nuclear power.

Prerequisite: (CHEM M3C or CHEM 1C or CHEM H2C or CHEM M2C) and MATH 2D

Same as CBE 176.

Restriction: Chemistry Majors have first consideration for enrollment. Chemical Engineering Majors have first consideration for enrollment.

Concurrent with CHEM 233 and CBE 276.

CHEM 133L. Nuclear and Radiochemistry Laboratory. 3 Units.
Practical aspects of production, separation, safe handling, detection, and measurement of radioactive isotopes. Experiments use the UCI nuclear reactor and emphasize uses of radioisotopes in chemistry, engineering, biology, and medicine. Materials fee.

Prerequisite or corequisite: CHEM 133

Restriction: Chemistry Majors have first consideration for enrollment.

CHEM 138. Introduction to Computational Organic Chemistry. 4 Units.
An introduction to the use of computational chemistry to investigate reaction mechanisms, to calculate structures, and to predict properties of molecules. Students have the opportunity to perform calculations employing computational methods which are widely used in various fields of chemistry. Materials fee.

Prerequisite: CHEM 51C

Restriction: Chemistry Majors have first consideration for enrollment.

CHEM 141. Environmental Chemistry. 4 Units.
Processes that control the fate of chemicals in the environment. Chemistry of the atmosphere, hydrosphere, and soils, especially as it pertains to pollutants.

Prerequisite: (CHEM 51C or CHEM H52C) and (MATH 2B or AP Calculus BC). AP Calculus BC with a minimum score of 4

CHEM 145A. Gas-Phase Atmospheric Chemistry. 4 Units.
Sources, chemistry, sinks, and measurements of key atmospheric gaseous species. Chemistry of photochemical oxidant formation, transformation of key inorganic and organic trace gases, and stratospheric ozone cycling. Applications of atmospheric chemistry models to control strategies.

Prerequisite: CHEM 132A and CHEM 132B and CHEM 132C

Concurrent with CHEM 245A.

CHEM 145B. Multi-Phase Atmospheric Chemistry. 4 Units.
Chemical and physical processes leading to the production, aging, and removal of atmospheric particles. Multi-phase processes involving gases, particles, water droplets, and environmental surfaces. Approaches for modeling these processes with applications to control strategies.

Prerequisite: CHEM 145A

Concurrent with CHEM 245B.

CHEM 150. Computational Chemistry. 4 Units.
Basic concepts, methods, and techniques in computational chemistry: density functional and wavefunction theory, molecular property calculations, analysis tools, potential energy surfaces, vibrational effects, molecular dynamics simulations.

Corequisite: CHEM 132A
Prerequisite: MATH 3A and (CHEM 132A or PHYS 113A)

Restriction: Chemistry Majors have first consideration for enrollment.

Concurrent with CHEM 250.

CHEM 150L. Computational Chemistry Laboratory. 4 Units.
Introduction to the practice of modern computational chemistry through a series of advanced computational experiments.

Prerequisite: CHEM 150 and (CHEM 5 or PHYS 50 or EECS 12)

Restriction: Chemistry Majors have first consideration for enrollment.

Concurrent with CHEM 250L.

CHEM 152. Advanced Analytical Chemistry. 5 Units.
In-depth treatment of modern instrumental methods for quantitative analysis of real samples and basic principles of instrument design. Laboratory experiments using spectroscopic, chromatographic, mass spectrometric, and other instrumental methods. Materials fee.

Prerequisite: (CHEM 1C or CHEM M3C or CHEM H2C or CHEM M2C) and (CHEM M3LC or CHEM H2LC)

Restriction: Chemistry Majors have first consideration for enrollment.

CHEM 153. Physical Chemistry Laboratory. 4 Units.
Introduction to the modern experimental approaches and software tools used in spectroscopy, kinetics, electrochemistry, and other physical chemistry experiments. Basics of interfacing with instruments using LabView. Materials fee.

Corequisite: CHEM 132C

Restriction: Chemistry Majors have first consideration for enrollment.

CHEM 156. Advanced Laboratory in Chemistry and Synthesis of Materials. 4 Units.
Modern synthesis and characterization of organic and inorganic materials including polymers, nanomaterials, and biomaterials. State-of-the-art characterization techniques include gel permeation chromatography, dynamic light scattering, thermal analysis, mechanical analysis, electron and scanning probe microscopy, X-ray diffraction, and porosimetry. Materials fee.

Prerequisite: (CHEM 51C or CHEM H52C) and (CHEM 51LC or CHEM H52LC or CHEM M52LC) and (CHEM 131A or CHEM 132B or PHMS 171)

Restriction: Chemistry Majors have first consideration for enrollment.

CHEM 160. Organic Synthesis Laboratory. 4 Units.
Modern experimental techniques in organic synthesis including experience with thin-layer chromatography, liquid chromatography, and gas chromatography. Modern methods of structure elucidation including FT NMR are employed in the characterization of products. Materials fee.

Corequisite: CHEM 100S
Prerequisite: CHEM 51C and CHEM 100S and (CHEM 51LC or CHEM H52LC or CHEM M52LC)

Restriction: Chemistry Majors have first consideration for enrollment.

CHEM 177. Medicinal Chemistry. 4 Units.
An introduction of the basics of drug activity and mechanisms. Strategies used to identify lead compounds such as natural product chemistry, combinatorial chemistry, molecular modeling, and high-through put screening. Relationship of molecular structure to pharmacological activity.

Prerequisite: CHEM 51A and CHEM 51B and CHEM 51C and (BIOL 98 or CHEM 128)

Same as PHMS 177.

Restriction: Pharmaceutical Sciences Majors have first consideration for enrollment.

CHEM 177L. Medicinal Chemistry Laboratory. 3 Units.
An introduction of the basics of drug activity and mechanisms. Strategies used to identify lead compounds such as natural product chemistry, combinatorial chemistry, molecular modeling, and high-through put screening. Relationship of molecular structure to pharmacological activity. Materials fee.

Corequisite: PHRMSCI 177 or CHEM 177.
Prerequisite: CHEM 51A and CHEM 51B and CHEM 51C and BIOL 100 and (BIOL 98 or CHEM 128)

Same as PHMS 177L.

Restriction: Pharmaceutical Sciences Majors have first consideration for enrollment.

(Ib)

CHEM 180. Undergraduate Research. 4 Units.
Research for credit arranged with a faculty member to sponsor and supervise work. Student time commitment of 10 to 15 hours per week is expected, and a written research report is required at the end of each quarter.

Prerequisite or corequisite: CHEM 100S

Repeatability: May be repeated for credit unlimited times.

CHEM 180W. Senior Thesis in Chemistry. 4 Units.
Students receive guidance on preparing research papers, proposals, reports, and other forms of scientific writing in chemistry-related fields; on effectively searching for and using chemical information; and on communicating data in poster and platform presentations.

Prerequisite: CHEM 180 or CHEM 199 or PHYS 195 or ESS 199 or CEMS 199 or CEE 199 or MAE 199 or BIOL 199 or PUBH 199. CHEM 180 with a grade of A or better. CHEM 199 with a grade of A or better. PHYS 195 with a grade of A or better. ESS 199 with a grade of A or better. CEMS 199 with a grade of A or better. CEE 199 with a grade of A or better. MAE 199 with a grade of A or better. BIOL 199 with a grade of A or better. PUBH 199 with a grade of A or better. Consent of the instructor is also accepted. Satisfactory completion of the Lower-Division Writing requirement.

Restriction: Upper-division students only. Chemistry Majors have first consideration for enrollment.

(Ib)

CHEM H180A. Honors Research in Chemistry. 4 Units.
Undergraduate honors research in Chemistry. A student time commitment of 10-15 hours per week is required.

Restriction: Chemistry Honors students only. Campuswide Honors Collegium students only.

CHEM H180B. Honors Research in Chemistry. 4 Units.
Undergraduate honors research in Chemistry. A student time commitment of 10-15 hours per week is required.

Prerequisite: CHEM H180A

Restriction: Campuswide Honors Collegium students only.

CHEM H180C. Honors Research in Chemistry. 4 Units.
Undergraduate honors research in Chemistry. A student time committment of 10-15 hours per week is required.

Prerequisite: CHEM H180B

Restriction: Chemistry Honors students only. Chemistry majors participating in the Campuswide Honors Program students only.

CHEM H181W. Honors Seminar in Chemistry. 2 Units.
Students will receive guidance in the preparation of oral and written research presentations. A written thesis will be prepared and a formal research seminar will be presented.

Corequisite: CHEM H180C
Prerequisite: CHEM H180A and CHEM H180B. Satisfactory completion of the Lower-Division Writing requirement.

(Ib)

CHEM 192. Tutoring in Chemistry. 2 Units.
Enrollment limited to participants in the Chemistry Peer Tutoring Program.

Repeatability: May be taken for credit 9 times.

Restriction: The first eight may be taken for a letter grade. The remaining ten units must be taken Pass/Not Pass only. NOTE: No more than eight units may be counted toward the 180 units required for graduation. Satisfies no degree requirement other than contribution to the 180-unit total.

CHEM 193. Research Methods. 4 Units.
Explores tools of inquiry for developing and implementing science research projects. Students undertake independent projects requiring data collection, analysis, and modeling, and the organization and presentation of results. Additional topics include ethical issues and role of scientific literature.

Prerequisite: BIOL 14 or PS 5

Same as BIOL 108, PHYS 193.

CHEM 197. Professional Internship. .5-4 Units.
Internship program that provides students with opportunity to develop professional skills necessary for competitive placement in their chosen chemical-inspired industry. Students gain new and field-specific skills outside the classroom while participating in a supervised internship.

Prerequisite: Enrollment requires completion of an application form. Student selection is made by a selection committee.

Repeatability: May be taken for credit for 13 units.

Restriction: Upper-division students only. Chemistry Majors only.

CHEM 199. Independent Study in Chemistry. 1-4 Units.
Independent research with Chemistry faculty. Student time commitment of three to four hours per week per unit is expected, and a written report on the independent study is required at the end of each quarter of enrollment.

Repeatability: Unlimited as topics vary.

CHEM 200. Conduct of Research . .5-2 Units.
Introduces new graduate students to ethical conduct of scientific research, mentoring, and current research in the Department of Chemistry.

Repeatability: May be taken for credit 2 times.

CHEM 201. Organic Reaction Mechanisms I. 4 Units.
Advanced treatment of basic mechanistic principles of modern organic chemistry. Topics include molecular orbital theory, orbital symmetry control of organic reactions, aromaticity, carbonium ion chemistry, free radical chemistry, the chemistry of carbenes and carbanions, photochemistry, electrophilic substitutions, aromatic chemistry.

Prerequisite: CHEM 132A and CHEM 132B and CHEM 132C

CHEM 202. Organic Reaction Mechanisms II. 4 Units.
Topics include more in-depth treatment of mechanistic concepts, kinetics, conformational analysis, computational methods, stereoelectronics, and both solution and enzymatic catalysis.

Prerequisite: CHEM 201. CHEM 201 with a grade of B- or better

CHEM 203. Organic Spectroscopy. 4 Units.
Modern methods used in structure determination of organic molecules. Topics include mass spectrometry; ultraviolet, chiroptical, infrared, and nuclear magnetic resonance spectroscopy.

Prerequisite: (CHEM 51A and CHEM 51B and CHEM 51C) or (CHEM H52A and CHEM H52B and CHEM H52C)

Restriction: Graduate students only.

CHEM 204. Organic Synthesis I. 4 Units.
Fundamentals of modern synthetic organic chemistry is developed. Major emphasis is on carbon-carbon bond forming methodology. Topics include carbonyl annelations, cycloadditions, sigmatropic rearrangements, and organometallic methods.

CHEM 205. Organic Synthesis II. 4 Units.
Fundamentals of modern synthetic organic chemistry will be developed. Major emphasis this quarter is on natural product total synthesis and retrosynthetic (antithetic) analysis.

Prerequisite: CHEM 204. CHEM 204 with a grade of B- or better

CHEM 206. Advanced Data Acquisition and Analysis. 4-6 Units.
Introduces students to a variety of practical laboratory techniques, including lock-in, boxcar, coincidence counting, noise filtering, PID control, properties of common transducers, computer interfacing to instruments, vacuum technology, laboratory safety, basic mechanical design, and shop skills. Materials fee.

Same as PHYS 206.

Concurrent with PHYS 106.

CHEM 207. Applied Physical Chemistry. 4 Units.
Introduction to fundamental concepts in molecular structure and reactivity: theory of bonding, valence and molecular orbitals; structure and reactivity in inorganic chemistry; elements in molecular group theory; nomenclature in organic chemistry; and survey of macromolecules.

Same as PHYS 207.

CHEM 208. Math Methods. 4 Units.
Applications of mathematics to physical and chemical problems. Calculus of special functions, complex variables and vectors; linear vector spaces and eigenvalue problems. Differential equations.

Same as PHYS 208.

CHEM 213. Chemical Kinetics. 4 Units.
Surveys gas phase and organic reaction mechanisms and their relationship to kinetic rate laws; treats the basic theory of elementary reaction rates. A brief presentation of modern cross-sectional kinetics is included.

Prerequisite: CHEM 132A and CHEM 132B and CHEM 132C

CHEM 215. Inorganic Chemistry I. 4 Units.
Principles of modern inorganic chemistry with applications to chemical systems of current interest. Inorganic phenomena are organized into general patterns which rationalize observed structures, stabilities, and physical properties.

Prerequisite: CHEM 107 and CHEM 132A and CHEM 132B and CHEM 132C

Restriction: Graduate students only.

CHEM 216. Organometallic Chemistry. 4 Units.
Synthesis and reactivity of organometallic complexes with an emphasis on mechanisms. Topics include bonding and fluxional properties; metal-carbon single and multiple bonds; metal š-complexes. Applications to homogenous catalysis and organic synthesis are incorporated throughout the course.

Prerequisite: CHEM 107 or CHEM 215. CHEM 215 with a grade of B- or better

CHEM 217. Physical Inorganic Chemistry. 4 Units.
General principles of the spectroscopy and magnetism of inorganic compounds. Characterization of inorganic complexes by infrared, near-infrared, visible, ultraviolet, NMR, EPR, EXAFS, and Mossbauer spectroscopies. Some necessary group theory developed.

Prerequisite: CHEM 215. CHEM 215 with a grade of B- or better

CHEM 218. Metallobiochemistry . 4 Units.
A review of the biochemistry of metallic elements emphasizing: methods for studying metals in biological systems; the chemical basis for nature's exploitation of specific elements; structures of active sites; mechanisms; solid-state structures and devices; metals in medicine.

Prerequisite or corequisite: CHEM 131C or CHEM 132C

Same as MBB 248.

CHEM 219. Chemical and Structural Biology. 4 Units.
A survey of the organic chemistry underlying biological function. Introduction to chemical genetics, receptor-ligand interactions, small molecule agonists and antagonists, combinatorial synthesis, high throughput assays, molecular evolution, protein and small molecule design.

Restriction: Graduate students only.

CHEM 220. Advanced Chemical Biology. 4 Units.
Modern topics in chemical biology, with an emphasis on application of principles from organic chemistry to biological research and biotechnology. Topics include methods to generate, identify, and manipulate major classes of biomolecules including nucleic acids, carbohydrates, lipids, and secondary metabolites.

Prerequisite: CHEM 219. CHEM 219 with a grade of B- or better

Restriction: Graduate students only.

CHEM 221A. Fundamentals of Molecular Biophysics. 4 Units.
An overview of the principles and concepts in molecular biophysics. Topics covered include energy and entropy in biology, non-equilibrium reaction kinetics, random walks and molecular diffusion, molecular forces in biology.

Prerequisite: Undergraduate courses in physical chemistry and biochemistry.

Repeatability: May be taken for credit 3 times.

CHEM 223. Biological Macromolecules. 4 Units.
Introduction to nucleic acid and protein structure, dynamics, and function. Topics include analytical methods, molecular evolution, folding, and catalysis.

Same as PHMS 223.

CHEM 225. Polymer Chemistry: Synthesis and Characterization of Polymers. 4 Units.
Structure of synthetic and natural polymers. Survey of modern polymer synthetic methods. Molecular weight and molecular weight distribution. Chain conformation and stereochemistry. Introduction to polymer characterization, chain models, and solution behavior.

Prerequisite: Undergraduate courses in organic and physical chemistry.

CHEM 228. Electromagnetism. 4 Units.
Maxwell's equations, electrodynamics, electromagnetic waves and radiation, wave propagation in media, interference and quantum optics, coherent and incoherent radiation, with practical applications in interferometry, lasers, waveguides, and optical instrumentation.

Same as PHYS 228.

CHEM 229A. Mathematical Methods for the Physical Sciences. 4 Units.
Mathematical and numerical analysis using Mathematica and C programming, as applied to problems in physical science.

Same as PHYS 229A.

Concurrent with PHYS 100.

CHEM 230. Classical Mechanics and Electromagnetic Theory. 4 Units.
Fundamentals of classical mechanics and electromagnetic theory are developed with specific application to molecular systems. Newtonian, Lagrangian, and Hamiltonian mechanics are developed. Boundary value problems in electrostatics are investigated. Multipole expansion and macroscopic media are discussed from a molecular viewpoint.

Prerequisite: CHEM 132A and CHEM 132B and CHEM 132C

CHEM 231A. Fundamentals of Quantum Mechanics. 4 Units.
The postulates of quantum mechanics are discussed and applied to a variety of model problems.

Prerequisite: CHEM 131A and CHEM 131B and CHEM 131C

CHEM 231B. Applications of Quantum Mechanics. 4 Units.
Approximate methods for solving atomic and molecular structure problems are developed, and the application of quantum mechanics to spectroscopy is introduced.

Prerequisite: CHEM 231A. CHEM 231A with a grade of B- or better

CHEM 231C. Molecular Spectroscopy. 4 Units.
Theory and techniques of spectroscopy as used for the study of molecular and condensed phase properties. Coherent time domain spectroscopies are covered.

Prerequisite: CHEM 231B. CHEM 231B with a grade of B- or better

CHEM 232A. Thermodynamics and Introduction to Statistical Mechanics. 4 Units.
A detailed discussion from an advanced point of view of the principles of classical thermodynamics. The fundamentals of statistical mechanics. Topics include an introduction to ensemble theory, Boltzmann statistics, classical statistical mechanics, and the statistical mechanics of ideal gas systems.

Prerequisite: CHEM 131A and CHEM 131B and CHEM 131C

CHEM 232B. Advanced Topics in Statistical Mechanics. 4 Units.
Continued discussion of the principles of statistical mechanics. Applications to topics of chemical interest including imperfect gases, liquids, solutions, and crystals. Modern techniques such as the use of autocorrelation function methods.

Prerequisite: CHEM 232A. CHEM 232A with a grade of B- or better

CHEM 232C. Non-Equilibrium Statistical Mechanics. 4 Units.
Phenomenology of material processes, including: kinetic theories of transport and continuum, linear response theory, critical phenomena of phase transition, self-assembly, and nucleation.

CHEM 233. Nuclear and Radiochemistry. 4 Units.
Advanced treatment of nuclear structure, nuclear reactions, and radioactive-decay processes. Introduction to nuclear activation analysis, isotope effects, radiation chemistry, hot-atom chemistry, nuclear age-dating methods, nuclear reactors, and nuclear power.

Same as CBE 276.

Restriction: Graduate students only.

Concurrent with CHEM 133 and CBE 176.

CHEM 237. Mathematical Methods in Chemistry. 4 Units.
Survey of essential math methods in chemistry. Topics may include series and limits, complex analysis, Fourier and Laplace transforms, linear algebra and operators (theory and algorithms), differential equations, and probability concepts for stochastic processes.

CHEM 238. Special Topics in Density Functional Theory . 1-4 Units.
Advanced topics in density functional theory.

Prerequisite: One year of graduate quantum mechanics, or the equivalent.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

CHEM 239. Machine Learning in Chemistry. 4 Units.
Introductory course in machine learning, accessible to any graduate student in chemistry. Covers the basics of theory and practice of machine learning in modern chemistry. No coding or previous experience required.

Prerequisite: Must be familiar with standard computer operation.

Restriction: Graduate students only.

CHEM 241. Current Issues Related to Air Quality, Climate, and Energy. 4 Units.
Current issues related to the atmosphere, climate, and air quality in the context of energy conversion and sustainability. Topics include transportation systems; building design; impacts on humans and ecosystems; modeling and meteorology; economics; and application to public policies.

Prerequisite: MAE 261 or CHEM 245 or ESS 240. MAE 261 with a grade of B- or better. CHEM 245 with a grade of B- or better. ESS 240 with a grade of B- or better

Same as MAE 260.

Restriction: Graduate students only.

CHEM 243. Advanced Instrumental Analysis. 4 Units.
Theory and applications of modern advanced instrumental methods of analysis. Includes data acquisition, storage, retrieval, and analysis; Fourier transform methods; vacuum technologies; magnetic sector; quadrupole and ion trap mass spectrometry; surface science spectroscopic methods; lasers and optics.

Prerequisite: CHEM 152 and CHEM 132C. CHEM 152 with a grade of B or better. CHEM 132C with a grade of B or better

CHEM 244. Detection and Measurement of Radiation. 4 Units.
Basic principles of detection and measurement of ionizing radiation; both theory and practical aspects of measurement techniques for alpha, beta, gamma, and neutron radiation, properties of different detector materials, electronics and data treatments, and analysis.

Prerequisite: CHEM 233 or CBE 276. CHEM 233 with a grade of B- or better. CBE 276 with a grade of B- or better

Same as CBE 277.

Restriction: Graduate students only.

CHEM 245A. Gas-Phase Atmospheric Chemistry. 4 Units.
Sources, chemistry, sinks, and measurements of key atmospheric gaseous species. Chemistry of photochemical oxidant formation, transformation of key inorganic and organic trace gases, and stratospheric ozone cycling. Applications of atmospheric chemistry models to control strategies.

Prerequisite: CHEM 132A and CHEM 132B and CHEM 132C

Concurrent with CHEM 145A.

CHEM 245B. Multi-Phase Atmospheric Chemistry. 4 Units.
Chemical and physical processes leading to the production, aging, and removal of atmospheric particles. Multi-phase processes involving gases, particles, water droplets, and environmental surfaces. Approaches for modeling these processes with applications to control strategies.

Prerequisite: CHEM 245A. CHEM 245A with a grade of B- or better

Concurrent with CHEM 145B.

CHEM 245C. Special Topics in Atmospheric Chemistry. 4 Units.
The subjects covered vary from year to year.

Prerequisite: CHEM 245B. CHEM 245B with a grade of B- or better

Repeatability: Unlimited as topics vary.

CHEM 246. Separations and Chromatography. 4 Units.
Introduction to modern separation techniques such as gas chromatography, high-performance liquid chromatography, supercritical fluid chromatography, capillary electrophoresis, and field flow fractionation. Applications of these separation strategies are discussed.

CHEM 248. Electrochemistry. 4 Units.
Fundamentals of electrochemistry including thermodynamics and the electrochemical potential, charge transfer kinetics, and mass transfer. Methods based on controlled potential and controlled current are described; the effects of slow heterogeneous kinetics and the perturbation caused by homogeneous chemistry are discussed.

CHEM 249. Analytical Spectroscopy. 4 Units.
Advanced treatment of spectroscopic techniques and instrumentation. Atomic and molecular absorption, emission, and scattering processes and their application to quantitative chemical analysis are outlined. Puts different spectroscopic techniques in perspective and demonstrates most appropriate applications to analytical problems.

CHEM 250. Computational Chemistry. 4 Units.
Basic concepts, methods, and techniques in computational chemistry: density functional and wavefunction theory, molecular property calculations, analysis tools, potential energy surfaces, vibrational effects, molecular dynamics simulations.

Restriction: Graduate students only.

Concurrent with CHEM 150.

CHEM 250L. Computational Chemistry Laboratory. 4 Units.
Introduction to the practice of modern computational chemistry through a series of advanced computational experiments.

Prerequisite: CHEM 250. CHEM 250 with a grade of B- or better

Restriction: Graduate students only.

Concurrent with CHEM 150L.

CHEM 251. Special Topics in Organic Chemistry. 1-4 Units.
Advanced topics in organic chemistry.

Repeatability: Unlimited as topics vary.

CHEM 252. Special Topics in Physical Chemistry. 1-4 Units.
Advanced topics in physical chemistry. Materials fee.

Repeatability: Unlimited as topics vary.

CHEM 254. Special Topics in Computational and Theoretical Chemistry. 4 Units.
Subjects covered vary from year to year.

Repeatability: Unlimited as topics vary.

CHEM 255. Special Topics in Quantum Science. 1 Unit.
Advanced topics in quantum science.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

CHEM 263. Materials Chemistry . 4 Units.
An introduction to crystalline solids, descriptive crystal chemistry, solid-state synthesis and characterization techniques, x-ray and electron diffraction, phase diagrams, electronic band structure of extended solids, semi conductors, and nanoscale inorganic materials.

CHEM 264. Analytical Methods for Organic Nanomaterials. 4 Units.
Fundamentals of analytical techniques related to measuring the structure and dynamics of organic nanomaterials. Topics include transmission electron microscopy, cryo-electron microscopy, liquid phase electron microscopy, scanning electron microscopy, atomic force microscopy, light scattering, small angle X-ray, and neutron scattering.

Restriction: Graduate students only.

CHEM 266. Current Topics in Chemical, Applied, and Materials Physics. 1 Unit.
The subjects covered vary from year to year. Connection between fundamental principles and implementations in practice in science, industry, and technology.

Repeatability: May be repeated for credit unlimited times.

Same as PHYS 266.

CHEM 267. Photochemistry. 4 Units.
Photochemical and photovoltaic processes in molecules and semiconductors; quantum mechanics; statistical thermodynamics; kinetics; and experimental techniques relevant to photon absorption and emission; photochemical charge separation, recombination, and transport of electrons and ions; and interfacial redox chemistry.

Restriction: Seniors only. Graduate students only.

CHEM 273. Technical Communication Skills. 2 Units.
Development of effective communication skills, oral and written presentations, through examples and practice.

Grading Option: Satisfactory/unsatisfactory only.

Same as PHYS 273.

CHEM 280. Research. 2-12 Units.
Supervised original research toward the preparation of a Ph.D dissertation or M.S. thesis.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.

CHEM 290. Seminar. 1 Unit.
Weekly seminars and discussions on general and varied topics of current interest in chemistry.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.

CHEM 291. Research Seminar. 4 Units.
Detailed discussion of research problems of current interest in the Department. Format, content, and frequency of the course are variable.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

CHEM 292. Graduate Symposium. 2 Units.
Students present public seminars on literature-based research topics in contemporary chemistry. Topics to be chosen by student and approved by instructor.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

CHEM 299. Independent Study. 1-4 Units.
Independent research with Chemistry faculty.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.

CHEM 399. University Teaching. 1-4 Units.
Required of and limited to Teaching Assistants.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.