

# CHEMISTRY (CHEM-SHU)

## CHEM-SHU 125 Foundations of Chemistry I (3 Credits)

*Typically offered Fall*

This course constitutes an introduction to general aspects of chemistry for science, engineering and math majors. Topics include the theories of atomic structure, stoichiometry, properties of gases, kinetic molecular theory, thermodynamics, quantum mechanics, electronic structure of atoms, periodicity of the elements, chemical bonding, and molecular structure. A particular emphasis is placed on developing physical and chemical intuition through problem solving. pre-req or co-req: MATH-SHU 121 Calculus or MATH-SHU 201 Honors Calculus Fulfillment:

Core Curriculum: Science Experimental Discovery in the Natural World Courses; Major: Biology Foundational Courses; Chemistry Foundational Courses; Mathematics & Honors Mathematics Science Lecture sections; Neural Science Foundational Courses; Physics Foundational Courses.

**Grading:** Ugrd Shanghai Graded

**Repeatable for additional credit:** No

- SB Crse Attr. NYU Shanghai: Biology Foundation
- SB Crse Attr. NYU Shanghai: Chemistry Foundational
- SB Crse Attr. NYU Shanghai: Experimental Discovery in the Natural World
- SB Crse Attr. NYU Shanghai: Honors Mathematics Math and Science Requirements
- SB Crse Attr. NYU Shanghai: Mathematics Math and Science Requirements
- SB Crse Attr. NYU Shanghai: Neural Science Foundational Course
- SB Crse Attr. NYU Shanghai: Physics Foundational Course

## CHEM-SHU 126 Foundations of Chemistry II (3 Credits)

*Typically offered Spring*

This course is a continuation of Foundations of Chemistry I. Topics covered include the theories of intermolecular interactions, molecular orbital theory, reaction kinetics, chemical equilibria, acid-base reactions, properties of solutions, properties of solids, phase changes, transition-metal chemistry, coordination chemistry, electrochemistry, and nuclear chemistry. Students will reinforce and refine their physical and chemical intuition with a problems-based approach. pre-req: CHEM-SHU 125 Foundations of Chemistry I AND pre-req or co-req: MATH-SHU 131 Calculus or MATH-SHU 201 Honors Calculus Fulfillment: Biology Foundational Courses; Chemistry Foundational Courses; Mathematics & Honors Mathematics Science Lecture sections; Neural Science Foundational Courses; Physics Foundational Courses.

**Grading:** Ugrd Shanghai Graded

**Repeatable for additional credit:** No

- SB Crse Attr. NYU Shanghai: Biology Foundation
- SB Crse Attr. NYU Shanghai: Chemistry Foundational
- SB Crse Attr. NYU Shanghai: Honors Mathematics Math and Science Requirements
- SB Crse Attr. NYU Shanghai: Mathematics Math and Science Requirements
- SB Crse Attr. NYU Shanghai: Neural Science Foundational Course
- SB Crse Attr. NYU Shanghai: Physics Foundational Course

## CHEM-SHU 127 Foundations of Chemistry I Lab (2 Credits)

*Typically offered Spring*

In this laboratory course, students will be familiarized with various techniques, equipment, data analysis skills, best practices in lab safety and ideas common to chemistry laboratories and experimental research. The lab will both introduce and reinforce principles covered in the Foundations of Chemistry Lectures by providing practical applications of chemical theories, including acid-base chemistry, thermodynamics, spectroscopy, chemical kinetics, and buffer solutions, and applying quantitative data analysis in the chemistry lab. In addition, the laboratory will emphasize scientific communication, including scientific writing. As part of the course, students will work on a multi-week project, comparable to a graduate level independent-research project. Previous activities have included studying crystal growth and DNA thermodynamic parameters. With the help of their instructors and peers, students will learn the skills of modern scientific research: proposing a hypothesis, developing a proposal to test the hypothesis, collecting and analyzing data, writing a report, and presenting the findings to the public as a poster or an oral presentation. These skills will help students to develop and build their careers regardless of the major or discipline of study they are seeking. pre-req or co-req: CHEM-SHU 125 Foundations of Chemistry I Fulfillment: Core Curriculum: Experimental Discovery in the Natural World Courses; Major: Biology Foundational Courses; Chemistry Foundational Courses; Mathematics & Honors Mathematics Science Lab sections; Neural Science Foundational Courses.

**Grading:** Ugrd Shanghai Graded

**Repeatable for additional credit:** No

- SB Crse Attr. NYU Shanghai: Biology Foundation
- SB Crse Attr. NYU Shanghai: Chemistry Foundational
- SB Crse Attr. NYU Shanghai: Experimental Discovery in the Natural World
- SB Crse Attr. NYU Shanghai: Honors Mathematics Math and Science Requirements
- SB Crse Attr. NYU Shanghai: Mathematics Math and Science Requirements
- SB Crse Attr. NYU Shanghai: Neural Science Foundational Course
- SB Crse Attr. NYU Shanghai: Physics Foundational Course

## CHEM-SHU 128 Foundations of Chemistry II Lab (2 Credits)

Prereq for CHEM-SHU 128 is Prereq OR Coreq: Calculus/ Honors Calc (MATH-121/201) AND Prereq OR Coreq: Found of Chem II (CHEM-SHU 126). Fulfillment: Biology Foundational course; Chemistry Foundational course; Neural Science Foundational course; Physics Foundational course.

**Grading:** Ugrd Shanghai Graded

**Repeatable for additional credit:** No

- SB Crse Attr. NYU Shanghai: Biology Foundation
- SB Crse Attr. NYU Shanghai: Chemistry Foundational
- SB Crse Attr. NYU Shanghai: Neural Science Foundational Course
- SB Crse Attr. NYU Shanghai: Physics Foundational Course

## CHEM-SHU 200 Topics in Chemistry: (4 Credits)

*Typically offered occasionally*

Prerequisite: CHEM-SHU 126.

**Grading:** Ugrd Shanghai Graded

**Repeatable for additional credit:** No

**CHEM-SHU 225 Organic Chemistry I (3 Credits)***Typically offered Fall*

This course uses an interactive, problems-based approach to study the structure and bonding of organic materials, conformational analysis, stereochemistry, and spectroscopy, topics that partly trace their roots to the development of quantum theory. The topics covered include basic reaction mechanisms such as substitution and elimination, and the reactions of aliphatic and aromatic hydrocarbons, alcohols, ethers, amines, carbonyl compounds, and carboxylic acids. The course incorporates modern analytical methods that are the cornerstone of contemporary organic chemistry. Prerequisite: CHEM-SHU 126. Fulfillment : Biology Major Additional Required Courses; Chemistry Major Additional Required Courses.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr. NYU Shanghai: Biology Required
- SB Crse Attr. NYU Shanghai: Chemistry Required

**CHEM-SHU 225L Organic Chemistry I Lab (2 Credits)***Typically offered Fall*

This Organic Chemistry I Laboratory course is intended to introduce students to major concepts and techniques in organic chemistry through laboratory experiments. The course will provide training in the techniques of the organic chemistry laboratory, such as carrying out chemical reactions and purification of chemical mixtures. Purification methods such as recrystallization, extraction, distillation, and column chromatography will be utilized. Chemical identification and purity will be determined by methods such as chemical tests, melting point, boiling point, thin-layer chromatography (TLC), gas chromatography (GC) and spectroscopy: infrared (IR), ultraviolet (UV) and visible light. Expanding students knowledge base and critical thinking skills will help students to prepare for a wide array of potential future challenges, including the upper level courses, organic requirements for medical schools, and independent research. This course satisfies: Chemistry Major: Additional Required Courses. Prereq or coreq: Organic Chem I (CHEM-SHU 225) Fulfillment : Biology Major Additional Required Courses; Chemistry Major Additional Required Courses.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr. NYU Shanghai: Biology Required
- SB Crse Attr. NYU Shanghai: Chemistry Required

**CHEM-SHU 226 Organic Chemistry II (3 Credits)***Typically offered Spring*

This is a continuation of the course Organic Chemistry I, directing to the same objectives: An introduction to the world of Organic Chemistry; learning the main classes of compounds, their structure, nomenclature, reactivity and reactions. Students who complete the course should be able to understand the symbolism used in organic chemistry, the three-dimensional structure of organic molecules, and how that influences organic reactions. Students should be able to reproduce reaction mechanisms and relate those to compounds and reactions they have not encountered. Students should be able to predict the major product of simple reactions on organic compounds containing only one functional group and apply those same principles to more complex compounds containing multiple functional groups. Students should be able to design simple organic syntheses. Students should be able to read and comprehend articles from the current literature. Prerequisite: CHEM-SHU 225. Fulfillment: Biology elective; Chemistry Additional Required Courses.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr. NYU Shanghai: Biology Elective
- SB Crse Attr. NYU Shanghai: Chemistry Required

**CHEM-SHU 226L Organic Chemistry II Lab (2 Credits)***Typically offered occasionally*

This Organic Chemistry II Laboratory course is a continuation of the Organic Chemistry I Laboratory course. Students who complete the course are able to correlate, for the different functional groups studied, the molecular structure with common chemical and physical properties (such as solubility, reactivity, boiling and melting points). Students are able to characterize and elucidate structures using chemical and spectroscopic techniques. Students are able to characterize organic compounds based on physical and chemical properties (such as polarimetry, FT-IR spectroscopy, <sup>1</sup>H FT-NMR and other spectroscopic data) and purify organic compounds by physical methods such as chromatography, recrystallization, solvent extraction, sublimation, distillation, etc. Co-requisite or Prerequisite: CHEM-SHU 226. Fulfillment: Biology elective; Chemistry Additional Required Courses.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr. NYU Shanghai: Biology Elective
- SB Crse Attr. NYU Shanghai: Chemistry Required

**CHEM-SHU 312 Analytical Chemistry (4 Credits)***Typically offered occasionally*

Analytical Chemistry uses qualitative and quantitative analytical tools for ascertaining the chemical composition of a substance. In this course, students will be introduced to instrumental methods, including titrations, spectroscopy (UV-Vis, FTIR, NMR, Mass Spectroscopy, Atomic Absorption Spectroscopy) and chromatography. Quantitative measurement methods will be introduced along with the statistical concepts and tools of estimation, confidence, accuracy and precision. Students will learn the theoretical and practical aspects of Analytical Chemistry through lectures and laboratory demonstrations. Prerequisites: CHEM-SHU 126 Foundations of Chemistry II. Fulfillment: Chemistry Major Electives.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Chemistry Elective

**CHEM-SHU 651 Physical Chemistry: Quantum Mechanics and Spectroscopy (4 Credits)***Typically offered occasionally*

An introduction to quantum mechanics—general principles and applications to important model systems. Covers electronic structure of one- and many-electron atoms, theory of chemical bonding in diatomic and polyatomic molecules. Includes principles and applications of molecular spectroscopy: rotational, vibrational, electronic, and nuclear magnetic resonance. Elements of photochemistry are also included. Prerequisites: PHYS-SHU 12 General Physics II OR PHYS-SHU 93 Foundations of Physics II Honors, and CHEM-SHU 126 Foundations of Chemistry II. Fulfillment: Chemistry additional required course.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Chemistry Required

**CHEM-SHU 652 Physical Chemistry: Thermodynamics and Kinetics (4 Credits)***Typically offered occasionally*

Develops the close connection between the microscopic world of quantum mechanics and the macroscopic world of thermodynamics. Topics include properties of gases, kinetics, elementary statistical thermodynamics, and thermodynamics of single and multicomponent systems. Prerequisite: CHEM-SHU 126 Foundations of Chemistry II and PHYS-SHU 12 General Physics II or PHYS-SHU 93 Found of Physics II Honors. Multivariable Calculus is strongly recommended. Linear Algebra and Differential Equations is also recommended Fulfillment: Chemistry Major Required.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Chemistry Required

**CHEM-SHU 752 Computational Chemistry (4 Credits)***Typically offered Spring*

Computational Chemistry, the study of chemical systems with computer modeling and simulation, provides a sophisticated set of tools that every practicing chemist should know about. This course will introduce both the theoretical and practical aspects of modern computational chemistry, with an emphasis on quantum chemical methods. Lectures are combined with hands-on computational exercises using state-of-the-art high performance computing-based tools. Topics include Molecular Mechanics, Molecular Dynamics, Ab Initio Molecular Orbital Theories (Hartree-Fock and Density Functional Theory), Calculation of Molecular and Spectroscopic Properties, and Electronic Excitations. With these tools, students will engage in an independent research project of their design. Prerequisites: [Physical Chemistry: Quantum Mechanics and Spectroscopy (CHEM-SHU 651) OR Quantum Mechanics (PHYS-SHU 301)] AND [Physical Chemistry: Thermodynamics and Kinetics (CHEM-SHU 652) OR Statistical Mechanics and Thermodynamics (PHYS-SHU 302)] Fulfillment: CORE AT; Chemistry elective.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Algorithmic Thinking
- SB Crse Attr: NYU Shanghai: Chemistry Elective

**CHEM-SHU 881 Biochemistry I (4 Credits)***Typically offered occasionally*

This course offers deeper and more complete treatments of the chemistry of living cells and biological chemistry than in the Foundations of Science courses. Topics include structure and function of proteins, lipids, carbohydrates, and nucleic acids; enzyme structure, mechanism and regulation of enzyme activity, and membrane structure and transport; mechanisms of cellular processes and cellular physiology, including ion channels and pumps, cell motility, and the immune response. Prerequisite: CHEM-SHU 226. Fulfillment: Biology Major Electives; Chemistry Major Electives; Neural Science Major Approved upper-level Biology courses.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Biology Elective
- SB Crse Attr: NYU Shanghai: Chemistry Elective
- SB Crse Attr: NYU Shanghai: Neural Science Approved upper-level Biology Course

**CHEM-SHU 882 Biochemistry II (4 Credits)***Typically offered occasionally*

Building on the lessons of Biochemistry 1, Biochemistry 2 emphasizes analysis of basic metabolic pathways, including glycolysis, electron transport, and oxidative phosphorylation, as well as mechanisms of metabolic regulation and integration. Prerequisite: CHEM-SHU 881. Fulfillment: Biology Major Electives; Chemistry Major Electives; Neural Science Major Approved upper-level Biology courses.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Biology Elective
- SB Crse Attr: NYU Shanghai: Chemistry Elective
- SB Crse Attr: NYU Shanghai: Neural Science Approved upper-level Biology Course

**CHEM-SHU 997 Independent Study – Chemistry (2-4 Credits)***Typically offered Fall and Spring*

Prerequisite: Foundations of Science I-III (or Physics I&II, Foundations of Chemistry I&II, Foundations of Biology I&II), and a minimum GPA of 3.0 overall and in all science and mathematics courses required for the major, permission of a chemistry faculty member (at NYU-Shanghai, NYU-Abu Dhabi, or NYU-New York) who will act as a sponsor and mentor, and approval of the Director of Undergraduate Studies (DUS) in Chemistry. The faculty mentor must be selected in consultation with the DUS. Offered in the Fall, Spring or Summer. 2 to 4 points per term for a maximum of 4 points. This course aims at engaging students in research. It is designed to offer students an opportunity to observe chemistry research up close and gain hands-on research experience by working as a member in an active research team. Independent Study I and II can be done with the same supervisor or two different supervisors. No lectures will be given. Student researchers are expected to attend and actively participate in lab/supervision meetings. A Proposal for Independent Study form must be filled out, signed by the DUS, and submitted to the Registrar. Requires a written report on the research to be evaluated by the faculty sponsor, with a copy submitted to the DUS and a copy to the Dean of Arts & Sciences. Department consent is needed. Fulfillment: Chemistry Major Electives.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** Yes

- SB Crse Attr: NYU Shanghai: Chemistry Elective

**CHEM-SHU 998 Integrated Science Capstone (4 Credits)***Typically offered every year*

This course will provide students with a completion of their undergraduate science education by making use of the skills and knowledge they acquired over the course of completing their major to apply to scientific problems across disciplines. Students will be paired with a faculty mentor to engage either in Independent Research or Literature Review to address a scientific question of the student's design, culminating in a written report. Students are encouraged to work with faculty mentors outside of their own field. Open only to Biology, Chemistry, and Physics majors in the senior year. Prerequisite: senior students with chemistry major. Fulfillment: Chemistry required.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No

- SB Crse Attr: NYU Shanghai: Chemistry Required

**CHEM-SHU 999 Chemistry Undergraduate Research Thesis (2-4 Credits)**

Prerequisites: Independent Study (CHEM-SHU 997 or 998), a minimum GPA of 3.65 overall, a minimum GPA of 3.65 in all science and mathematics courses required for the major, and permission of a faculty sponsor and the Dean of Arts & Sciences. Open to Chemistry majors only. The faculty mentor must be selected in consultation with the Dean of Arts & Sciences. May not be used for the major in chemistry. Offered in the fall, spring, and summer. 2 points. For chemistry majors who have completed at least one semester of laboratory research (CHEM-SHU 997 or 998) and are able to expand this work into a thesis. Requires writing a Thesis (i.e., a full literature search of the subject and a formal written report on the research in publication form), which is defended in front of a committee of three faculty (which includes the faculty sponsor), chosen by the student in consultation with the faculty mentor. (The defense may be a brief oral presentation followed by a question-and-answer session.) The Thesis and defense must be evaluated by the committee, with the cover page of the thesis signed by all committee members, with a copy of the Thesis submitted to the Dean of Arts & Sciences. (It is recommended that the student meet with the faculty committee at least once mid-semester to evaluate and guide the student's progress on the thesis work.) Department consent is needed.

**Grading:** Ugrd Shanghai Graded**Repeatable for additional credit:** No