CHEMISTRY

Undergraduate Office: 340 Havemeyer; 212-854-2163

Departmental Office: 344 Havemeyer; 212-854-2202
https://chem.columbia.edu/

Program Manager for Undergraduate Studies: Dr. Vesna Gasperov, 355 Chandler; 212-854-2017; vg2231@columbia.edu

Biochemistry Advisers:
Please see Dr. Gasperov for your initial advising session for Biochemistry.

Biology: (for course planning queries) Prof. John Hunt, 702A Fairchild; 212-854-5443; jfh21@columbia.edu (stockwell@biology.columbia.edu); (for research and graduate school queries) Prof. James Manley, 1117A Fairchild; 212-854-4647; jlm2@columbia.edu (stockwell@biology.columbia.edu)
Chemistry: Prof. Virginia Cornish, 1209 Northwest Corner Building; 212-854-5209; vc114@columbia.edu (stockwell@biology.columbia.edu)

Chemistry, the study of molecules, is a central science interesting for its own sake but also necessary as an intellectual link to the other sciences of biology, physics, and environmental science. Faculty find the various disciplines of chemistry fascinating because they establish intellectual bridges between the macroscopic or human-scale world that we see, smell, and touch, and the microscopic world that affects every aspect of our lives. The study of chemistry begins on the microscopic scale and extends to engage a variety of different macroscopic contexts.

Chemistry is currently making its largest impact on society at the nexus between chemistry and biology and the nexus between chemistry and engineering, particularly where new materials are being developed. A typical chemistry laboratory now has more computers than test tubes and no longer smells of rotten eggs.

The chemistry department majors are designed to help students focus on these new developments and to understand the factors influencing the nature of the discipline. Because the science is constantly changing, courses change as well, and while organic and physical chemistry remain the bedrock courses, they too differ greatly from the same courses 40 years ago. Many consider biochemistry to be a foundation course as well. Although different paths within the chemistry major take different trajectories, there is a core that provides the essential foundation students need regardless of the path they choose. Students should consider majoring in chemistry if they share or can develop a fascination with the explanatory power that comes with an advanced understanding of the nature and influence of the microscopic world of molecules.

Students who choose to major in chemistry may elect to continue graduate study in this field and obtain a Ph.D. which is a solid basis for a career in research, either in the industry or in a university. A major in chemistry also provides students with an astonishing range of career choices such as working in the chemical or pharmaceutical industries or in many other businesses where a technical background is highly desirable. Other options include becoming a financial analyst for a technical company, a science writer, a high school chemistry teacher, a patent attorney, an environmental consultant, or a hospital laboratory manager, among others. The choices are both numerous and various as well as intellectually exciting and personally fulfilling.

Advanced Placement

The department grants advanced placement (AP) credit for a score of 4 or 5 or the equivalent. The amount of credit granted is based on the results of the department assessment exam and completion of the requisite course. Students who receive permission to register for CHEM UN1604 2ND TERM GEN CHEM (INTENSIVE) are granted 3 points of credit; students who receive permission to register for CHEM UN2045 INTENSVE ORGANIC CHEMISTRY-CHEM UN2046 INTENSVE ORG CHEM-FOR 1ST YEAR are granted 6 points of credit. In either case, credit is granted only upon completion of the course with a grade of C or better. Students must complete a department assessment exam prior to registering for either of these courses.

Programs of Study

The Department of Chemistry offers four distinct academic major programs for undergraduates interested in professional-level training and education in the chemical sciences: chemistry, chemical physics, biochemistry and environmental chemistry. For students interested in a program of less extensive study and coursework, the department offers a concentration in chemistry.

Course Information

The results of the department assessment exam are used to advise students which track to pursue. The Department of Chemistry offers three different tracks. Students who wish to take Track 2 or 3 classes must take the department assessment exam. Students who wish to pursue Track 1 classes do not need to take the assessment exam.

Track Information

In the first year, Track 1 students with one year of high school chemistry take a one-year course in general chemistry, and the one-term laboratory course that accompanies it. In the second year, students study organic chemistry, and take organic chemistry laboratory.

Students who qualify by prior assessment during orientation week can place into the advanced tracks. There are two options. Track 2 students take, in the fall term, a special one-term intensive course in general chemistry in place of the one-year course. In the second year, students study organic chemistry and take organic chemistry laboratory. Track 3 students take a one-year course in organic chemistry for first-year students and the one-term intensive general chemistry laboratory course. In the second year, students enroll in physical chemistry and the organic chemistry laboratory course.

Additional information on the tracks can be found in the *Requirements* section.

Additional Courses

First-year students may also elect to take CHEM UN2408. This seminar focuses on topics in modern chemistry, and is offered to all students who have taken at least one semester of college chemistry and have an interest in chemical research.

Biochemistry (BIOC GU4501, BIOC GU4512) is recommended for students interested in the biomedical sciences.

Physical chemistry (CHEM UN3079-CHEM UN3080), a one-year program, requires prior preparation in mathematics and physics. The accompanying laboratory is CHEM UN3085-CHEM UN3086.

Also offered are a senior seminar (CHEM UN3920); advanced courses in biochemistry, inorganic, organic, and physical chemistry; and an introduction to research (CHEM UN3098).

Sample Programs

Some *typical* programs are shown below. Programs are crafted by the student and the Director of Undergraduate Studies and Program Manager to meet individual needs and interests.

Track 1

First Year

CHEM UN1403	GENERAL CHEMISTRY I-LECTU
CHEM UN1404	GENERAL CHEMISTRY II-LECTURES
CHEM UN1500	GENERAL CHEMISTRY LABORATORY
CHEM UN2408	First-Year Seminar in Chemical Research

Calculus and physics as required.

Second Year

CHEM UN2443	Organic Chemistry I (Lecture)
CHEM UN2444	ORGANIC CHEMSTRY II-LECTURES
CHEM UN2493	Organic Chemistry Laboratory I (Techniques)
CHEM UN2494	ORGANIC CHEM. LAB II SYNTHESIS

Calculus and physics as required.

Third Year

CHEM UN3079	Physical Chemistry I
CHEM UN3080	Physical Chemistry II
BIOC GU4501	Biochemistry: Structure and Metabolism
CHEM UN3546	Advanced Organic Chemistry Laboratory
CHEM UN3098	Supervised Independent Research

Fourth Year

CHEM UN3085	Physical and Analytical Chemistry Laboratory I
CHEM UN3086	Physical and Analytical Chemistry Laboratory II
CHEM UN3920	Senior Seminar in Chemical Research
CHEM GU4071	Inorganic Chemistry

Advanced courses (4000-level or higher)

Track 2

First Year

CHEM UN1507	Intensive General Chemistry Laboratory
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)
CHEM UN2408	First-Year Seminar in Chemical Research

Calculus and physics as required.

Second Year

CHEM UN2443	Organic Chemistry I (Lecture)
CHEM UN2444	ORGANIC CHEMSTRY II-LECTURES
CHEM UN2493	Organic Chemistry Laboratory I (Techniques)
CHEM UN2494	ORGANIC CHEM. LAB II SYNTHESIS

Calculus and physics as required.

Third Year

CHEM UN3079	Physical Chemistry I
CHEM UN3080	Physical Chemistry II
BIOC GU4501	Biochemistry: Structure and Metabolism
CHEM UN3546	Advanced Organic Chemistry Laboratory
CHEM UN3098	Supervised Independent Research

Fourth Year

CHEM UN3085	Physical and Analytical Chemistry Laboratory I
CHEM UN3086	Physical and Analytical Chemistry Laboratory II
CHEM UN3920	Senior Seminar in Chemical Research
CHEM GU4071	Inorganic Chemistry

Advanced courses (4000- level or higher)

Track 3

First Year

CHEM UN1507	Intensive General Chemistry Laboratory
CHEM UN2045	INTENSVE ORGANIC CHEMISTRY
CHEM UN2408	First-Year Seminar in Chemical Research

Calculus and Physics as required.

Second Year

CHEM UN2046	INTENSVE ORG CHEM-FOR 1ST YEAR
CHEM UN3079	Physical Chemistry I
CHEM UN3080	Physical Chemistry II
CHEM UN2545	Intensive Organic Chemistry Laboratory
CHEM UN3546	Advanced Organic Chemistry Laboratory

Calculus and physics as required.

Third Year

BIOC GU4501	Biochemistry: Structure and Metabolism
CHEM UN3085	Physical and Analytical Chemistry Laboratory I
CHEM UN3086	Physical and Analytical Chemistry Laboratory II
CHEM UN3098	Supervised Independent Research
CHEM GU4071	Inorganic Chemistry

Fourth Year

CHEM UN3920	Senior Seminar in Chemical Research

Advanced courses (4000-level or higher)

Professors

Virginia W. Cornish
Richard A. Friesner
Ruben Gonzalez
Laura Kaufman
James L. Leighton
Ann E. McDermott
Wei Min
Jack R. Norton
Colin Nuckolls
Gerard Parkin
David R. Reichman
Tomislav Rovis
Dalibor Sames
Brent Stockwell
James J. Valentini

Latha Venkataraman
Xiaoyang Zhu

Associate Professors

Angelo Cacciuto
Luis Campos
Jonathan Owen
Xavier Roy

Assistant Professors

Timothy Berkelbach
Milan Delor
Neel Shah

Senior Lecturers

Luis Avila
Anna Ghurbanyan
Sarah Hansen
Fay Ng
Joseph Ulichny

Lecturers

Robert Beer
John Decatur
Charles E. Doubleday
Ruben Savizky
Talha Siddiqui

Guidelines for all Chemistry Majors, Concentrators, and Interdepartmental Majors

Students majoring in chemistry or in one of the interdepartmental majors in chemistry should go to the director of undergraduate studies or the undergraduate program manager in the Department of Chemistry to discuss their program of study. Chemistry majors and interdepartmental majors usually postpone part of the Core Curriculum beyond the sophomore year.

Chemistry Tracks

All students who wish to start with Track 2 or 3 courses must take an assessment during orientation week ahead of fall semester. The results of the assessment are used to advise students which track to pursue. Unless otherwise specified below, all students must complete one of the following tracks:

Track 1

CHEM UN1403	GENERAL CHEMISTRY I-LECTU
CHEM UN1404	GENERAL CHEMISTRY II-LECTURES
CHEM UN1500	GENERAL CHEMISTRY LABORATORY
CHEM UN2443	Organic Chemistry I (Lecture)
CHEM UN2444	ORGANIC CHEMSTRY II-LECTURES
CHEM UN2493	Organic Chemistry Laboratory I (Techniques)
CHEM UN2494	ORGANIC CHEM. LAB II SYNTHESIS

Track 2

CHEM UN1500	GENERAL CHEMISTRY LABORATORY
or CHEM UN1507	Intensive General Chemistry Laboratory
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)
CHEM UN2443	Organic Chemistry I (Lecture)
CHEM UN2444	ORGANIC CHEMSTRY II-LECTURES
CHEM UN2493	Organic Chemistry Laboratory I (Techniques)
CHEM UN2494	ORGANIC CHEM. LAB II SYNTHESIS

Track 3

CHEM UN1507	Intensive General Chemistry Laboratory
CHEM UN2045	INTENSVE ORGANIC CHEMISTRY
CHEM UN2046	INTENSVE ORG CHEM-FOR 1ST YEAR
CHEM UN2545	Intensive Organic Chemistry Laboratory

Physics Sequences

Unless otherwise specified below, all students must complete one of the following sequences:

Sequence A

For students with limited background in high school physics:

PHYS UN1401	Introduction To Mechanics and Thermodynamics
PHYS UN1402	INTRO ELEC/MAGNETSM # OPTCS
PHYS UN1403	Introduction to Classical and Quantum Waves
For chemistry majors, the following laboratory courses are recommended, NOT required. For chemical physics majors, the following laboratory courses are required:	
PHYS UN1494	Introduction to Experimental Physics
PHYS UN2699	Experiments in Classical and Modern Physics
PHYS UN3081	INTERMEDIATE LABORATORY WORK

Sequence B

PHYS UN1601	Physics, I: Mechanics and Relativity
PHYS UN1602	Physics, II: Thermodynamics, Electricity, and Magnetism
PHYS UN2601	Physics, III: Classical and Quantum Waves
For chemistry majors, the following laboratory courses are recommended NOT required. For chemical physics majors, the following laboratory courses are required:	
PHYS UN2699	Experiments in Classical and Modern Physics
PHYS UN3081	INTERMEDIATE LABORATORY WORK

Sequence C

For students with advanced preparation in physics and mathematics:

PHYS UN2801 - PHYS UN2802	Accelerated Physics I and Accelerated Physics II
For chemistry majors, the following laboratory courses are recommended NOT required. For chemical physics majors, the following laboratory courses are required:	
PHYS UN2699	Experiments in Classical and Modern Physics
or PHYS UN3081	INTERMEDIATE LABORATORY WORK

Major in Chemistry

Select one of the tracks outlined above in *Guidelines for all Chemistry Majors, Concentrators, and Interdepartmental Majors* and complete the following lectures and labs.

Chemistry	
Select one of the chemistry tracks outlined above.	
CHEM UN2408	First-Year Seminar in Chemical Research (Recommended NOT required)
CHEM UN3079	Physical Chemistry I
CHEM UN3080	Physical Chemistry II
CHEM UN3085	Physical and Analytical Chemistry Laboratory I
CHEM UN3086	Physical and Analytical Chemistry Laboratory II
CHEM UN3546	Advanced Organic Chemistry Laboratory
CHEM UN3920	Senior Seminar in Chemical Research
CHEM GU4071	Inorganic Chemistry
Select one course from the following:	
CHEM UN3098	Supervised Independent Research
OR Chemistry courses numbered CHEM GU4000 or above for 2 credit points or more	
Physics	
Select one of the physics sequences outlined above in the Guidelines section.	
Mathematics	
Select one of the following sequences:	
Four semesters of calculus:	
MATH UN1101 - MATH UN1102 - MATH UN1201 - MATH UN1202	CALCULUS I and CALCULUS II and Calculus III and CALCULUS IV
Two semesters of honors mathematics:	
MATH UN1207 - MATH UN1208	Honors Mathematics A and HONORS MATHEMATICS B

Major in Biochemistry

Select one of the tracks outlined above in *Guidelines for all Chemistry Majors, Concentrators, and Interdepartmental Majors* and complete the following lectures and labs.

Chemistry	
Select one of the chemistry tracks outlined above.	
CHEM UN2408	First-Year Seminar in Chemical Research (Recommended NOT required)
CHEM UN3079	Physical Chemistry I
CHEM UN3080	Physical Chemistry II
Biology	
BIOL UN1908	First Year Seminar in Biology (Recommended NOT required)
BIOL UN2005	INTRO BIO I: BIOCHEM,GEN,MOLEC
BIOL UN2006	INTRO BIO II:CELL BIO,DEV/PHYS
BIOC GU4501	Biochemistry: Structure and Metabolism
or BIOC UN3300	Biochemistry
BIOC GU4512	Molecular Biology
Physics	
Select one of the following physics sequences:	
Sequence A:	
PHYS UN1201 - PHYS UN1202	General Physics I and General Physics II
Sequence B:	
PHYS UN1401 - PHYS UN1402 - PHYS UN1403	Introduction To Mechanics and Thermodynamics and INTRO ELEC/MAGNETSM # OPTCS and Introduction to Classical and Quantum Waves (PHYS UN1403 is recommended NOT required)
Sequence C:	
PHYS UN1601 - PHYS UN1602 - PHYS UN2601	Physics, I: Mechanics and Relativity and Physics, II: Thermodynamics, Electricity, and Magnetism and Physics, III: Classical and Quantum Waves (PHYS UN2601 is recommended but not required)
Sequence D:	
PHYS UN2801 - PHYS UN2802	Accelerated Physics I and Accelerated Physics II
Mathematics	
Select one of the following sequences:	
Two semesters of calculus:	
MATH UN1101 - MATH UN1102 - MATH UN1201 - MATH UN1202	CALCULUS I and CALCULUS II and Calculus III and CALCULUS IV
Two semesters of honors mathematics:	
MATH UN1207 - MATH UN1208	Honors Mathematics A and HONORS MATHEMATICS B
AP credit and one term of calculus (Calculus II or higher)	
Additional Courses	
Select two of the following upper level laboratory courses (one should be a Biology lab):	
BIOL UN3040 - BIOL UN2501	Lab in Molecular Biology and Contemporary Biology Laboratory
BIOL UN3050	Project Laboratory In Protein Biochemistry
BIOL UN3052	PROJECT LAB-MOLECULAR GENETICS
BIOL UN3500	Independent Biological Research
CHEM UN3085	Physical and Analytical Chemistry Laboratory I
CHEM UN3086	Physical and Analytical Chemistry Laboratory II
CHEM UN3098	Supervised Independent Research
CHEM UN3546	Advanced Organic Chemistry Laboratory
Select any three courses from the following:	
CHEM GU4071	Inorganic Chemistry
CHEM GU4102	Chemistry for the Brain
CHEM GU4103	Organometallic Chemistry
CHEM GU4147	Advanced Organic Chemistry
CHEM GU4312	Chemical Biology
CHEM GU4313	Peptide and Protein Chemistry
BIOC GU4323	Biophysical Chemistry I
BIOC GU4324	Biophysical Chemistry II
MATH UN3027	Ordinary Differential Equations
or MATH UN2030	ORDINARY DIFFERENTIAL EQUATIONS
One additional semester of calculus	
One additional semester of honors math:	
MATH UN1207	Honors Mathematics A
or MATH UN1208	HONORS MATHEMATICS B

Any biology course at the 3000/4000 level for 3 or more points. The following are recommended:	
BIOL UN3004	Neurobiology I: Cellular and Molecular Neurobiology
or BIOL UN3005	Neurobiology II: Development & Systems
BIOL UN3008	The Cellular Physiology of Disease
BIOL UN3022	Developmental Biology
BIOL UN3034	Biotechnology
BIOL UN3041	Cell Biology
BIOL UN3073	Cellular and Molecular Immunology
BIOL GU4065	Molecular Biology of Disease
BIOL GU4300	Drugs and Disease

Major in Chemical Physics

Select one of the tracks outlined above in *Guidelines for all Chemistry Majors, Concentrators, and Interdepartmental Majors* and complete the following lectures and labs.

Chemistry	
Select one of the chemistry tracks outlined above.	
CHEM UN3079	Physical Chemistry I
CHEM UN3080	Physical Chemistry II
CHEM UN3085	Physical and Analytical Chemistry Laboratory I
CHEM UN3086	Physical and Analytical Chemistry Laboratory II
CHEM UN3098	Supervised Independent Research
CHEM UN3920	Senior Seminar in Chemical Research
CHEM GU4221	Quantum Chemistry
or PHYS GU4021	Quantum Mechanics I
Physics	
Select one of the physics sequences outlined above in Guidelines for all Chemistry Majors, Concentrators and Interdepartmental Majors. For the chemical physics major, one lab MUST be completed for the sequence chosen.	
Complete the following lectures:	
PHYS UN3003	Mechanics
PHYS UN3007	Electricity and Magnetism
PHYS UN3008	Electromagnetic Waves and Optics
Mathematics	
Select one of the following sequences:	
Four semesters of calculus:	
MATH UN1101 - MATH UN1102 - MATH UN1201 - MATH UN1202	CALCULUS I and CALCULUS II and Calculus III and CALCULUS IV
Two semesters of honors mathematics:	
MATH UN1207 - MATH UN1208 - MATH UN3027	Honors Mathematics A and HONORS MATHEMATICS B and Ordinary Differential Equations
Two semesters of advanced calculus:	
MATH UN1202 - MATH UN3027	CALCULUS IV and Ordinary Differential Equations

Major in Environmental Chemistry

The requirements for this program were modified on February 1, 2016. Students who declared this program before this date should contact the director of undergraduate studies for the department in order to confirm their correct course of study.

Select one of the tracks outlined above in *Guidelines for all Chemistry Majors, Concentrators, and Interdepartmental Majors* and complete the following lectures and labs.

Chemistry	
Select one of the chemistry tracks outlined above. A second semester of Organic Chemistry lecture is recommended NOT required.	
CHEM UN3079	Physical Chemistry I
CHEM GU4071	Inorganic Chemistry
The following courses are recommended NOT required:	
CHEM UN2408	First-Year Seminar in Chemical Research
CHEM UN3920	Senior Seminar in Chemical Research
Earth and Environmental Science	
Select two of the following three courses:	
EESC UN2100	Earth's Environmental Systems: The Climate System
EESC UN2200	EARTH'S ENVIRONMENTAL SYSTEMS: THE SOLID EARTH
EESC UN2300	Earth's Environmental Systems: The Life System
Additional course required:	
EESC UN3101	Geochemistry for a Habitable Planet
Select one of the following labs:	
EESC BC3016	Environmental Measurements
CHEM UN3085	Physical and Analytical Chemistry Laboratory I
Select one option for Independent Research in Environmental Chemistry:	
EESC BC3800 - EESC BC3801	Senior Research Seminar and Senior Research Seminar
CHEM UN3098	Supervised Independent Research (It is strongly recommended to take CHEM UN3920 if taking CHEM UN3098)
Physics	
Select one of the following physics sequences:	
Sequence A:	
PHYS UN1201 - PHYS UN1202	General Physics I and General Physics II
Sequence B:	
PHYS UN1401 - PHYS UN1402 - PHYS UN1403	Introduction To Mechanics and Thermodynamics and INTRO ELEC/MAGNETSM # OPTCS and Introduction to Classical and Quantum Waves (Recommended NOT required)
Sequence C:	
PHYS UN1601 - PHYS UN1602 - PHYS UN2601	Physics, I: Mechanics and Relativity and Physics, II: Thermodynamics, Electricity, and Magnetism and Physics, III: Classical and Quantum Waves (Recommended, not required)
Sequence D:	
PHYS UN2801 - PHYS UN2802	Accelerated Physics I and Accelerated Physics II
Mathematics	
Two semesters of calculus:	
MATH UN1101	CALCULUS I
MATH UN1102	CALCULUS II
MATH UN1201	Calculus III

MATH UN1202	CALCULUS IV
Additional Courses	
Select any two of the following:	
Chemistry:	
CHEM UN3080	Physical Chemistry II
CHEM GU4103	Organometallic Chemistry
CHEM GU4147	Advanced Organic Chemistry
Earth and Environmental Science:	
EESC BC3017	Environmental Data Analysis
EESC BC3025	Hydrology
EESC GU4008	Introduction to Atmospheric Science
EESC GU4009	CHEMICAL GEOLOGY
EESC GU4040	CLIM THERMODYN/ENERGY TRANSFER
EESC GU4050	Global Assessment and Monitoring Using Remote Sensing
EESC GU4600	EARTH RESOURCES # SUSTAIN DEV
EESC GU4835	Wetlands and Climate Change
EESC GU4885	The Chemistry of Continental Waters
EESC GU4888	Stable Isotope Geochemistry
EESC GU4924	Introduction to Atmospheric Chemistry
EESC GU4925	Principles of Physical Oceanography
EESC GU4926	Principles of Chemical Oceanography
Earth and Environmental Engineering:	
EAEE E4001	INDUST ECOLOGY-EARTH RESOURCES
EAEE E4003	AQUATIC CHEMISTRY
Mathematics:	
One additonal semester of calculus	

Concentration in Chemistry

No more than four points of CHEM UN3098 Supervised Independent Research may be counted toward the concentration.

Select one of the three chemistry tracks listed below.	
PHYS UN1201 - PHYS UN1202	General Physics I and General Physics II
Two semesters of calculus	

Chemistry Tracks

Track 1

CHEM UN1403	GENERAL CHEMISTRY I-LECTU
CHEM UN1404	GENERAL CHEMISTRY II-LECTURES
CHEM UN1500	GENERAL CHEMISTRY LABORATORY
Select 22 points of chemistry at the 2000-level or higher (excluding CHEM UN2408).	

Track 2

CHEM UN1500	GENERAL CHEMISTRY LABORATORY
or CHEM UN1507	Intensive General Chemistry Laboratory
CHEM UN1604	2ND TERM GEN CHEM (INTENSIVE)
Select 22 points of chemistry at the 2000-level or higher (excluding CHEM UN2408).	

Track 3

CHEM UN1507	Intensive General Chemistry Laboratory
CHEM UN2045	INTENSVE ORGANIC CHEMISTRY
CHEM UN2046	INTENSVE ORG CHEM-FOR 1ST YEAR
Select 18 points of chemistry at the 2000-level or higher (excluding CHEM UN2408).	

CHEM UN0001 Preparation for College Chemistry. *0 points*.
Not for credit toward the bachelor's degree. Given on a Pass/Fail basis only.

Prerequisites: High school algebra or the instructor's permission. Recommended preparation: high school physics and chemistry. This course is preparation for *Chemistry UN1403* or the equivalent, as well as for other science courses. It is intended for students who have not attended school for sometime or who do not have a firm grasp of high school chemistry. Topics include inorganic nomenclature, chemical reactions, chemical bonding and its relation to molecular structure, stoichiometry, periodic properties of elements, chemical equilibrium, gas laws, acids and bases, and electrochemistry.

Fall 2022: CHEM UN0001

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 0001	001/11221	T Th 6:10pm - 7:25pm 209 Havemeyer Hall	Luis Avila	0	20/50

Fall 2022

Please note that some lab fees have increased. You may consult the Directory of Classes for the most up to date fees.

CHEM UN1403 GENERAL CHEMISTRY I-LECTU. *3.00 points*.

Fall 2022: CHEM UN1403

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 1403	001/11224	M W 10:10am - 11:25am 309 Havemeyer Hall	Gerard Parkin	3.00	219/225
CHEM 1403	002/11222	T Th 10:10am - 11:25am 309 Havemeyer Hall	Xavier Roy	3.00	180/190
CHEM 1403	003/11225	T Th 6:10pm - 7:25pm 309 Havemeyer Hall	Ruben Savizky	3.00	199/190
CHEM 1403	004/11227	M W 6:10pm - 7:25pm 203 Mathematics Building	Robert Beer	3.00	87/120

Spring 2023: CHEM UN1403

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 1403	001/11247	T Th 6:10pm - 7:25pm 309 Havemeyer Hall	Ruben Savizky	3.00	126/130
CHEM 1403	AU1/18334	T Th 6:10pm - 7:25pm Othr Other	Ruben Savizky	3.00	8/10

CHEM UN1500 GENERAL CHEMISTRY LABORATORY. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement
Lab Fee: $140.

Corequisites: CHEM UN1403,CHEM UN1404
Corequisites: CHEM UN1403,CHEM UN1404 An introduction to basic lab techniques of modern experimental chemistry, including quantitative procedures and chemical analysis. Students must register for a Lab Lecture section for this course (CHEM UN1501). Please check the Directory of Classes for details. Please note that CHEM UN1500 is offered in the fall and spring semesters. Mandatory lab check-in will be held during the first week of classes in both the fall and spring semesters. You may be asked to serve as research subjects in studies under direction of the faculty while enrolled in this course (CHEM UN1500 Sec 1, 2, 5, 7 and CHEM UN1501 Sec 1). Participation in voluntary

Fall 2022: CHEM UN1500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 1500	001/11228	T 1:10pm - 4:50pm 302 Havemeyer Hall	Sarah Hansen	3.00	16/46
CHEM 1500	002/11229	T 6:10pm - 9:50pm 302 Havemeyer Hall	Joseph Ulichny	3.00	46/46
CHEM 1500	003/11231	W 1:10pm - 4:50pm 302 Havemeyer Hall	Joseph Ulichny	3.00	41/46
CHEM 1500	004/11232	Th 1:10pm - 4:50pm 302 Havemeyer Hall	Sarah Hansen	3.00	8/46

Spring 2023: CHEM UN1500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 1500	001/11655	M 2:10pm - 5:50pm 302 Havemeyer Hall	Sarah Hansen	3.00	25/24
CHEM 1500	002/11656	T 1:10pm - 4:50pm 302 Havemeyer Hall	Sarah Hansen	3.00	32/46
CHEM 1500	003/11657	T 6:10pm - 9:50pm 302 Havemeyer Hall	Joseph Ulichny	3.00	45/46
CHEM 1500	004/11658	W 8:40am - 12:25pm 302 Havemeyer Hall	Sarah Hansen	3.00	25/46
CHEM 1500	005/11659	W 1:10pm - 4:50pm 302 Havemeyer Hall	Joseph Ulichny	3.00	42/46
CHEM 1500	006/11660	Th 1:10pm - 4:50pm 302 Havemeyer Hall	Sarah Hansen	3.00	18/46
CHEM 1500	007/11661	Th 6:10pm - 9:50pm 302 Havemeyer Hall	Joseph Ulichny	3.00	46/46
CHEM 1500	008/11662	F 1:10pm - 4:50pm 302 Havemeyer Hall	Joseph Ulichny	3.00	22/24

CHEM UN1507 Intensive General Chemistry Laboratory. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement
Lab Fee: $140.

Prerequisites: CHEM UN1604 or CHEM UN2045
Corequisites: CHEM UN2045
A student-centered experimental course intended for students who are taking or have completed CHEM UN1604 (Second Semester General Chemistry Intensive Lecture offered in Fall), CHEM UN2045 (Intensive Organic Chemistry offered in Fall), or CHEM UN2046 (Intensive Organic Chemistry Lecture offered in Spring). The course will provide an introduction to theory and practice of modern experimental chemistry in a contextual, student-centered collaborative learning environment. This course differs from CHEM UN1500 in its pedagogy and its emphasis on instrumentation and methods. Students must also attend the compulsory Mentoring Session. Please check the Directory of Classes for details. Please note that CHEM UN1507 is offered in the fall and spring semesters.

Fall 2022: CHEM UN1507

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 1507	001/11236	M 1:00pm - 6:00pm 302 Havemeyer Hall	Luis Avila	3	12/18
CHEM 1507	002/11237	F 1:00pm - 6:00pm 302 Havemeyer Hall	Luis Avila	3	7/18

Spring 2023: CHEM UN1507

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 1507	001/11665	M 1:00pm - 6:00pm 302 Havemeyer Hall	Luis Avila	3	18/18
CHEM 1507	002/11666	F 1:00pm - 6:00pm 302 Havemeyer Hall	Luis Avila	3	18/18

CHEM UN1604 2ND TERM GEN CHEM (INTENSIVE). *4.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: Acceptable performance on the Department placement exam during orientation week AND either a grade of "B" or better in CHEM UN1403 or AP chemistry or the equivalent.
Corequisites: MATH UN1102
Prerequisites: Acceptable performance on the Department placement exam during orientation week AND either a grade of "B" or better in CHEM UN1403 or AP chemistry or the equivalent. Please contact Vesna Gasperov (vg2231@columbia.edu) or your academic advisor at CSA for further information. Corequisites: MATH UN1102 Topics include chemical kinetics, thermodynamics and chemical bonding. Students must register simultaneously for a corresponding recitation section. Please check Courseworks or contact the instructor or departmental adviser for additional details. When registering, be sure to add your name to the wait list for the recitation corresponding to the lecture section (CHEM UN1606). Information about registration for the required recitation will be sent out before classes begin. Please expect to also be available for review sessions on Fridays from 8:10am-9:55am

Fall 2022: CHEM UN1604

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 1604	001/11239	T Th 11:40am - 12:55pm 209 Havemeyer Hall	Wei Min	4.00	55/120

CHEM UN2443 Organic Chemistry I (Lecture). *4 points*.
Prerequisites: (CHEM UN1403 and CHEM UN1404) or CHEM UN1604
The principles of organic chemistry. The structure and reactivity of organic molecules are examined from the standpoint of modern theories of chemistry. Topics include stereochemistry, reactions of organic molecules, mechanisms of organic reactions, syntheses and degradations of organic molecules, and spectroscopic techniques of structure determination. Although CHEM UN2443 and CHEM UN2444 are separate courses, students are expected to take both terms sequentially. Students must ensure they register for the recitation which corresponds to the lecture section. Please check the Directory of Classes for details.

Fall 2022: CHEM UN2443

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 2443	001/11241	M W 11:40am - 12:55pm 309 Havemeyer Hall	Christopher Eckdahl	4	166/160
CHEM 2443	002/11242	T Th 1:10pm - 2:25pm 309 Havemeyer Hall	Christopher Eckdahl	4	119/170
CHEM 2443	003/11243	M W 6:10pm - 7:25pm 309 Havemeyer Hall	Charles Doubleday	4	64/120
CHEM 2443	AU1/18522	M W 11:40am - 12:55pm 309 Havemeyer Hall	Christopher Eckdahl	4	2/10

Spring 2023: CHEM UN2443

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 2443	001/11541	T Th 1:10pm - 2:25pm 309 Havemeyer Hall	Christopher Eckdahl	4	37/50

CHEM UN2493 Organic Chemistry Laboratory I (Techniques). *0 points*.
Lab Fee: $63.00

Prerequisites: (CHEM UN1403 and CHEM UN1404) or (CHEM UN1604) and (CHEM UN1500 or CHEM UN1507)
Corequisites: CHEM UN2443
Techniques of experimental organic chemistry, with emphasis on understanding fundamental principles underlying the experiments in methodology of solving laboratory problems involving organic molecules. Attendance at the first lab lecture and laboratory session is mandatory. Please note that CHEM UN2493 is the first part of a full year organic chemistry laboratory course. Students must register for the lab lecture section (CHEM UN2495) which corresponds to their lab section. Students must attend ONE lab lecture and ONE lab section every other week. Please contact your advisers for further information.

Fall 2022: CHEM UN2493

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 2493	001/11246	M 1:10pm - 5:00pm 202a Havemeyer Hall	Talha Siddiqui	0	23/24
CHEM 2493	002/11248	T 12:00pm - 3:50pm 202a Havemeyer Hall	Talha Siddiqui	0	8/24
CHEM 2493	003/11249	T 6:10pm - 10:00pm 202a Havemeyer Hall	Talha Siddiqui	0	27/34
CHEM 2493	004/11250	W 1:10pm - 5:00pm 202a Havemeyer Hall	Anna Ghurbanyan	0	30/34
CHEM 2493	005/11252	Th 12:00pm - 3:50pm 202a Havemeyer Hall	Anna Ghurbanyan	0	31/34
CHEM 2493	006/11253	F 11:00am - 2:50pm 202a Havemeyer Hall	Anna Ghurbanyan	0	28/34
CHEM 2493	007/11254	M 1:10pm - 5:00pm 202a Havemeyer Hall	Talha Siddiqui	0	23/24
CHEM 2493	008/11255	T 12:00pm - 3:50pm 202a Havemeyer Hall	Talha Siddiqui	0	11/24
CHEM 2493	009/11256	T 6:10pm - 10:00pm 202a Havemeyer Hall	Talha Siddiqui	0	16/34
CHEM 2493	010/11257	W 1:10pm - 5:00pm 202a Havemeyer Hall	Anna Ghurbanyan	0	33/34
CHEM 2493	011/11258	Th 12:00pm - 3:50pm 202a Havemeyer Hall	Anna Ghurbanyan	0	24/34
CHEM 2493	012/11259	F 11:00am - 2:50pm 202a Havemeyer Hall	Anna Ghurbanyan	0	18/34

CHEM UN2495 Organic Chem. Laboratory I. *1.5 point*.
Corequisites: CHEM UN2493
The course is the lab lecture which accompanies the Organic Chemistry Laboratory I (Techniques) course.

Fall 2022: CHEM UN2495

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 2495	001/11260	W 4:10pm - 5:25pm 309 Havemeyer Hall	Talha Siddiqui	1.5	58/110
CHEM 2495	002/11261	M 4:10pm - 5:25pm 309 Havemeyer Hall	Anna Ghurbanyan	1.5	89/110
CHEM 2495	003/11262	W 4:10pm - 5:25pm 309 Havemeyer Hall	Talha Siddiqui	1.5	50/110
CHEM 2495	004/11263	M 4:10pm - 5:25pm 309 Havemeyer Hall	Anna Ghurbanyan	1.5	74/110

CHEM UN2545 Intensive Organic Chemistry Laboratory. *3 points*.
Lab Fee: $125.

Prerequisites: (CHEM UN2045 and CHEM UN2046) and CHEM UN1507
The lab is intended for students who have taken Intensive Organic Chemistry, CHEM UN2045 - CHEM UN2046 and who intend to major in Chemistry, Biochemistry, Chemical Physics, or Environmental Chemistry.

Fall 2022: CHEM UN2545

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 2545	001/11264	M 1:00pm - 6:00pm 202b Havemeyer Hall	Fay Ng	3	14/13
CHEM 2545	002/11265	T 1:00pm - 6:00pm 202b Havemeyer Hall	Fay Ng	3	6/10

CHEM UN3079 Physical Chemistry I. *4 points*.
Prerequisites: (CHEM UN1403 and CHEM UN1404) or (CHEM UN1604) or (CHEM UN2045 and CHEM UN2046) and (MATH UN1101 and MATH UN1102) or (MATH UN1207 and MATH UN1208) and (PHYS UN1401 and PHYS UN1402) PHYS UN1201 - PHYS UN1202 is acceptable; PHYS UN1401 - PHYS UN1402 or the equivalent is HIGHLY recommended.
Corequisites: CHEM UN3085
Elementary, but comprehensive, treatment of the fundamental laws governing the behavior of individual atoms and molecules and collections of them. CHEM UN3079 covers the thermodynamics of chemical systems at equilibrium and the chemical kinetics of nonequilibrium systems. Although CHEM UN3079 and CHEM UN3080 are separate courses, students are expected to take both terms sequentially. A recitation section is required. Please check the Directory of Classes for details and also speak with the TA for the course.

Fall 2022: CHEM UN3079

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 3079	001/11266	M W 8:40am - 9:55am 209 Havemeyer Hall	Xiaoyang Zhu	4	31/60

CHEM UN3085 Physical and Analytical Chemistry Laboratory I. *4 points*.
Lab Fee: $125 per term.

Corequisites: CHEM UN3079
A student-centered experimental course intended for students who are co-registered or have completed CHEM UN3079 and CHEM UN3080. The course emphasizes techniques of experimental physical chemistry and instrumental analysis, including vibrational, electronic, and laser spectroscopy; electroanalytical methods; calorimetry; reaction kinetics; hydrodynamic methods; scanning probe microscopy; applications of computers to reduce experimental data; and computational chemistry. Students must also attend the compulsory Mentoring Session. Please check the Directory of Classes for details.

Fall 2022: CHEM UN3085

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 3085	001/11267	T 12:00pm - 6:00pm 222 Havemeyer Hall	Luis Avila	4	13/15

CHEM UN3098 Supervised Independent Research. *4 points*.
Lab Fee: $105 per term.

Prerequisites: the instructor's permission for entrance, and the departmental representative's permission for aggregate points in excess of 12 or less than 4.
This course may be repeated for credit (see major and concentration requirements). Individual research under the supervision of a member of the staff. Research areas include organic, physical, inorganic, analytical, and biological chemistry. Please note that *CHEM UN3098* is offered in the fall and spring semesters.

Fall 2022: CHEM UN3098

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 3098	001/11268		Vesna Gasperov	4	6/25

Spring 2023: CHEM UN3098

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 3098	001/11998		Vesna Gasperov	4	10/25

CHEM UN3920 Senior Seminar in Chemical Research. *2 points*.
Pass/Fail credit only.

Open to senior chemistry, biochemistry, environmental chemistry, and chemical physics majors; senior chemistry concentrators; and students who have taken or are currently enrolled in *CHEM UN3098*. Senior seminar provides direct access to modern chemical research through selected studies by the students from active fields of chemical research. Topics to be presented and discussed draw from the current scientific literature and/or *UN3098* research.

Fall 2022: CHEM UN3920

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 3920	001/11270	F 2:40pm - 4:30pm 711 Havemeyer Hall	Laura Kaufman	2	7/40

BCHM UN3300 BIOCHEMISTRY. *3.00 points*.
Prerequisites: one year each of Introductory Biology and General Chemistry. Corequisites: Organic Chemistry. Biochemistry is the study of the chemical processes within organisms that give rise to the immense complexity of life. This complexity emerges from a highly regulated and coordinated flow of chemical energy from one biomolecule to another. This course serves to familiarize students with the spectrum of biomolecules (carbohydrates, lipids, amino acids, nucleic acids, etc.) as well as the fundamental chemical processes (glycolysis, citric acid cycle, fatty acid metabolism, etc.) that allow life to happen. In particular, this course will employ active learning techniques and critical thinking problem-solving to engage students in answering the question: how is the complexity of life possible? NOTE: While Organic Chemistry is listed as a corequisite, it is highly recommended that you take Organic Chemistry beforehand

Fall 2022: BCHM UN3300

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BCHM 3300	001/13221	T 7:10pm - 9:30pm 602 Hamilton Hall	Danny Ho	3.00	49/80

BIOC GU4501 Biochemistry: Structure and Metabolism. *4 points*.
Undergraduates should register for *BIOC C3501*.

Prerequisites: one year of *BIOL C2005* and *BIOL C2006* and one year of organic chemistry.
Lecture and recitation. Students wishing to cover the full range of modern biochemistry should take both *BIOC C3501* and *C3512*. *C3501* covers subject matters in modern biochemistry, including chemical biology and structural biology, discussing the structure and function of both proteins and small molecules in biological systems. Proteins are the primary class of biological macromolecules and serve to carry out most cellular functions. Small organic molecules function in energy production and creating building blocks for the components of cells and can also be used to perturb the functions of proteins directly. The first half of the course covers protein structure, enzyme kinetics and enzyme mechanism.
The second half of the course explores how small molecules are used endogenously by living systems in metabolic and catabolic pathways; this part of the course focuses on mechanistic organic chemistry involved in metabolic pathways.

Fall 2022: BIOC GU4501

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BIOC 4501	001/10360	T Th 2:40pm - 3:55pm 303 Uris Hall	Brent Stockwell, Hengrui Liu	4	63/64

CHEM GU4071 Inorganic Chemistry. *4.5 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: (CHEM UN1403 and CHEM UN1404) or (CHEM UN1604) or (CHEM UN2045 and CHEM UN2046) , or the equivalent.
Principles governing the structure and reactivity of inorganic compounds surveyed from experimental and theoretical viewpoints. Topics include inorganic solids, aqueous and nonaqueous solutions, the chemistry of selected main group elements, transition metal chemistry, metal clusters, metal carbonyls, and organometallic chemistry, bonding and resonance, symmetry and molecular orbitals, and spectroscopy.

Fall 2022: CHEM GU4071

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 4071	001/11728	M W 10:10am - 11:25am 320 Havemeyer Hall	Jonathan Owen	4.5	21/42

CHEM GU4147 Advanced Organic Chemistry. *4.5 points*.
Prerequisites: elementary organic and physical chemistry.
The mechanisms of organic reactions, structure of organic molecules, and theories of reactivity. How reactive intermediates are recognized and mechanisms are deduced using kinetics, stereochemistry, isotopes, and physical measurements.

Fall 2022: CHEM GU4147

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 4147	001/11730	T Th 8:40am - 9:55am 320 Havemeyer Hall	Tomislav Rovis	4.5	7/42

CHEM GU4148 Synthetic Methods in Organic Chemistry I. *4.5 points*.
Prerequisites: Organic chemistry.
This course is intended for graduate students and advanced undergraduate students. The main purpose of the course is to introduce students to modern synthetic chemistry via the selected series of topics (synthetic planning and the logic of organic assembly, classical and new reactions/methods and their use in complex target synthesis). Mechanistic underpinning of the discussed reaction processes will also be briefly discussed. For each module (see the content below), specific examples of syntheses of natural products and/or synthetic materials will be provided. In addition to lectures, students will select and present relevant papers in the class (the number of student symposia will depend on the final enrollment in this course). The basic knowledge of transition metal chemistry is recommended for the cross-coupling reactions (i.e., structure, electron counting, and elemental reaction types of transition metals).

Fall 2022: CHEM GU4148

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 4148	001/11731	T Th 10:10am - 11:25am 320 Havemeyer Hall	Makeda Tekle-Smith	4.5	10/42

CHEM GU4221 Quantum Chemistry. *4.5 points*.
Prerequisites: elementary physical chemistry.
Basic quantum mechanics: the Schrodinger equation and its interpretation, exact solutions in simple cases, methods or approximation, angular Mementum and electronic spin, and an introduction to atomic and molecular structure.

Fall 2022: CHEM GU4221

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 4221	001/11733	M W 11:40am - 12:55pm 320 Havemeyer Hall	Timothy Berkelbach	4.5	14/42

CHEM GU4230 Statistical Mechanics. *4.5 points*.
Prerequisites: elementary physical chemistry.
Corequisites: *CHEM G4221*.
Topics include the classical and quantum statistical mechanics of gases, liquids, and solids.

Fall 2022: CHEM GU4230

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 4230	001/11734	T Th 11:40am - 12:55pm 320 Havemeyer Hall	Angelo Cacciuto	4.5	10/42

CHEM GU4312 Chemical Biology. *4 points*.
Prerequisites: (CHEM UN2443 and CHEM UN2444) and (CHEM UN3079 and CHEM UN3080) and (BIOC UN3501) , or the equivalent.
Development and application of chemical methods for understanding the molecular mechanisms of cellular processes. Review of the biosynthesis, chemical synthesis, and structure and function of proteins and nucleic acids. Application of chemical methods--including structural biology, enzymology, chemical genetics, and the synthesis of modified biological molecules--to the study of cellular processes--including transcription, translation, and signal transduction.

Fall 2022: CHEM GU4312

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 4312	001/11735	M W 1:10pm - 2:25pm 320 Havemeyer Hall	Virginia Cornish	4	11/42

BIOC GU4323 Biophysical Chemistry I. *4 points*.
This course provides a rigorous introduction to the theory underlying widely used biophysical methods, which will be illustrated by practical applications to contemporary biomedical research problems. The course has two equally important goals. The first goal is to explicate the fundamental approaches used by physical chemists to understand the behavior of molecules and to develop related analytical tools. The second goal is to prepare students to apply these methods themselves to their own research projects. The course will be divided into seven modules: (i) solution thermodynamics; (ii) hydrodynamic methods; (iii) statistical analysis of experimental data; (iv) basic quantum mechanics; (v) optical spectroscopy with an emphasis on fluorescence; (vi) nuclear magnetic resonance spectroscopy; and (vii) light-scattering and diffraction methods. The first three modules will be covered during the fall term. In each module, the underlying physical theories and models with be presented and used to derive the mathematical equations applied to the analysis of experimental data. Weekly recitations will emphasize the analysis of real experimental data and understanding the applications of biophysical experimentation in published research papers.

CHEM GR6168 Materials Chemistry IIA. *2.5 points*.
Prerequisites: CHEM UN2443 , or the equivalent.
This is an introductory course to the emerging field macromolecular materials chemistry. The general topics will be based on the chemistry, self-assembly, and performance of block copolymers and conjugated polymers. Particular emphasis will be devoted to the demands required to drive materials from scientific curiosity to commercialization. At the fundamental level, the course will cover topics on polymerization techniques, electronic structure of organic semiconductors, characterization strategies, nanostructures and self-assembly.

Spring 2023

Please note that some lab fees have increased. You may consult the Directory of Classes for the most up to date fees.

CHEM UN1403 GENERAL CHEMISTRY I-LECTU. *3.00 points*.

Fall 2022: CHEM UN1403

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 1403	001/11224	M W 10:10am - 11:25am 309 Havemeyer Hall	Gerard Parkin	3.00	219/225
CHEM 1403	002/11222	T Th 10:10am - 11:25am 309 Havemeyer Hall	Xavier Roy	3.00	180/190
CHEM 1403	003/11225	T Th 6:10pm - 7:25pm 309 Havemeyer Hall	Ruben Savizky	3.00	199/190
CHEM 1403	004/11227	M W 6:10pm - 7:25pm 203 Mathematics Building	Robert Beer	3.00	87/120

Spring 2023: CHEM UN1403

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 1403	001/11247	T Th 6:10pm - 7:25pm 309 Havemeyer Hall	Ruben Savizky	3.00	126/130
CHEM 1403	AU1/18334	T Th 6:10pm - 7:25pm Othr Other	Ruben Savizky	3.00	8/10

CHEM UN1404 GENERAL CHEMISTRY II-LECTURES. *4.00 points*.
CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: CHEM UN1403
Prerequisites: CHEM UN1403 Although CHEM UN1403 and CHEM UN 1404 are separate courses, students are expected to take both terms sequentially. Topics include gases, kinetic theory of gases, states of matter: liquids and solids, chemical equilibria, applications of equilibria, acids and bases, chemical thermodynamics, energy, enthalpy, entropy, free energy, periodic properties, chemical kinetics, and electrochemistry. The order of presentation of topics may differ from the order presented here, and from year to year. Students must ensure they register for the recitation that corresponds to the lecture section. Please check the Directory of Classes for details

Spring 2023: CHEM UN1404

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 1404	001/11248	T Th 10:10am - 11:25am 309 Havemeyer Hall	Laura Kaufman	4.00	194/190
CHEM 1404	002/11249	M W 8:40am - 9:55am 309 Havemeyer Hall	Angelo Cacciuto	4.00	125/132
CHEM 1404	003/11250	M W 6:10pm - 7:25pm 402 Chandler	Robert Beer	4.00	69/120
CHEM 1404	AU2/18468	M W 8:40am - 9:55am Othr Other	Angelo Cacciuto	4.00	0/10

CHEM UN1500 GENERAL CHEMISTRY LABORATORY. *3.00 points*.
CC/GS: Partial Fulfillment of Science Requirement
Lab Fee: $140.

Corequisites: CHEM UN1403,CHEM UN1404
Corequisites: CHEM UN1403,CHEM UN1404 An introduction to basic lab techniques of modern experimental chemistry, including quantitative procedures and chemical analysis. Students must register for a Lab Lecture section for this course (CHEM UN1501). Please check the Directory of Classes for details. Please note that CHEM UN1500 is offered in the fall and spring semesters. Mandatory lab check-in will be held during the first week of classes in both the fall and spring semesters. You may be asked to serve as research subjects in studies under direction of the faculty while enrolled in this course (CHEM UN1500 Sec 1, 2, 5, 7 and CHEM UN1501 Sec 1). Participation in voluntary

Fall 2022: CHEM UN1500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 1500	001/11228	T 1:10pm - 4:50pm 302 Havemeyer Hall	Sarah Hansen	3.00	16/46
CHEM 1500	002/11229	T 6:10pm - 9:50pm 302 Havemeyer Hall	Joseph Ulichny	3.00	46/46
CHEM 1500	003/11231	W 1:10pm - 4:50pm 302 Havemeyer Hall	Joseph Ulichny	3.00	41/46
CHEM 1500	004/11232	Th 1:10pm - 4:50pm 302 Havemeyer Hall	Sarah Hansen	3.00	8/46

Spring 2023: CHEM UN1500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 1500	001/11655	M 2:10pm - 5:50pm 302 Havemeyer Hall	Sarah Hansen	3.00	25/24
CHEM 1500	002/11656	T 1:10pm - 4:50pm 302 Havemeyer Hall	Sarah Hansen	3.00	32/46
CHEM 1500	003/11657	T 6:10pm - 9:50pm 302 Havemeyer Hall	Joseph Ulichny	3.00	45/46
CHEM 1500	004/11658	W 8:40am - 12:25pm 302 Havemeyer Hall	Sarah Hansen	3.00	25/46
CHEM 1500	005/11659	W 1:10pm - 4:50pm 302 Havemeyer Hall	Joseph Ulichny	3.00	42/46
CHEM 1500	006/11660	Th 1:10pm - 4:50pm 302 Havemeyer Hall	Sarah Hansen	3.00	18/46
CHEM 1500	007/11661	Th 6:10pm - 9:50pm 302 Havemeyer Hall	Joseph Ulichny	3.00	46/46
CHEM 1500	008/11662	F 1:10pm - 4:50pm 302 Havemeyer Hall	Joseph Ulichny	3.00	22/24

CHEM UN1507 Intensive General Chemistry Laboratory. *3 points*.
CC/GS: Partial Fulfillment of Science Requirement
Lab Fee: $140.

Prerequisites: CHEM UN1604 or CHEM UN2045
Corequisites: CHEM UN2045
A student-centered experimental course intended for students who are taking or have completed CHEM UN1604 (Second Semester General Chemistry Intensive Lecture offered in Fall), CHEM UN2045 (Intensive Organic Chemistry offered in Fall), or CHEM UN2046 (Intensive Organic Chemistry Lecture offered in Spring). The course will provide an introduction to theory and practice of modern experimental chemistry in a contextual, student-centered collaborative learning environment. This course differs from CHEM UN1500 in its pedagogy and its emphasis on instrumentation and methods. Students must also attend the compulsory Mentoring Session. Please check the Directory of Classes for details. Please note that CHEM UN1507 is offered in the fall and spring semesters.

Fall 2022: CHEM UN1507

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 1507	001/11236	M 1:00pm - 6:00pm 302 Havemeyer Hall	Luis Avila	3	12/18
CHEM 1507	002/11237	F 1:00pm - 6:00pm 302 Havemeyer Hall	Luis Avila	3	7/18

Spring 2023: CHEM UN1507

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 1507	001/11665	M 1:00pm - 6:00pm 302 Havemeyer Hall	Luis Avila	3	18/18
CHEM 1507	002/11666	F 1:00pm - 6:00pm 302 Havemeyer Hall	Luis Avila	3	18/18

CHEM UN2045 INTENSVE ORGANIC CHEMISTRY. *4.00 points*.
Prerequisites: A grade of 5 on the Chemistry Advanced Placement exam and an acceptable grade on the Department placement exam or an acceptable grade in CHEM UN1604.
Corequisites: CHEM UN1507
Prerequisites: A grade of 5 on the Chemistry Advanced Placement exam and an acceptable grade on the Department placement exam.
Corequisites: CHEM UN1507 Premedical students may take CHEM UN2045, CHEM UN2046, CHEM UN1507 and CHEM UN2545 to meet the minimum requirements for admission to medical school. This course covers the same material as CHEM UN2443-CHEM UN2444, but is intended for students who have learned the principles of general chemistry in high school OR have completed CHEM UN1604 in their first year at Columbia. First year students enrolled in CHEM UN2045-CHEM UN2046 are expected to enroll concurrently in CHEM UN1507. Although CHEM UN2045 and CHEM UN2046 are separate courses, students are expected to take both terms sequentially. A recitation section is required. Please check the Directory of Classes for details and also speak with the TA for the course

Spring 2023: CHEM UN2045

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 2045	001/11540	T Th 1:10pm - 2:25pm 209 Havemeyer Hall	Luis Campos	4.00	13/50

CHEM UN2408 First-Year Seminar in Chemical Research. *1 point*.
Prerequisites: CHEM UN1403 or CHEM UN1604 or CHEM UN2045 or the instructor's permission.
A one-hour weekly lecture, discussion, and critical analysis of topics that reflect problems in modern chemistry, with emphasis on current areas of active chemical research.

Spring 2023: CHEM UN2408

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 2408	001/11667	F 12:00pm - 12:50pm 209 Havemeyer Hall	Vesna Gasperov	1	33/80

CHEM UN2444 ORGANIC CHEMSTRY II-LECTURES. *4.00 points*.
Prerequisites: CHEM UN1404 or CHEM UN1604 and CHEM UN1500 and CHEM UN2443
Prerequisites: CHEM UN1404 or CHEM UN1604, CHEM UN1500 and CHEMUN2443. The principles of organic chemistry. The structure and reactivity of organic molecules are examined from the standpoint of modern theories of chemistry. Topics include stereochemistry, reactions of organic molecules, mechanisms of organic reactions, syntheses and degradations of organic molecules, and spectroscopic techniques of structure determination. Although CHEM UN2443 and CHEM UN2444 are separate courses, students are expected to take both terms sequentially. Students must ensure they register for the recitation which corresponds to the lecture section. Please check the Directory of Classes for details

Spring 2023: CHEM UN2444

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 2444	001/11543	M W 11:40am - 12:55pm 309 Havemeyer Hall	Christopher Eckdahl	4.00	161/140
CHEM 2444	002/11544	M W 6:10pm - 7:25pm 309 Havemeyer Hall	Charles Doubleday	4.00	94/120
CHEM 2444	003/19453	T Th 11:40am - 12:55pm 309 Havemeyer Hall	James Leighton	4.00	46/60
CHEM 2444	AU2/18469	M W 6:10pm - 7:25pm Othr Other	Charles Doubleday	4.00	1/10

CHEM UN2494 ORGANIC CHEM. LAB II SYNTHESIS. *0.00 points*.
Lab Fee: $62.00

Prerequisites: (CHEM UN1403 and CHEM UN1404) and CHEM UN1500 and CHEM UN2493
Corequisites: CHEM UN2444
Prerequisites: CHEM W1403-CHEM W1404; CHEM W1500; CHEM W2493. Corequisites: CHEM W2444. Please note that you must complete CHEM W2493 before you register for CHEM W2494. This lab introduces students to experimental design and trains students in the execution and evaluation of scientific data. The technique experiments in the first half of the course (CHEM W2493) teach students to develop and master the required experimental skills to perform the challenging synthesis experiments in the second semester. The learning outcomes for this lab are the knowledge and experimental skills associated with the most important synthetic routes widely used in industrial and research environments. Attendance at the first lab lecture and laboratory session is mandatory. Please note that CHEM W2494 is the second part of a full year organic chemistry laboratory course. Students must register for the lab lecture section (CHEM W2496) which corresponds to their lab section. Students must attend ONE lab lecture and ONE lab section every other week. Please contact your advisors for further information.

Spring 2023: CHEM UN2494

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 2494	001/11980	M 1:10pm - 5:00pm 202a Havemeyer Hall	Talha Siddiqui	0.00	24/24
CHEM 2494	002/11981	T 12:00pm - 3:50pm 202a Havemeyer Hall	Talha Siddiqui	0.00	13/24
CHEM 2494	003/11982	T 6:10pm - 10:00pm 202a Havemeyer Hall	Talha Siddiqui	0.00	31/34
CHEM 2494	004/11983	W 1:10pm - 5:00pm 202a Havemeyer Hall	Anna Ghurbanyan	0.00	34/34
CHEM 2494	005/11984	Th 12:00pm - 3:50pm 202a Havemeyer Hall	Anna Ghurbanyan	0.00	31/34
CHEM 2494	006/11985	F 11:00am - 2:50pm 202a Havemeyer Hall	Anna Ghurbanyan	0.00	32/34
CHEM 2494	007/11986	M 1:10pm - 5:00pm 202a Havemeyer Hall	Talha Siddiqui	0.00	21/24
CHEM 2494	008/11987	T 12:00pm - 3:50pm 202a Havemeyer Hall	Talha Siddiqui	0.00	13/24
CHEM 2494	009/11988	T 6:10pm - 10:00pm 202a Havemeyer Hall	Talha Siddiqui	0.00	28/34
CHEM 2494	010/11989	W 1:10pm - 5:00pm 202a Havemeyer Hall	Anna Ghurbanyan	0.00	35/34
CHEM 2494	011/11990	Th 12:00pm - 3:50pm 202a Havemeyer Hall	Anna Ghurbanyan	0.00	25/34
CHEM 2494	012/11991	F 11:00am - 2:50pm 202a Havemeyer Hall	Anna Ghurbanyan	0.00	28/34

CHEM UN2496 Organic Chem. Laboratory II . *1.5 point*.
Corequisites: CHEM UN2494
The course is the lab lecture which accompanies the Organic Chemistry Laboratory II (Synthesis) course.

Spring 2023: CHEM UN2496

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 2496	001/11992	W 4:10pm - 5:25pm 309 Havemeyer Hall	Talha Siddiqui	1.5	63/110
CHEM 2496	002/11994	M 4:10pm - 5:25pm 309 Havemeyer Hall	Anna Ghurbanyan	1.5	82/140
CHEM 2496	003/11995	W 4:10pm - 5:25pm 309 Havemeyer Hall	Talha Siddiqui	1.5	58/110
CHEM 2496	004/11996	M 4:10pm - 5:25pm 309 Havemeyer Hall	Anna Ghurbanyan	1.5	79/140

CHEM UN3080 Physical Chemistry II. *4 points*.
Prerequisites: CHEM UN3079
Corequisites: CHEM UN3086
CHEM UN3080 covers the quantum mechanics of atoms and molecules, the quantum statistical mechanics of chemical systems, and the connection of statistical mechanics to thermodynamics. Although CHEM UN3079 and CHEM UN3080 are separate courses, students are expected to take both terms sequentially. A recitation section is required. Please check the Directory of Classes for details and also speak with the TA for the course

Spring 2023: CHEM UN3080

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 3080	001/11545	M W 10:10am - 11:25am 209 Havemeyer Hall	Milan Delor	4	27/60

CHEM UN3086 Physical and Analytical Chemistry Laboratory II. *4 points*.
Lab Fee: $125 per term.

Prerequisites: CHEM UN3085 , CHEM UN3080 is acceptable corequisite for CHEM UN3086.
A student-centered experimental course intended for students who are co-registered or have complete CHEM UN3079 and CHEM UN3080. The course emphasizes techniques of experimental physical chemistry and instrumental analysis, including vibrational, electronic, and laser spectroscopy; electroanalytical methods; calorimetry; reaction kinetics; hydrodynamic methods; scanning probe microscopy; applications of computers to reduce experimental data; and computational chemistry. Students must also attend the compulsory Mentoring Session. Please check the Directory of Classes for details.

Spring 2023: CHEM UN3086

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 3086	001/11997	T 12:00pm - 6:00pm 222 Havemeyer Hall	Luis Avila	4	12/15

CHEM UN3098 Supervised Independent Research. *4 points*.
Lab Fee: $105 per term.

Prerequisites: the instructor's permission for entrance, and the departmental representative's permission for aggregate points in excess of 12 or less than 4.
This course may be repeated for credit (see major and concentration requirements). Individual research under the supervision of a member of the staff. Research areas include organic, physical, inorganic, analytical, and biological chemistry. Please note that *CHEM UN3098* is offered in the fall and spring semesters.

Fall 2022: CHEM UN3098

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 3098	001/11268		Vesna Gasperov	4	6/25

Spring 2023: CHEM UN3098

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 3098	001/11998		Vesna Gasperov	4	10/25

CHEM UN3546 Advanced Organic Chemistry Laboratory. *3 points*.
Laboratory Fee: $125.

Prerequisites: CHEM UN2493 and CHEM UN2494 , or the equivalent.
A project laboratory with emphasis on complex synthesis and advanced techniques including qualitative organic analysis and instrumentation.

Spring 2023: CHEM UN3546

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 3546	001/11999	M 1:00pm - 6:00pm 202b Havemeyer Hall	Fay Ng	3	4/10
CHEM 3546	002/12000	T 1:00pm - 6:00pm 202b Havemeyer Hall	Fay Ng	3	4/10

CHEM GU4102 Chemistry for the Brain. *4.5 points*.
This course was upgraded from 2.5 to 4.5 and assigned a new number.

Prerequisites: Organic chemistry and biology courses, neuroscience or neurobiology recommended, but not required.
The study of the brain is one of the most exciting frontiers in science and medicine today. Although neuroscience is by nature a multi-disciplinary effort, chemistry has played many critical roles in the development of modern neuroscience, neuropharmacology, and brain imaging. Chemistry, and the chemical probes it generates, such as molecular modulators, therapeutics, imaging agents, sensors, or actuators, will continue to impact neuroscience on both preclinical and clinical levels. In this course, two major themes will be discussed. In the first one, titled "Imaging brain function with chemical tools," we will discuss molecular designs and functional parameters of widely used fluorescent sensors in neuroscience (calcium, voltage, and neurotransmitter sensors), their impact on neuroscience, pros and cons of genetically encoded sensors versus chemical probes, and translatability of these approaches to the human brain. In the second major theme, titled "Perturbation of the brain function with chemical tools," we will examine psychoactive substances, the basics of medicinal chemistry, brain receptor activation mechanisms and coupled signaling pathways, and their effects on circuit and brain function. We will also discuss recent approaches, failures and successes in the treatment of neurodegenerative and psychiatric disorders. Recent advances in precise brain function perturbation by light (optogenetics and photopharmacology) will also be introduced. In the context of both themes we will discuss the current and future possibilities for the design of novel materials, drawing on the wide molecular structural space (small molecules, proteins, polymers, nanomaterials), aimed at monitoring, modulating, and repairing human brain function. This course is intended for students (undergraduate and graduate) from the science, engineering and medical departments.

Spring 2023: CHEM GU4102

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 4102	001/12566	T Th 10:10am - 11:25am 320 Havemeyer Hall	Dalibor Sames	4.5	19/21

CHEM GU4103 Organometallic Chemistry. *4.5 points*.
Prerequisites: (CHEM UN2443 and CHEM UN2444) , or the equivalent. Some background in inorganic and physical chemistry is helpful but not required.
Main group and transition metal organometallic chemistry: bonding, structure, reactions, kinetics, and mechanisms.

Spring 2023: CHEM GU4103

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 4103	001/12567	T Th 8:40am - 9:55am 320 Havemeyer Hall	Jack Norton	4.5	7/42

CHEM GU4104 Structural Methods in Inorganic Chemistry. *2 points*.
The determination of structures by diffraction methods, focusing on single crystal X-ray diffraction, is described. Emphasis is placed on a critical evaluation of published data.

Spring 2023: CHEM GU4104

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 4104	001/12879	M W 8:40am - 9:55am 320 Havemeyer Hall	Gerard Parkin	2	10/42

CHEM GU4145 NMR Spectroscopy. *1 point*.
Prerequisites: elementary organic chemistry.
Introduction to theory and practice of NMR spectroscopy. Instrumental aspects, basic NMR theory, NOE, and a survey of 2D methods are covered.

Spring 2023: CHEM GU4145

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 4145	001/12572	F 11:00am - 11:50am 320 Havemeyer Hall	John Decatur	1	13/42

CHEM GU4232 Introduction to Molecular Modeling. *4.5 points*.
Prerequisites: physical chemistry sequence.
Molecular modeling has become an integral part of research in many areas of chemistry, and in industry in drug discovery and materials design. Many experimental papers in the literature are routinely complemented by molecular modeling calculations. Experimental scientists working in industry have a significant advantage if they know how to optimally use modeling software. The course would consist of a normal lecture part plus a lab session every week in which the students learn to use modeling software by working on projects.

Spring 2023: CHEM GU4232

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 4232	001/13230	M W 1:10pm - 2:25pm 320 Havemeyer Hall	Richard Friesner	4.5	12/42

CHEM GU4313 Peptide and Protein Chemistry. *4.00 points*.
The goal of this course is to explore how chemical methods and concepts have impacted our ability to understand and manipulate protein structure and function. We will navigate this subject through a combination of lectures and structured discussions on research articles from the literature. The course is divided into three segments: (1) In the first part, we will review the rudiments of protein structure and function, then delve into various aspects of enzyme chemistry and polypeptide biosynthesis. (2) In the second part of the course, we will cover synthetic methods to produce and chemically modify peptides and proteins. (3) In the final part, we will discuss chemical approaches to control protein function and monitor protein activity, focusing on methods that use small molecules and mass spectrometry proteomics

Spring 2023: CHEM GU4313

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 4313	001/12575	T Th 1:10pm - 2:25pm 320 Havemeyer Hall	Neel Shah	4.00	19/20

CHEM GU4324 BIOPHYSICAL CHEMISTRY II. *4.50 points*.

Spring 2023: CHEM GU4324

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 4324	001/12576	T F 4:10pm - 5:25pm 320 Havemeyer Hall	Ann McDermott, Ruben Gonzalez	4.50	11/42

BIOC GU4512 Molecular Biology. *3 points*.
Prerequisites: one year of biology. Recommended but not required: BIOC UN3501
This is a lecture course designed for advanced undergraduates and graduate students. The focus is on understanding at the molecular level how genetic information is stored within the cell and how it is regulated. Topics covered include genome organization, DNA replication, transcription, RNA processing, and translation. This course will also emphasize the critical analysis of the scientific literature and help students understand how to identify important biological problems and how to address them experimentally. SCE and TC students may register for this course, but they must first obtain the written permission of the instructor, by filling out a paper Registration Adjustment Form (Add/Drop form). The form can be downloaded at the URL below, but must be signed by the instructor and returned to the office of the registrar. http://registrar.columbia.edu/sites/default/files/content/reg-adjustment.pdf

Spring 2023: BIOC GU4512

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
BIOC 4512	001/14195	M W 2:40pm - 3:55pm 141 Uris Hall	James Manley, Alice Heicklen	3	64/66

CHEM GR6169 Materials Chemistry IIB. *2.5 points*.
Prerequisites: CHEM UN2443 , or the equivalent.
This is an introductory course to the field of inorganic nanomaterials chemistry. The course will cover the synthesis, the structural, electronic and magnetic characterization, and the physical properties of zero-, one- and two-dimensional inorganic nanomaterials. Particular emphasis will be devoted to the design of building blocks that can organize into functional assemblies and to the emergence of collective physical properties. The course will also explore the recent and developing electronic and optoelectronic applications of these materials.

CHEM GR6222 Quantum Chemistry II. *2.5 points*.
Prerequisites: CHEM GU4221
Atomic and molecular quantum mechanics: fundamentals of electronic structure, many-body wave functions and operators, Hartree-Fock and density functional theory, the Dirac equation.

CHEM GR6231 Intermediate Statistical Mechanics. *2.5 points*.
Prerequisites: CHEM GU4221 and CHEM GU4230
Phase transitions and critical phenomena; renormalization group methods; classical theory of fluids.

CHEM G8130 The Chemistry of Nanocrystals. *2.5 points*.
This course will provide a discussion of the thermodynamics and kinetics of colloidal crystallization and stabilization, the physical properties of quantum confined semiconductor and metal nanocrystals, methods of nanocrystal characterization, and examples of nanocrystals in technological applications. Prospective students should be familiar with basic principles of quantum mechanics, thermodynamics of phase transitions, and inorganic chemistry – particularly molecular orbital theory. Undergraduate students interested in this course should obtain approval from the instructor prior to registering.

CHEM GR8232 Advanced Statistical Mechanics. *2.5 points*.
Prerequisites: CHEM GU4221 and CHEM GU4230 , or their equivalents.
Stochastic processes; Brownian motion; Langevin equations and fluctuation-dissipation theorems; reaction rate theory; time correlation functions and linear response theory.

CHEM GR8223 Quantum Chemistry, III. *2.5 points*.
Not offered during 2022-23 academic year.

Prerequisites: *CHEM G6222*.
Nonlinear spectroscopy: second harmonic and vibrational sum frequency generation; applications to surface and colloidal nano-microparticle interfaces; nonradiative molecular processes.

CHEM G8300 Biophotonics. *2.5 points*.
Not offered during 2022-23 academic year.

Biophotonics tools are changing the way many biological problems are addressed by revealing direct and precious visualization information inside live cells, tissues and organisms. This interdisciplinary course will not only provide fundamental knowledge of optics, laser, microscopy, linear and nonlinear molecular spectroscopy, but also introduce physical principles of various emerging microscopy techniques including single-molecule biophysics, multi-photon microscopy, label-free chemical imaging, super-resolution imaging, novel molecular probes, optical coherence tomography and emerging technology. A few guest lectures from expert instructors across the campus are expected.

Courses Offered in Alternate Years

Please contact the Undergraduate Program Manager, Vesna Gasperov (vg2231@columbia.edu), for further information.

CHEM GU4103 Organometallic Chemistry. *4.5 points*.
Prerequisites: (CHEM UN2443 and CHEM UN2444) , or the equivalent. Some background in inorganic and physical chemistry is helpful but not required.
Main group and transition metal organometallic chemistry: bonding, structure, reactions, kinetics, and mechanisms.

Spring 2023: CHEM GU4103

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 4103	001/12567	T Th 8:40am - 9:55am 320 Havemeyer Hall	Jack Norton	4.5	7/42

CHEM GU4104 Structural Methods in Inorganic Chemistry. *2 points*.
The determination of structures by diffraction methods, focusing on single crystal X-ray diffraction, is described. Emphasis is placed on a critical evaluation of published data.

Spring 2023: CHEM GU4104

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
CHEM 4104	001/12879	M W 8:40am - 9:55am 320 Havemeyer Hall	Gerard Parkin	2	10/42

CHEM GU4111 APPLICATIONS OF NMR SPECTROSCOPY TO INOR. *2.50 points*.
The use of multinuclear NMR spectroscopy in the determination of the structures of inorganic molecules and the use of dynamic NMR spectroscopy (variable temperature NMR and magnetization transfer techniques) to provide information concerned with reaction mechanisms

CHEM GU4154 Chemical Characterization for Synthetic Chemists. *3 points*.
Prerequisites: Columbia University's laboratory safety certification is required. One year each of (i) general chemistry lecture/lab; (ii) organic or inorganic chemistry lecture/lab; and (iii) research experience in a chemistry lab are recommended.
This course will teach synthetic chemists to use mass spectrometry, analytical chromatography, and single-crystal X-ray diffraction as tools for research in synthetic chemistry. The teaching approach will be practical with an emphasis on hands-on experience. Students will gain: (1) A user-level understanding of the theory of these analytical methods. (2) Hands-on proficiency with a variety of instruments available at Columbia. (3) An introduction to advanced instrument capabilities and an awareness of their applications. (4) Proficiency in processing and interpreting data.

CHEM GU4210 Writing Workshop for Chemists. *1 point*.
Prerequisites: recommended for undergraduate students to have taken at least one semester of independent research.
This course offers undergraduate and graduate students an introduction to scientific writing and provides an opportunity for them to become more familiar with the skill and craft of communicating complex scientific research. This course will provide students with the basic grammatical, stylistic and practical skills required to write effective academic journal articles, theses, or research proposals. In addition, through an innovative partnership with Columbia University Libraries' Digital Science Center, students will learn how to apply these basic skills to their writing through the use of state-of-the-art software and on-line resources. Regular opportunities to write, peer edit and revise throughout the semester will allow students to put what they are learning into immediate practice. It is recommended that undergraduates have taken at least one semester of research for credit before taking this course. Undergraduates should plan to take this course after taking the required Core course University Writing.

CHEM GR6168 Materials Chemistry IIA. *2.5 points*.
Prerequisites: CHEM UN2443 , or the equivalent.
This is an introductory course to the emerging field macromolecular materials chemistry. The general topics will be based on the chemistry, self-assembly, and performance of block copolymers and conjugated polymers. Particular emphasis will be devoted to the demands required to drive materials from scientific curiosity to commercialization. At the fundamental level, the course will cover topics on polymerization techniques, electronic structure of organic semiconductors, characterization strategies, nanostructures and self-assembly.

CHEM GR6169 Materials Chemistry IIB. *2.5 points*.
Prerequisites: CHEM UN2443 , or the equivalent.
This is an introductory course to the field of inorganic nanomaterials chemistry. The course will cover the synthesis, the structural, electronic and magnetic characterization, and the physical properties of zero-, one- and two-dimensional inorganic nanomaterials. Particular emphasis will be devoted to the design of building blocks that can organize into functional assemblies and to the emergence of collective physical properties. The course will also explore the recent and developing electronic and optoelectronic applications of these materials.

CHEM GR6222 Quantum Chemistry II. *2.5 points*.
Prerequisites: CHEM GU4221
Atomic and molecular quantum mechanics: fundamentals of electronic structure, many-body wave functions and operators, Hartree-Fock and density functional theory, the Dirac equation.

CHEM GR6231 Intermediate Statistical Mechanics. *2.5 points*.
Prerequisites: CHEM GU4221 and CHEM GU4230
Phase transitions and critical phenomena; renormalization group methods; classical theory of fluids.

CHEM GR8106 Kinetics. *2.5 points*.
Not offered during 2022-23 academic year.

Kinetics and mechanisms of inorganic reactions.

CHEM GR8120 Polymers in Nanotechnology. *2.5 points*.
Polymeric materials have long been ubiquitous items and played important roles in revolutionizing the way we live. Due to the advent of modern polymerization fabrication strategies, polymers are rapidly gaining interest for the development of next generation devices and medical treatment. This course will focus on the chemistry polymers and their use as nanostructured materials created by self-assembly and top-down fabrication techniques. Specifically, the class will be divided into two sections describing the uses of organic nanostructures on a) surfaces and b) as particles. Patterned surfaces will be described in terms of photo-, imprint-, and block copolymer lithography. The preparation of nanoparticles through polymer synthesis, dendrimers, and mechanical manipulation will be the second part.

CHEM GR8223 Quantum Chemistry, III. *2.5 points*.
Not offered during 2022-23 academic year.

Prerequisites: *CHEM G6222*.
Nonlinear spectroscopy: second harmonic and vibrational sum frequency generation; applications to surface and colloidal nano-microparticle interfaces; nonradiative molecular processes.

CHEM GR8232 Advanced Statistical Mechanics. *2.5 points*.
Prerequisites: CHEM GU4221 and CHEM GU4230 , or their equivalents.
Stochastic processes; Brownian motion; Langevin equations and fluctuation-dissipation theorems; reaction rate theory; time correlation functions and linear response theory.

CHEM GR8349 Research Ethics & Philosophy. *2.5 points*.
This lecture course aims to address philosophical and ethical questions in scientific research. What are the most important traits of successful scientists whose discoveries have greatly benefited humanity (and led to Nobel Prizes)? What distinguishes great science from mediocre or pathological "science"? What are the ethical standards of scientific research? How do we identify scientific misconduct or fraud? Why are ethical standards so critical to the integrity of the research enterprise? The course requires extensive participation of students in the form of discussions and debates. Grades will be based on participation, writing assignments, and one oral presentation.