

# AS.030 (CHEMISTRY)

## Courses

### AS.030.101. Introductory Chemistry I. 3 Credits.

The fundamental principles of chemistry, including atomic and molecular structure, bonding, elementary thermodynamics, equilibrium and acids and bases, are introduced in this course. Can be taken with Introductory Chemistry Laboratory – I unless lab has been previously completed.

Note: Students taking this course and the laboratory 030.105 may not take any other course in the summer sessions and should devote full time to these subjects. High school physics and calculus are strongly recommended as prerequisites. First and second terms must be taken in sequence. Students not enrolled in college (unless they are rising freshmen) may not take this course. Course is offered in Summer and Fall terms only.

Area: Natural Sciences

### AS.030.102. Introductory Chemistry II. 3 Credits.

Continuation of AS.030.101 emphasizing chemical kinetics, chemical bonding. Topics: energy levels and wave functions for particle-in-a-box and hydrogen atom and approximate wave functions for molecules including introduction to hybrid orbitals. Course is offered in Spring and Summer terms only.

**Prerequisite(s):** Students enrolled in AS.030.103 may not enroll in or receive credit for AS.030.102.;AS.030.101

Area: Natural Sciences

### AS.030.103. Applied Chemical Equilibrium and Reactivity w/lab. 4 Credits.

This course is designed for students who have scored a 4 or 5 on the AP Chemistry Exam or who have scored a 6 or 7 HL IB Chemistry Exam. This course will review an advanced introductory chemistry sequence in a single semester. Chemical equilibrium, reactivity and bonding will be covered. These topics will be explored through laboratory experiments and problem solving, and discussing these principles in the context of current research. For details on chemistry placement and exam credit policies, please see [http://www.advising.jhu.edu/placement\\_chemistry.php](http://www.advising.jhu.edu/placement_chemistry.php) Students who have previously enrolled in AS.030.101 or AS.030.105 may not earn credit for AS.030.103 and students enrolled in AS.030.103 may not enroll in or receive credit for AS.030.102/AS.030.106.

**Prerequisite(s):** Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.

Area: Natural Sciences

### AS.030.104. Applications of Chemistry in Medicine. 1 Credit.

Chemistry is one of the oldest scientific disciplines through major contributions have been made in various fields such as health care, medicine, pharmaceutical sciences, materials and polymer science and forensic chemistry, to name a few. The development of new drugs involves chemical analysis and synthesis of new compounds. Chemistry also plays a vital role in the development and growth of several consumer-based industries such as pigments and paints, pharmaceuticals, cosmetics and oil and natural gas. In this program, students will be introduced to applications of chemistry in medicine and pharmaceutical sciences. Prerequisite: Background in chemistry and biology.

### AS.030.105. Introductory Chemistry Laboratory I. 1 Credit.

Laboratory work includes quantitative analysis and the measurement of physical properties. Open only to those who are registered for or have successfully completed Introductory Chemistry 030.101. Course is offered in Summer and Fall terms only.

**Prerequisite(s):** Students enrolled in AS.030.105 may not enroll in AS.030.115, AS.030.103, or AS.030.107.;Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;Students may take AS.030.101 at the same time as or complete it before enrolling in AS.030.105.

Area: Natural Sciences

### AS.030.106. Introductory Chemistry Laboratory II. 1 Credit.

Laboratory work includes some quantitative analysis and the measurement of physical properties. Open only to those who are registered for or have completed Introductory Chemistry II (AS.030.102). Permission required for pre-college students. Course offered in Spring and Summer terms only.

**Prerequisite(s):** Students enrolled in AS.030.103 may not enroll in or receive credit for AS.030.106.;Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;AS.030.105 AND AS.030.101

Area: Natural Sciences

### AS.030.111. Reading and Interpreting Scientific Studies. 3 Credits.

Many controversial health claims have entered the public consciousness over the years. Claims made by popular media are often conflicting and it can be difficult to trust their validity without directly examining their sources: data produced in scientific journals. However, the unfamiliar structure and technical jargon of these publications often act as a roadblock to understanding. This course aims to introduce common research methods and approaches and provide strategies for approaching research articles and interpreting their results using popular scientific topics as examples. Students will examine the biochemistry behind controversial topics such as CBD supplements, dieting, and gene editing and more importantly, build the skills to determine for themselves the validity of some of the many claims that enter the public consciousness.

Area: Natural Sciences

### AS.030.113. Chemistry with Problem Solving II. 2 Credits.

This course is for students who have had moderate or limited exposure to the subject. Special emphasis is placed on scientific problem-solving skills. There are two discussion sections per week, including one devoted exclusively to interactive quantitative problem solving. A typical student may have taken a year of descriptive chemistry as a high school sophomore, but has not been exposed to the problem-solving mathematical approach used in university-level science courses. Taken concurrently with AS.030.101 and AS.030.102.

### AS.030.205. Introductory Organic Chemistry I. 4 Credits.

The fundamental chemistry of the compounds of carbon. Methods of structure determination and synthesis. The mechanisms of typical organic reactions and the relations between physical and chemical properties and structures. Course offered only in Summer and Fall terms.

**Prerequisite(s):** AS.030.102 OR AS.030.103

Area: Natural Sciences

**AS.030.206. Organic Chemistry II. 4 Credits.**

Continuation of AS.030.205 Organic Chemistry I with special emphasis on organic synthesis and related synthetic methods. Students may not simultaneously enroll for AS.030.212 and AS.030.206. Course only offered in Spring and Summer terms.

**Prerequisite(s):** AS.030.205

**Corequisite(s):** Students may not simultaneously enroll for AS.030.212 and AS.030.206.

Area: Natural Sciences

**AS.030.212. Honors Organic Chemistry II. 4 Credits.**

Second semester undergraduate organic chemistry from a more advanced perspective, emphasizing connections to modern examples from biochemistry (protein and DNA structure, chemical logic of metabolism, enzyme mechanisms), catalysis, materials (polymer synthesis, supramolecular chemistry), medicine (drug structure and function) and more. The standard topics of second semester organic chemistry (e.g. reactivity of aromatic and carbonyl-containing molecules) will all be covered, but amplified and enriched with topics as noted.

Students may not simultaneously enroll in AS.030.212 and AS.030.206.

Prereq: Must receive a B+ or better in the first semester (AS.030.205)

**Prerequisite(s):** Must receive a B+ or better in the first semester (AS.030.205)

Area: Natural Sciences

**AS.030.225. Introductory Organic Chemistry Laboratory. 3 Credits.**

Laboratory work includes fundamental laboratory techniques and preparation of representative organic compounds. Open only to those who are registered for or have completed Introductory Organic Chemistry. Note: This one-semester course is offered each term. Introductory Organic Chemistry I/II requires one semester of the laboratory.

**Prerequisite(s):** Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;AS.030.205 AND ((AS.030.102 AND AS.030.106) AND AS.030.103) can be taken prior to enrolling or at the same time as AS.030.225.

**Corequisite(s):** Students may not simultaneously enroll for AS.030.225 and AS.030.227

Area: Natural Sciences

**AS.030.227. Chemical Chirality: An Introduction in Organic Chem. Lab, Techniques. 3 Credits.**

This is a project lab designed for Chemistry Majors who are concurrently enrolled in AS.030.205. Techniques for the organic chemistry laboratory including methods of purification, isolation, synthesis, and analysis will be explored through a project focused on chemical chirality. Students may not simultaneously enroll for AS.030.225 and AS.030.227.

**Prerequisite(s):** Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;AS.030.205 may be taken at the same time or prior to enrolling in AS.030.227.

**Corequisite(s):** Students may not simultaneously enroll for AS.030.225 and AS.030.227.

Area: Natural Sciences

**AS.030.228. Intermediate Organic Chemistry Laboratory. 3 Credits.**

Lab skills already acquired in AS.030.225 will be further developed for synthesis, isolation, purification, and identification of organic compounds. Spectroscopic techniques, applications will be emphasized. Recommended Course Background: AS.030.225

**Prerequisite(s):** Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;AS.030.205 AND (AS.030.225 OR AS.030.227);(AS.030.206 OR AS.030.212)

Area: Natural Sciences

**AS.030.245. Quantitative Analytical Laboratory. 3 Credits.**

This is a 3 credit lab that will serve as an introduction into analytical techniques and quantitative methods. There will be a 1 hour of pre-lab lecture component to this course to discuss the lab for that day.

**Prerequisite(s):** (AS.030.102 OR AS.030.103) AND AS.030.205

Area: Natural Sciences

**AS.030.301. Physical Chemistry I. 3 Credits.**

The laws of thermodynamics, their statistical foundation, and their application to chemical phenomena. Students should have knowledge of general physics, general chemistry, and calculus (two semesters recommended). Freshmen by permission only.

Area: Natural Sciences

**AS.030.302. Physical Chemistry II. 3 Credits.**

Introduction to quantum mechanics, its application to simple problems for which classical mechanics fails. Topics: Harmonic oscillator, hydrogen atom, very approximate treatments of atoms and molecules, and theoretical basis for spectroscopy. Recommended Course Background: AS.030.301

Area: Natural Sciences

**AS.030.305. Physical Chemistry Instrumentation Laboratory I. 3 Credits.**

This course is designed to illustrate the principles of physical chemistry and to introduce the student to techniques and instruments used in modern chemical research. Chemistry majors are expected to take this sequence of courses, rather than AS.030.307. Chemistry majors only.

**Prerequisite(s):** Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module..

Area: Natural Sciences

**AS.030.306. Physical Chemistry Instrumentation Laboratory II. 3 Credits.**

Designed to illustrate the principles of physical chemistry, introduce the student to spectroscopic techniques and instruments used in modern chemical research. Chemistry majors are expected to take this course rather than 030.307.

**Prerequisite(s):** Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;AS.030.301 OR AS.030.302

Area: Natural Sciences

**AS.030.316. Biochemistry II. 3 Credits.**

Biochemical anabolism, nucleic acid structure, molecular basis of transcription, translation and regulation, signal transduction with an emphasis on physical concepts and chemical mechanisms. Format will include lectures and class discussion of readings from the literature.

**Prerequisite(s):** AS.030.315 OR AS.250.315 OR AS.020.305

Area: Natural Sciences

**AS.030.356. Advanced Inorganic Lab. 3 Credits.**

Laboratory designed to illustrate the principles and practice of inorganic chemistry through the synthesis and characterization of transition metal and organometallic compounds. Methods used include vacuum and inert atmosphere techniques. Instrumental approaches and modern spectroscopic techniques are applied to the characterization of compounds generated. It is strongly recommended that students have taken or are taking one of the following courses: AS.030.204, AS.030.442, AS.030.449, or AS.030.472.

**Prerequisite(s):** AS.030.228

Area: Natural Sciences

**AS.030.371. Chemistry for Connoisseurs. 3 Credits.**

This course will survey the structural and physical properties of chemicals often considered as part of the "finer things in life" including topical discussions of the chemistries of food, drink, art, cosmetics and clothing, among others. Despite the pretentious name, the general theme of the course is to put chemical identities onto the things we interact with on a daily basis but most likely take for granted at a molecular level. Current event topics in consumer chemistry will also be covered as they arise. Students will have the chance to research topics of interest. The course material will be enriched by the contributions from special guest lecturers and occasional field trips.

**Prerequisite(s):** AS.030.205 or equivalent

Area: Natural Sciences

Writing Intensive

**AS.030.403. Optoelectronic Materials and Devices: Synthesis, Spectroscopy, and Applications. 3 Credits.**

This course provides an introduction to the vast chemistry and physics of solid-state materials. The course begins with a fundamental description of bonding in crystalline solids and calculation of electronic band structure. We then extend our discussion to methods for the synthesis of low-dimensional materials and hierarchical structures, including quantum dots (0D), nanowires (1D), graphene and graphene analogs (2D), and thin-film superlattices. An in-depth discussion of spectroscopic and characterization techniques for solid-state materials will follow and focus on some of the foundational studies of quantum devices and cooperative phenomena. At this stage we will describe recent advances in electron-microscopy (e.g. aberration-corrected and energy filtered TEM, atom-probe tomography) that are revolutionizing the structural, compositional, and electronic characterization of materials. The course will conclude with a survey of contemporary topics in solid-state and nanomaterials science, including functional devices and circuits, assembly, energy conversion and catalysis, and biological sensing. Recommended Course Background: AS.030.301 and AS.030.402 are preferred, but instructor approval may be granted in lieu of these courses.

Area: Natural Sciences

**AS.030.404. Electrochemical Systems for Energy Conversion and Storage. 3 Credits.**

This course will be focused on the fundamentals and applications of electrochemical methods in catalysis, charge transport, and energy conversion and storage. Topics that will be covered are basic electrochemical techniques, homogenous and heterogeneous (photo)electrocatalysis, fuel cells, and charge storage devices. The class will conclude with a group report and presentation on a recent development in the field of energy catalysis, conversion, and storage. Course topics include: 1) Fundamentals of electrochemistry, 2) Potential sweep methods and current-controlled techniques, 3) Impedance analysis, 4) Electrochemistry coupled with other characterization methods, 5) Electrocatalysis and photoelectrochemical catalysis, 6) Basics in fuel cells and current technologies (alkaline, polymer exchange membrane, solid oxide...), 7) Basics in batteries and current technologies (Pb acid, Li-based, other metals...) Recommended Course Background: AS.030.204 or AS.030.449 or AS.030.472, or instructor approval for undergraduate students. No pre-requisites for graduate students

Area: Natural Sciences

**AS.030.405. Introduction to Computational Chemistry. 3 Credits.**

This course provides an introduction to the state-of-the-art computational chemistry. The course integrates the basics about molecular electronic structure theories and the corresponding computational aspects and practice in chemical applications. The discussions of theories cover the modern quantum-chemical methods, ranging from mean-field methods (Hartree-Fock method and density-functional theory) to post mean-field methods for treating electron-correlation effects (configuration interaction and coupled cluster). Demonstrative calculations and computer lab practice are designed to deal with the computation of energetic properties (e.g., heat of formation, bond dissociation energy, reaction activation energy, etc) and structural properties (geometry, vibrational frequencies, etc) of representative molecular systems using standard quantum chemistry program package (the Gaussian program, most probably). The class will conclude with a report and presentation on a piece of recent computational work pertinent to the student's research interests.

**AS.030.415. Bioinorganic and Organometallic Chemistry. 3 Credits.**

This course will cover key concepts of Bioinorganic chemistry (including metalloenzymes, synthetic catalysts, drugs, and molecular sensors) and Organometallic Chemistry (types of ligands, interactions with metals) and their applications in catalysis and bioinorganic chemistry. A background in organic chemistry and physical chemistry I is strongly recommended.

**Prerequisite(s):** AS.030.206

**AS.030.417. Metallo(bio)chemistry of Molecular Oxygen. 1.5 Credits.**

This advanced (but descriptive) course focuses on how transition metals of the first row, i.e., iron, manganese and copper), process molecular oxygen (O<sub>2</sub>) in metalloenzymes and coordination complexes. Chemical behavior discussed will be reversible O<sub>2</sub>-binding (e.g., blood dioxygen carriers and their synthetic analogs), insertion of one or both atoms of molecular oxygen into organic substrates (i.e., oxygenase activity), or oxidase (bio)chemistry, wherein the metal ion center facilitates O<sub>2</sub>-reduction to hydrogen peroxide or water. The focus will be on the metal's role and mechanism of action. Practical societal applications will also be discussed.

**Prerequisite(s):** AS.030.449 or equivalent

**AS.030.421. Data Science Tools for the Chemical and Materials Sciences. 3 Credits.**

Advances in measurement techniques and simulations have driven an explosion in the variety, quality, and quantity of data collected when investigating chemical and materials processes. Advances in computing have led to the practicality of machine learning (ML) and related analytical methods to explore and extract meaning from this cornucopia of data, and data science has been called the fourth pillar of the scientific method. This course will provide an introduction to modern tools of data science, including the Python programming language, Jupyter notebooks, ML algorithms and their practical implementation, and high performance computing, with specific emphasis on applying these tools to data of chemical relevance, including UV/Vis, IR and NMR spectra, 3-D micro computed tomography, and physical property data including specific heat, magnetization, and resistivity.

**AS.030.424. Molecular Synthetic Biology. 3 Credits.**

Synthetic Biology is changing the world around us. This course is designed to help you to understand these powerful emerging technologies and the science behind it, and to help prepare you if you want to contribute toward these exciting developments.

**Prerequisite(s):** AS.030.315 OR AS.020.305

Writing Intensive

**AS.030.441. Spectroscopic Methods of Organic Structure Determination. 3 Credits.**

The course provides fundamental theoretical background for and emphasizes practical application of ultraviolet/visible and infrared spectroscopy, proton and carbon-13 nuclear magnetic resonance and mass spectrometry to the structure proof of organic compounds.

Area: Natural Sciences

**AS.030.442. Organometallic Chemistry. 3 Credits.**

An introduction to organometallic chemistry beginning with structure, bonding, and reactivity and continuing into applications to fine chemical synthesis and catalysis. Required Course Background: Organic chemistry-I and -II. Level: Upper level Undergraduate AND Graduate Students

Area: Natural Sciences

**AS.030.449. Chemistry of Inorganic Compounds. 3 Credits.**

Physical and chemical properties of inorganic, coordination and organometallic compounds are discussed in terms of molecular orbital, ligand field and crystal field theories. Emphasis on structure and reactivity of these inorganic compounds. Other topics: magnetic properties, electronic spectra, magnetic resonance spectra, reaction kinetics.

Area: Natural Sciences

**AS.030.452. Materials & Surface. 3 Credits.**

The chemistry associated with surfaces and interfaces as well as a molecular level understanding of their essential roles in many technological fields. The first half of this course addresses various analytical techniques used to study surfaces including X-ray, photoelectron spectroscopy, and scanning tunneling microscopy. The second half of this course uses a number of case studies to illustrate the application of surface analytical techniques in contemporary research.

Area: Natural Sciences

**AS.030.453. Intermediate Quantum Chemistry. 3 Credits.**

The principles of quantum mechanics are developed and applied to chemical problems.

**Prerequisite(s):** AS.030.302

Area: Natural Sciences

**AS.030.454. Electrochemistry for Energy Conversion and Storage. 1.5 Credits.**

This half-semester course introduces fundamental concepts in electrochemistry and the application of electrochemical methods for chemical research. The goal of this course is to enable students to practice electrochemistry in laboratory for any field. We will discuss how to use electrochemistry as an analytical technique in your toolbox for understanding chemical reactions as well as the role of electrochemistry in energy conversion and storage.

**AS.030.456. Chemical Applications of Group Theory. 3 Credits.**

This class will introduce group theory in the chemical/physical context. In addition to the fundamentals of (practical/applied) group theory, this course will explore how the tools of group theory enable powerful, general statements to be made about the behavior of chemical systems from the atomic scale to the macroscale, often without requiring detailed calculations or knowledge of most microscopic details. It is particularly targeted at upper level chemistry and physics undergraduates who have a basic knowledge of quantum mechanics and a brief familiarity with linear algebra.

Area: Natural Sciences

**AS.030.501. Independent Research in Physical Chemistry I. 3 Credits.**

Research under the direction of members of the physical chemistry faculty.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.502. Independent Research in Physical Chemistry. 1 - 3 Credits.**

Research under the direction of members of the physical chemistry faculty.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.503. Independent Research in Inorganic Chemistry I. 3 Credits.**

Research under the direction of members of the inorganic chemistry faculty.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.504. Independent Research in Inorganic Chemistry. 1 - 3 Credits.**

Research under the direction of members of the inorganic chemistry faculty.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.505. Independent Research in Organic Chemistry I. 3 Credits.**

Research under the direction of members of the organic chemistry faculty.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.506. Independent Research in Organic Chemistry I. 1 - 3 Credits.**

Research under the direction of members of the organic chemistry faculty.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.507. Independent Research in Biochemistry. 3 Credits.**

Research under the direction of members of the biochemistry faculty.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.509. Independent Research in Biochemistry II. 3 Credits.**

Research under the direction of members of the biochemistry faculty.

Recommended Course Background: AS.030.507-AS.030.508 and permission of instructor.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.510. Independent Research in Biochemistry II. 1 - 3 Credits.**

Research under the direction of members of the biochemistry faculty.

Recommended Course Background: AS.030.507-AS.030.508 and permission of instructor.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.511. Independent Research in Materials Chemistry. 1 - 3 Credits.**

Research under the direction of members of the Materials Chemistry faculty.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.512. Independent Research in Materials Chemistry. 1 - 3 Credits.**

Research under the direction of the materials chemistry faculty.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.513. Independent Research in Medical Science. 3 Credits.**

Research under the direction of members of the medical faculty.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.514. Independent Research in Medical Science. 3 Credits.**

Research under the direction of members of the medical faculty.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.516. Independent Research in Chemical Biology II. 1 - 3 Credits.**

Research under the direction of Chemical Biology faculty. Permission of instructor required.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.521. Independent Research in Inorganic Chemistry II. 3 Credits.**

Research under the direction of the inorganic chemistry faculty.

Recommended Course Background: AS.030.503-AS.030.504 and permission of instructor.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.522. Independent Research in Inorganic Chemistry II. 1 - 3 Credits.**

Research under the direction of the inorganic chemistry faculty.

Recommended Course Background: AS.030.503-AS.030.504 and permission of instructor.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.523. Independent Research in Physical Chemistry II. 3 Credits.**

Research under the direction of the physical chemistry faculty.

Recommended Course Background: AS.030.501-AS.030.502 and permission of instructor.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.525. Independent Research in Organic Chemistry II. 3 Credits.**

Research under the direction of the organic chemistry faculty.

Recommended Course Background: AS.030.505-AS.030.506 and permission of instructor.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.526. Independent Research in Organic Chemistry II. 1 - 3 Credits.**

Research under the direction of members of the Organic Chemistry faculty.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.527. Independent Study. 3 Credits.**

Research under the direction of the chemistry faculty.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.530. Independent Research in Inorganic and Materials Chemistry. 1 - 3 Credits.**

Research under the direction of members of the Inorganic Chemistry faculty.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.540. Independent Research in Solid State and Materials Chemistry. 1 - 3 Credits.**

Research under the direction of members of the Physical Chemistry faculty.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.593. Research-Organic Chemistry I. 3 Credits.**

Research under the direction of Organic Chemistry faculty members.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.597. Research - Summer. 3 Credits.**

Research under the direction of the chemistry faculty members.

**Prerequisite(s):** You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

**AS.030.601. Statistical Mechanics. 3 Credits.**

An introduction to statistical mechanics of cooperative phenomena using lattice gases and polymers as the main models. Covered topics: phase transitions and critical phenomena, scaling laws, and the use of statistical mechanics to describe time dependent phenomena.

**AS.030.610. Chemical Kinetics. 3 Credits.**

The molecular mechanism of elementary physical and chemical rate processes will be studied. Topics such as elastic scattering, collisional vibrational and rotational energy transfer, chemically reactive collisions, and the theory of unimolecular decay will be covered.

**AS.030.613. Chemistry-Biology Interface Program Forum I. 1 Credit.**

Chemistry-Biology Interface (CBI) program students and faculty will meet weekly in a forum that will host presentations from CBI faculty and students as well as invited guest speakers. These meetings will serve as a valuable opportunity for students to develop presentation skills and interact with CBI students and faculty. Enrollment is required for first- and second-year CBI students, and is recommended for advanced-year graduate students.

**AS.030.614. Chemical-Biology Program Interface Forum II. 1 Credit.**

Chemistry-Biology Interface (CBI) program students and faculty will meet weekly in a forum that will host presentations from CBI faculty and students as well as invited guest speakers. These meetings will serve as a valuable opportunity for students to develop presentation skills and interact with CBI students and faculty. Enrollment is required for first and second year CBI students, and is recommended for advanced year graduate students.

**AS.030.616. The Chemistry of Transition Metals in Biology. 1.5 Credits.**

This course will cover fundamental principles in inorganic chemistry, biochemistry, and spectroscopy that are important to the field of bioinorganic chemistry. Current topics in bioinorganic chemistry will be covered, including metalloenzyme structure and function and related synthetic model systems. An emphasis will be placed on the role of transition metals in these systems, and their chemical mechanisms. The collection and interpretation of data from modern bioinorganic spectroscopic tools (e.g. UV-vis, EPR, raman, Mössbauer, X-ray absorption) will be discussed in the context of these current topics.

**AS.030.617. Metallo(bio)chemistry of Molecular Oxygen. 1.5 Credits.**

This advanced (but descriptive) course focuses on how transition metals of the first row, i.e., iron, manganese and copper, process molecular oxygen (O<sub>2</sub>) in metalloenzymes and coordination complexes. Chemical behavior discussed will be reversible O<sub>2</sub>-binding (e.g., blood dioxygen carriers and their synthetic analogs), insertion of one or both atoms of molecular oxygen into organic substrates (i.e., oxygenase activity), or oxidase (bio)chemistry, wherein the metal ion center facilitates O<sub>2</sub>-reduction to hydrogen peroxide or water. The focus will be on the metal's role and mechanism of action. Practical societal applications will also be discussed.

**AS.030.619. Chemical Biology I. 3 Credits.**

Parts I and II constitute the core course of the Chemistry-Biology Interface (CBI) Program. An introduction to the structure, synthesis, reactivity, and function of biological macromolecules (proteins, nucleic acids, carbohydrates, and lipids) will be provided using the principles of organic and inorganic chemistry. Discussion will incorporate a broad survey of molecular recognition and mechanistic considerations, and introduce the tools of molecular and cellular biology that are utilized in research at the interface of chemistry with biology and medicine. Recommended Course Background: AS.030.206 or equivalent.

**AS.030.620. Chemical Biology II. 3 Credits.**

Selected topics of current importance in chemical biology are covered. They include protein engineering and proteomics, cell signaling, protein-nucleic acid interactions (e.g. replication, transcription, DNA repair), catalytic RNA and the ribosome, biosynthesis of natural products, mechanisms of drug action, combinatorial chemistry and chemical genetics, and in vitro selection. Recommended Course Background: AS.030.619 or permission required.

**AS.030.621. Literature-Organic Chemistry. 1 Credit.**

Chemistry graduate students prepare and present their findings based upon approved chemistry literature of their choice.

**AS.030.622. Seminar: Literature of Chemistry. 1 Credit.**

Seminars are presented by advanced graduate students on topics from current chemical journals. Most first-year graduate students are expected to attend for credit. Undergraduates may take the course on a satisfactory/unsatisfactory basis.

**AS.030.623. Molecular Synthetic Biology. 3 Credits.**

Principles and methods for the design and optimization of new biological systems, from a molecular perspective. Topics include: introduction to genetic parts and modern methods for their assembly; synthesis and incorporation of nucleic acids at the level of nucleotides, genes, and genomes; design of genetic programs; library generation and screening; directed evolution and its application to create new proteins and metabolic pathways; computational design of protein and RNA using physical and bioinformatic approaches; non-canonical amino acids and genetic code expansion. This course will also feature critical evaluation of the primary literature in this fast-paced field, and practical experience with relevant software and computational tools.

**AS.030.625. Advanced Mechanistic Organic Chemistry I. 3 Credits.**

The course covers the application of techniques in physical chemistry to the study of organic reaction mechanisms. Topics include chemical bonding and structure, stereochemistry, conformational effects, molecular orbital theory, methods to determine reaction mechanisms, reactive intermediates, and photochemistry. Recommended Course Background: AS.030.205-AS.030.206

**AS.030.626. Advanced Mechanistic Organic Chemistry II. 3 Credits.**

This course covers advanced organic reactions and their mechanisms. Emphasis is given both to methods of postulating mechanisms for rationalizing reaction results and to the use of mechanistic thinking for designing reactions and reagents. This course is intended to be taken in sequence with AS.030.425. Recommended Course Background: AS.030.205-AS.030.206

**AS.030.630. Molecular Photophysics and Photochemistry. 3 Credits.**

This course will introduce fundamental physical, chemical, and analytical concepts underlying light-induced chemical and (molecular-based) material processes. The final weeks of this course will build from these core concepts to survey molecular photoresponses and their consequences or applications in environmental chemistry, chemical biology, and materials science.

Area: Natural Sciences

**AS.030.633. Bioorganic and Natural Product Chemistry. 1.5 Credits.**

This is a natural products chemistry course organized according to the major natural product groups and emphasizing their origins, fundamental chemistry and applications in medicine. The organization is part traditional lecture and part case studies, like law school or business school, involving your participation in independent research, short essays and presentations. The last Workshops will be elective on your part as to topic with approval from C.A.T. Mixed in will be examples of organic and chemoenzymatic synthesis and biomimetic synthesis, relevant aspects of cofactor and enzyme function and their engineering, spectroscopic and kinetic tools.

**AS.030.636. Principles of Multidimensional NMR Spectroscopy. 1.5 Credits.**

This course is intended to be of general interest to those wanting to broaden their spectroscopy skills and will cover the theoretical and practical aspects of multidimensional NMR spectroscopy. This includes approaches to optimization of data acquisition and post-acquisition data processing as well as the development of the theoretical background needed to understand and design NMR pulse sequences.

**AS.030.648. Biocatalysis: Fundamentals, Recent Advances, and Industrial Applications. 3 Credits.**

Biocatalysis is a rapidly evolving field that adapts biology's mechanisms for innovation to offer revolutionary solutions for chemical production.

This course features an in-depth coverage of various topics in biocatalysis with examples of how biocatalysis has reshaped various aspects of modern industries including food manufacturing, pharmaceuticals, consumer products, and biomaterials. This course also provides an overview of common enzyme classes used in bioindustries with extensive discussions of their catalytic mechanisms and engineering. Integrated within the course will be reviewing of important literatures, assessment of critical industrial biocatalytic processes, and hands-on experience of common bioinformatic and computational tools for new enzyme discovery.

**AS.030.652. A Theoretical and Experimental Approach to X-ray Crystallography. 3 Credits.**

The X-ray course will provide a complete approach to X-ray structure to determination (mostly concerned with small molecules) and its uses in Chemistry. The first segment of this course will cover all theoretical aspects of X-ray crystallography, i.e. crystals and crystallization, the nature of X-rays, the diffraction phenomenon of X-rays by crystals, symmetry and space groups, crystal structure analysis. Additionally, the course will provide laboratory experience for the students, involving hands-on instrumentation, experimental methodology to X-ray structure determination, structure solution/refinement, data analyses and publishing data. The course is aimed for graduate students with a strong interest in organic/inorganic chemistry, materials sciences, and physics. Undergraduate students with a major in chemistry are also encouraged to participate.

Area: Natural Sciences

**AS.030.676. Modern Synthetic Methods in Total Synthesis. 3 Credits.**

An exploration of modern synthetic methods in the context of total synthesis.

**AS.030.677. Advanced Organic Synthesis I. 3 Credits.**

The reactions and principles involved in the synthesis of simple and complex organic compounds. Discussion of famous natural product syntheses and practice in developing rational designs for organic syntheses. Problems in the design of syntheses and in the use of chemical literature.

**AS.030.678. Advanced Organic Synthesis II. 3 Credits.**

Advanced discussion of organic stereochemistry & its application to problems in asymmetric reactions and catalysis will be presented. Emphasis will be placed on the latest reports in the literature, especially with respect to the development of new catalytic, asymmetric processes.

**AS.030.681. Nucleic Acids: Fundamental Chemistry and Applications. 1.5 Credits.**

The course will begin with an overview of nucleic acid structure, synthesis and reactivity. Subsequent topics will include nucleic acid damage & repair, expanding the genetic code, the role of nucleic acids in epigenetics and applications in biotechnology, such as the development of nucleic acid sensors.

**AS.030.691. Hardware, Software and Materials Chemistry. 3 Credits.**

The course is designed to provide the essential principles and concepts underlying the modern study of the structure and properties of solids in bulk crystals, thin films, and nanoscale objects. Topics include basic crystallography, structure determination by x-ray, neutron, and electron diffraction, fundamental concepts of bonding in solids, lattice dynamics, electronic band structure, magnetism, and strongly correlated electron behavior. Particular emphasis is placed on the impact of the structure, dimensionality, and electron count on electrical and magnetic properties (electric conduction, superconductivity, thermoelectricity, etc). More course info available at <http://occamy.chemistry.jhu.edu>. Cross-listed with Physics and Astronomy

**AS.030.800. Summer Independent Research. 9 Credits.**

This course is for active Chemistry PhD students during summer terms

**AS.030.803. CBI Rotations. 3 Credits.**

Open to AS Chemical Biology Interface Graduate Students only

**AS.030.897. Dissertation Research. 10 - 20 Credits.**

Open to AS Chemistry Graduate Students only.