

# CHEMISTRY

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## Department of Chemistry

Spencer Chemistry Building

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<http://sbc.umkc.edu/>

The Department of Chemistry offers programs of study leading to the bachelor of arts, bachelor of science and master of science degrees, and participates in UMKC's interdisciplinary Ph.D. program. To the extent that each program is flexible (see degree requirements), it is possible to specialize at the graduate level in the areas of analytical, inorganic, organic, physical or polymer chemistry.

## Research facilities and Laboratories

### Major Instrumentation

- Varian Inova 400 MHz NMR spectrometer.
- Bruker 250 MHz NMR spectrometer with solid state probe.
- IBM 200 Electron Spin Resonance Spectrometer.
- AA and ICP-AA spectrophotometers.
- CARY-1 UV-Visible dual beam spectrophotometer.
- Cambridge Structural Database Subscription (Van Horn).
- Raman and Infrared Spectroscopy Lab (Durig).
- Positron Annihilation and Gamma-ray Spectroscopy Lab (Van Horn).
- ABI Pioneer peptide synthesizer.
- Sprint BioCad liquid chromatography system.
- Finnigan MAT Double Focusing mass spectrometer.

### Research Instrumentation

- Ocean Optics UV-Vis-NIR and other UV-Visible spectrophotometers.
- Metrohm Titrando system with "PC Control" software.
- BAS Epsilon electrochemistry apparatus (Peng).
- Shimadzu HPLC (Van Horn).
- Shimadzu RF-5301PC Fluorescence spectrophotometer.
- Perkin Elmer Polarimeter (Buszek).

### Support Facilities

- Chemical Stores.

### On Campus Resources

- Jasco J-710 Circular Dichroism Spectropolarimeter.
- Varian 600 MHz NMR Spectrometer (Laity).
- ESI-mass spectrometer and Triple-Quad LC-ESI MS with nanospray adaptor (School of Pharmaceutical Sciences).
- Machine Shop (Department of Physics).

Computer facilities include UMKC's Academic Research servers using HP's Itanium technology and numerous personal computers located in Spencer Hall and Flarsheim Hall for teaching and research purposes. A computational research laboratory is also housed in the department with a number of high-speed workstations and modern software.

## Faculty

**Paul M. Barron**; assistant teaching professor of chemistry, coordinator of general chemistry laboratories, principal undergraduate advisor; Ph.D. (University of Nebraska).

**Keith R. Buszek**<sup>2,3</sup> professor of chemistry; B.S. (University of California, Irvine); Ph.D. (University of California, Los Angeles).

**Xiaobo Chen**<sup>2,3</sup>; professor of chemistry; B.S. (Peking University, China); M.S. (Chinese Academy of Sciences); Ph.D. (Case Western Reserve University).

**Jerry R. Dias**<sup>2,3</sup> curators' professor emeritus of chemistry; B.S. (San Jose State College); Ph.D. (Arizona State University).

**Andrea Drew Gounev**; teaching professor of chemistry, coordinator of organic laboratories, principal undergraduate advisor; B.S. Ph.D. (University of South Carolina).

**Todor K. Gounev**; teaching professor of chemistry; B.S., M.S. (University of Sophia, Bulgaria); Ph.D. (University of South Carolina).

**Andrew J. Holder**<sup>2</sup> professor of chemistry; B.S. (Mobile College); Ph.D. (University of Southern Mississippi).

**Lena Hoober-Burkhardt**; assistant teaching professor of chemistry, coordinator of advanced chemistry laboratories, undergraduate advisor; B.A. (Princeton University); Ph.D. (University of Southern California).

**Kathleen V. Kilway**<sup>2,3</sup> chair and curators' teaching professor of chemistry; B.S. (St. Mary's College); M.S., Ph.D. (University of California-San Diego).

**Shin Moteki**<sup>2,3</sup> assistant professor of chemistry; Ph.D. (University of Nebraska-Lincoln).

**Nathan A. Oyler**<sup>2,3</sup> associate professor of chemistry; B.S. (University of Arizona); Ph.D. (University of Washington).

**Zhonghua Peng**<sup>2,3</sup> curators' professor of chemistry; B.S. (University of Science and Technology of China); M.S. (Chinese Academy of Sciences); Ph.D. (University of Chicago).

**Mohammad Rafiee**<sup>2,3</sup> assistant professor of chemistry; B.S., Ph.D. (Bu-Ali Sina University, Iran).

**J. David Van Horn**<sup>2,3</sup> associate professor of chemistry; B.A. (Point Loma Nazarene College); Ph.D. (University of Utah).

**Charles J. Wurrey**<sup>2</sup> curators' distinguished teaching professor emeritus and James C. Olson professor of chemistry; B.S. (Northern Michigan University); Ph.D. (Massachusetts Institute of Technology).

<sup>1</sup> Associate or Adjunct Graduate Faculty

<sup>2</sup> Members of UMKC Graduate Faculty

<sup>3</sup> Members of UMKC Doctoral Faculty

## Emeritus faculty

John W. Connolly, Jerry R. Dias (Curators' Professor Emeritus of Chemistry), Henry A. Droll, Peter Groner, Y.C. Jerry Jean (Curator's Professor Emeritus), Peter F. Lott, Layton L. McCoy, Thomas C. Sandreczki, Kenneth S. Schmitz, Timothy F. Thomas, Charles J. Wurrey (Curator's Distinguished Teaching Professor Emeritus and James C. Olson's Professor of Chemistry)

## Undergraduate

### Undergraduate Degrees:

- Minor in Chemistry
- Bachelor of Arts: Chemistry
- Bachelor of Science: Chemistry

## General Information about Undergraduate Programs

### Admission Requirements

Other than University of Missouri admission requirements, there are no special prerequisites for beginning either the bachelor of arts or the bachelor of science program. High school chemistry and a good working knowledge of algebra and arithmetic are desirable for entering the bachelor of science program. It should be noted that much of the bachelor of science program, and some of the bachelor of arts program, are highly structured in the order which chemistry courses must be taken. It is assumed that transfer students, Associates degree students, and community college students should have begun the appropriate course sequence in their previous schools. All students are required to consult with a Chemistry Undergraduate Advisor before their registration at UMKC.

## Career Implication of the Bachelor's Degree

The Department of Chemistry offers two bachelor of science degree programs. Both require a minimum of 43 credit hours of chemistry courses; they are designed for those who want to work in the field of chemistry. The American Chemical Society approved degree is based on the guidelines established by the American Chemical Society (ACS) and specifically requires Organic and Inorganic Synthesis (CHEM 382) and a Biochemistry course (either CHEM 367 or BIOLOGY 441). Many of those receiving the bachelor of science degree have gone on to graduate work, professional schools, and advanced degrees. Others have gone directly into the chemical industry (laboratory assistants).

In contrast, the bachelor of arts degree is more flexible because it requires only a minimum of 26 credit hours of chemistry. The bachelor of arts student is shown a minimum of what chemistry is about. By choosing suitable courses, this degree prepares the individual with the chemical background for work in other areas. Examples include technical librarian, medical technologist, business administration, public health, and sales or advertising in the chemical industry. The majority of students pursuing the bachelor of arts in chemistry do so in preparation for professional schools, such as medicine, dentistry, and pharmacy. The bachelor of arts can also provide a student with a background in chemistry equivalent to that of a bachelor of science, but tailored to the individual's desires.

## Teacher Certification in Chemistry

Certification as a middle school (grades 5-9) science or secondary (grades 9-12) chemistry teacher in or Missouri requires that a student complete a teacher preparation program. Once you complete a bachelor's degree in chemistry, you can apply to the School of Education for the Master of Arts in Teaching program, which prepares you for the teaching profession and teacher certification. A separate application for the Master of Arts in Teaching program is required. For further information about the program, consult the School of Education section of this catalog or contact the Division of Teacher Education and Curriculum Studies at (816) 235-2245.

## Honors Program

Students with outstanding records of achievement may be eligible to enroll in special honors courses. Such courses are designated by the letter H preceding the course number, or special arrangements can be made with instructors of regular courses. Students enrolled in the special courses should consult with their faculty advisor to arrange for optimal degree planning.

## Prerequisites and Co-requisites

A minimum grade of C- or higher is required for all prerequisite and co-requisite courses for all students taking courses within the Department of Chemistry. Additionally, students must be concurrently enrolled in all co-requisite courses. In exceptional cases, students may receive written consent to waive one or both of these requirements from the Chair of the Chemistry Undergraduate Curriculum Committee by completing and submitting a detailed petition form to the Department and only if approval of the petition is granted.

## Academic Standing

Academic standing is determined at the end of each semester, fall, spring and summer for each student. Good standing at the university is attained with a University of Missouri (UM) cumulative GPA of 2.0 or higher and in SBC with a UM chemistry GPA (major's applicable courses) of 2.0 or higher.

## Grade Point Average

In general, the UM GPA is calculated by dividing the total grade points earned in courses on any UM campus by the total number of graded semester hours attempted. If a course attempted within UM is repeated, the previous hours and grade point remain in the student's GPA. Courses taken credit/no credit, courses earning grades of S, P, I or AT, and courses transferred from non-University of Missouri institutions are not included in the UM GPA calculations. See appropriate sections below.

In general, the UM chemistry GPA is calculated by dividing the total grade points earned in majors courses on any UM campus by the total number of graded semester hours attempted. If a course attempted within UM is repeated, the previous hours and grade point remain in the student's GPA. Courses taken credit/no credit, courses earning grades of S, P, I or AT, and courses transferred from non-University of Missouri institutions are not included in the UM GPA calculations. See appropriate sections below.

Request for GPA Adjustments for repeated courses may be initiated by students and submitted by an SBC Academic Advisor after completion of the repeating attempt. A student's academic standing may be revised after the GPA adjustment is made in Pathway. GPA adjustments may be used for a maximum of 15 semester hours. See the UMKC Repeated Courses policy and GPA Readjustment form for more information.

If a student's UM cumulative GPA and/or UM chemistry GPA falls below the 2.0 minimum the student will no longer be in good standing. Students who fail to maintain good standing will be placed on Academic Warning, Probation, or will be declared Academically Ineligible to continue.

## ACADEMIC WARNING

First Time College (FTC) students with a declared major in SBC will be placed on Academic Warning when their UM cumulative GPA and/or UM chemistry GPA is between 1.5 and 2.0 at the end of their first semester at UMKC.

A student on Academic Warning will have the same requirements as students on Academic Probation as described below. Students may return to good academic standing by raising their UM cumulative GPA and/or UM chemistry GPA to the minimum 2.0 required. If the student cannot raise their UM cumulative GPA and/or UM chemistry GPA to 2.0 or higher after the warning semester, they may be placed on Academic Probation for a maximum

of 2 (two) additional semesters. After 1 (one) warning semester and 2 (two) probation semesters, the student must return to good standing or be declared academically ineligible to continue as a student in SBC and/or UMKC.

First Time College (FTC) students with a declared major in SBC will be placed on Academic Probation when their UM cumulative GPA and/or UM chemistry GPA is below 1.5 at the end of their first semester at UMKC. See Academic Probation below.

Transfer students and continuing students are not eligible to be placed on Academic Warning.

### ACADEMIC PROBATION

Students with a declared major in SBC will be placed on Academic Probation if their UM cumulative GPA and/or UM chemistry GPA falls below 2.0. When an SBC student is placed on academic probation as a result of the previous semester grades, the students will be notified prior to the beginning of the next semester through their UMKC email. The student will be required to enter into an Academic Success Contract designed to provide the student with assistance to support a return to good standing. The contract will specify enrollment requirements and keep the advisor and student in close contact throughout the semester to provide additional support. The contract will outline the student's responsibilities while on probation including, but not limited to the following:

1. Return to good standing by raising UM cumulative GPA and/or UM chemistry GPA above the minimum 2.0. **OR**
2. If the student cannot return to good standing after the contract semester, they may be continued on probation for one additional semester if they earn a grade of **C- or higher in all contracted courses AND** earn a 2.5 (**B- average**) or higher semester/chemistry GPA during the contracted semester.
3. Participate in additional activities as listed in the contract.

The contract's requirements may be altered **ONLY** in consultation with the student's assigned academic advisor. The requirements of the contract are binding with or without the student signature.

If a student fails to meet the terms of the contract, they may be declared academically ineligible to enroll in future semesters as a student with a declared major in SBC.

If a student cannot raise their UM cumulative GPA and/or UM chemistry GPA above 2.0, they may remain on probation one additional semester provided they meet the requirements in #2 above. If a student's UM cumulative and/or UM chemistry GPA is still below 2.0 after a second semester on probation, they will be declared academically ineligible to continue as a student in SBC. A student may, if eligible (UM cumulative GPA above 2.0), transfer to another academic unit at UMKC.

Students who have been placed on academic probation and have returned to good standing may be placed on academic probation again if their UM cumulative GPA and/or UM chemistry GPA fall below the minimum 2.0 required.

### ACADEMIC INELIGIBILITY

Students on academic probation or academic warning that do not meet the terms of their Academic Success Contract with SBC become academically ineligible to enroll in future semesters as a student with a declared major in SBC. Students declared academically ineligible will be notified through their UMKC email prior to the start of the next semester. If the student's UM cumulative GPA is above 2.0 the student may continue at UMKC, but will need to meet with an advisor in a different academic unit to discuss options and declare a major other than chemistry to do so. Students will have until the date given in the email notification to change their major; failure to make these changes by the date indicated will result in cancellation of their registration with any fees paid refunded. Students who have become academically ineligible may re-declare chemistry as their major after raising their UM cumulative GPA and UM chemistry GPA above the minimum 2.0 required.

## Undergraduate Advising

Roo Advising (<http://catalog.umkc.edu/roo-advising/>)

Roadvising@umkc.edu

816-235-1148

Academic advising for undergraduate students is delivered through Roo Advising. Academic Advising is an integral part of student's university experience and has a significant impact on student success. The goals of Roo Advising are to provide students an exceptional advising experience that is equitable, holistic, personal, and timely. Advisors will assist students with the following:

- Understand degree requirements and have a early plan to graduation
- Navigate UMKC processes, systems, and services
- Explore, clarify and confirm fit with their major and career plans
- Develop clear and personalized academic objectives for short and long-term goals
- Enhance self-efficacy and sense of agency

Our professional academic advisors will assist students in all aspects of their undergraduate educational career.

- Assist students in choosing majors and developing academic plans
- Inform students about general education requirements
- Advise students on class selection and registration
- Offer advise on educational and career goals
- Assist students to connect with support services on campus
- Regularly review academic progress and progression toward degree completion
- Connect students with faculty mentors and UMKC Career Services
- Review academic policies and procedures
- Help student with other related issues or problems of an academic nature

### **Academic Advising**

To facilitate progress toward the student's degree, and to ensure that courses selected support completion of degree requirements, students are required to participate in advising each semester before registering for classes. Academic advising is required for all undergraduate students and is enforced using an advising hold in Pathway. In general, students should schedule an appointment to meet with their assigned academic advisor to discuss their enrollment plan and request their advising hold be released. Once students have a fully approved academic plan, there may be options to have holds released without a requirement for an appointment with certain programs.

Students enrolled in double majors or dual degree programs may be advised by two or more advisors with expertise in the specific programs. The advisor for student's primary degree program will have the major advising responsibility.

Students have many options to meet with their assigned academic advisor. Students are encouraged to schedule an appointment with their assigned advisor to ensure appropriate time is set aside to address student's issues and concerns.

### **Schedule an appointment**

Students can schedule an appointment to meet with their assigned academic advisor on their own through UMKC Connect (<https://umkc.starfishsolutions.com/starfish-ops/support/login.html>). If assistance is required, students can call Roo Advising at 816-235-1148 or send an email to [rooadvising@umkc.edu](mailto:rooadvising@umkc.edu).

### **Walk-in Advising**

Walk-In Advising will be available the week prior to and the first week of each term. In addition, walk-in advising is available during regular terms.

- Monday and Tuesday 11am-12:00pm
- Wednesday and Thursday 1:00pm-2:00pm

### **Advising Office Locations**

Roo Advising is delivered across UMKC

- Arts & Cultural Studies-Scofield Hall, Room 9
- Business & Management-Scofield Hall, Room 9
- Human Behavior, Education & Justice-Scofield Hall, Room 9 and School of Education, Suite 129 (for education majors only)
- Natural & Health Sciences-Flarsheim Hall, Suite 510 (including Health Sciences-non nursing tracks and public health)and Health Sciences Building (Health Sciences Campus, 2411 Holmes, Kansas City, MO) Suite 1410 (for Health Sciences nursing tracks and Nursing program only)
- Numbers, Engineering, Technology, & the Cosmos-Flarsheim Hall, Suite 336)

### **Faculty Mentors**

Faculty in student's declared degree programs are a significant and valuable resource for students. As experts in their respective fields they can assist students with their exploration of major and career options. Faculty can assist students to consider elective options tailored to their specific interests and assist students to make connections with professionals in Kansas City, Missouri, the United States, or across the globe. In addition, faculty can help students to make connections with colleagues in graduate or professional schools that may be of interest to students.

Students are responsible for becoming familiar with all academic regulations of the campus as outlined in the catalog and in other University documents.

## Graduate

### Graduate Degrees:

- Master of Science: Chemistry
  - Emphasis areas:
    - Analytical
    - Inorganic
    - Organic
    - Physical
    - Polymer
  - Thesis-Based Option
  - Non-Thesis Option

## Graduate Study in Chemistry Information

Both the Master of Science (MS) degree and interdisciplinary Ph.D. degree with Chemistry as the primary discipline have the basic aim of training students to work independently in chemistry. Both programs train the student through a broad but flexible base of coursework for further education, but the interdisciplinary Ph.D. places a greater emphasis on original research.

### Master of Science: Chemistry

The Chemistry Department offers the master of science degree, with an emphasis in analytical, inorganic, organic, physical, or polymer chemistry. Students may complete a M.S. in Chemistry in a Thesis-Based or in a Non-Thesis Option. The non-thesis M.S. program has an emphasis on coursework, while the Thesis-Based degree has an emphasis on both coursework and original research. Graduating chemistry M.S. students will be exposed to the most recent advances in chemical sciences. In addition, thesis-based M.S. students will experience the excitement of performing guided research.

Students, who have received a grade of B- (2.7) or better in graduate coursework taken as part of a degree program at another institution, may transfer up to 6 credit hours of this work on approval of a majority of the student's committee. A written request for this approval must be submitted within one year of full admission to the program.

### Interdisciplinary Doctor of Philosophy Program: Chemistry (<http://catalog.umkc.edu/colleges-schools/graduate-studies/chemistry/>)

Doctor of philosophy (Ph.D.) programs at UMKC are interdisciplinary. Students desiring to study at the doctoral level in the discipline of chemistry (as the primary unit) must apply to the School of Graduate Studies. Detailed information on the general and discipline-specific admission requirements for the doctoral degree may be found in the Graduate Academic Regulations and Information (<https://catalog.umkc.edu/general-graduate-academic-regulations-information/>) section of this catalog.

Students pursuing an Interdisciplinary Ph.D. degree, who have selected chemistry as one of their disciplines, should consult the School of Graduate Studies section of this catalog for degree requirements, and other academic regulations applicable to their degree programs. The interdisciplinary Ph.D. with Chemistry as the primary unit has research track only. (For further information on the Interdisciplinary Ph.D. Program, see the chemistry (<https://catalog.umkc.edu/colleges-schools/graduate-studies/chemistry/>) discipline within the School of Graduate Studies (<https://catalog.umkc.edu/colleges-schools/graduate-studies/>) section of this catalog.)

### Courses

CHEM 111 Physical Basis Of Chemistry Credits: 3

An introductory course in the basic principles applicable to chemistry for students who intend to take but are not adequately prepared to take CHEM 211. The emphasis is on quantitative relationships and problem solving. NOTE: This course does not count towards a Chemistry major or minor.

**Prerequisites:** Departmental consent.

CHEM 115 Elements Of Chemistry I Credits: 4

A one-term course in general chemistry with special emphasis on organic chemistry and biochemistry. A terminal course that does not meet requirements as a prerequisite for any higher level chemistry course. NOTE: This course does not count towards a Chemistry major or minor.

**Co-requisites:** CHEM 115L.

CHEM 115L Elements Of Chemistry, Laboratory I Credit: 1

A one-term course in general chemistry with special emphasis on organic chemistry and biochemistry. A terminal course that does not meet requirements as a prerequisite for any higher level chemistry course. NOTE: This course does not count towards a Chemistry major or minor.

**Co-requisites:** CHEM 115.

**CHEM 160 Chemistry, Society, And The Environment Credits: 3**

This course is intended to offer a survey of chemical and scientific concepts surrounding current issues. The emphasis will be on the application of fundamental chemical knowledge to allow a full understanding of these issues in the context of currently known facts and theories. Through classroom discussion and application of the scientific method, the ramifications of the issues will be examined. Topics will include pollution, the importance of the chemical industry, its responsibilities to society, and other items of current scientific and environmental interest. NOTE: This course does not count towards a Chemistry major or minor.

**CHEM 160L Laboratory For Chemistry, Society, And The Environment Credit: 1**

This course is offered in support of CHEM 160. It will consist of field activities, experiments, and demonstrations to reinforce the concepts and ideas presented in that course. NOTE: This course does not count towards a Chemistry major or minor.

**CHEM 206 Human Nutrition Credits: 3**

Introduction to nutrition for health and wellness and the use of chemical energy in the breakdown and synthesis of biomolecules. Nutrition as it applies to a variety of life situations from infancy to older adults. Learning encompasses elements of anatomy and physiology related to nutrition and health. NOTE: This course does not count towards a Chemistry major or minor.

**CHEM 211 General Chemistry I Credits: 4**

Stoichiometry, gas laws, thermochemistry, atomic structure, molecular shapes and bonding theories. Recommended preparation: working knowledge of College Algebra.

**Co-requisites:** CHEM 211L.

**CHEM 211 - MOTR CHEM 150L: Chemistry I with Lab****CHEM 211L Experimental General Chemistry I Credit: 1**

Introduction to the laboratory techniques used in studying the chemical properties of substances. Some quantitative techniques are included.

**Co-requisites:** CHEM 211.

**CHEM 211L - MOTR CHEM 150L: Chemistry I with Lab****CHEM 212LR Experimental General Chemistry II Credit: 1**

Introduction to analysis and synthesis. Descriptive chemistry of the more common elements.

**Prerequisites:** CHEM 211 and CHEM 211L (each with a grade of C- or better).

**Co-requisites:** CHEM 212R.

**CHEM 212R General Chemistry II Credits: 4**

Liquids and solids, solutions, equilibrium, kinetics, electrochemistry and thermodynamics. Introductory course to all advanced work in chemistry.

**Prerequisites:** CHEM 211 and CHEM 211L (each with a grade of C- or better).

**Co-requisites:** CHEM 212LR.

**CHEM 311 Laboratory Safety And Health I Credit: 1**

An introduction to laboratory safety and health. Topics to be discussed include good laboratory practice; laboratory hazards; safe chemical handling, storage and disposal; first aid; protective equipment; and federal regulations.

**Prerequisites:** CHEM 320 or CHEM 321.

**CHEM 320 Elementary Organic Chemistry Credits: 4**

This one-semester course covers all fundamental principles of organic chemistry, including modern bonding theory, analytical techniques, physical properties, and chemical reactions. This course is designed to satisfy requirements for students in the UMKC Six-Year Medical Program or certain Biology B.A. majors. This course is not recommended for pre-medical, pre-dental, pre-pharmacy or other pre-health students.

**Prerequisites:** CHEM 212R and CHEM 212LR (each with a grade of C- or better).

**Co-requisites:** CHEM 320L.

**CHEM 320L Experimental Organic Chemistry Credit: 1**

Elementary organic chemistry experiments to teach basic laboratory operations.

**Prerequisites:** CHEM 212R and CHEM 212LR (each with a grade of C- or better).

**Co-requisites:** CHEM 320.



**CHEM 321 Organic Chemistry I Credits: 3**

The two terms (CHEM 321, CHEM 322R) constitute an integrated unit in which the chemistry of aliphatic, aromatic, and some heterocyclic compounds are studied. The study begins with simple monofunctional compounds and ends with polyfunctional natural products.

**Prerequisites:** CHEM 212R and CHEM 212LR (each with a grade of C- or better).

**Co-requisites:** CHEM 321L.

**CHEM 321L Organic Chemistry Laboratory I Credit: 1**

Introduces the student to basic techniques and procedures in isolation, purification, and characterization of organic compounds and simple reactions used in the organic chemistry laboratory. The student will also be trained in the proper way to write a scientific laboratory report.

**Prerequisites:** CHEM 212R and CHEM 212LR (each with a grade of C- or better).

**Co-requisites:** CHEM 321.

**CHEM 322L Organic Chemistry Laboratory II Credit: 1**

An extension of CHEM 321L. This course builds from the basic techniques, procedures, and writing to more advanced organic operations.

**Prerequisites:** CHEM 321 and CHEM 321L (or equivalents; each with a C- or better).

**Co-requisites:** CHEM 322R.

**CHEM 322R Organic Chemistry II Credits: 3**

Continuation of CHEM 321.

**Prerequisites:** CHEM 321 and CHEM 321L (each with a grade of C- or better).

**Co-requisites:** CHEM 322L.

**CHEM 330 Elementary Physical Chemistry Credits: 3**

An introductory course in the principles of physical chemistry for students who have not had calculus.

**Prerequisites:** CHEM 320 or CHEM 322R (each with a grade of C- or better).

**CHEM 341 Analytical Chemistry I: Quantitative Analysis Credits: 4**

Principles of gravimetric, volumetric, electrolytic, and other methods of analysis.

**Prerequisites:** CHEM 212R and 212LR (each with a C- or better).

**CHEM 341WI Analytical Chemistry I: Quantitative Analysis Credits: 4**

Principles of gravimetric, volumetric, electrolytic, and other methods of analysis.

**Prerequisites:** CHEM 212R and CHEM 212LR (each with a grade of C- or better).

**CHEM 345R Instrumental Analysis Credits: 3**

An introductory course on the use of instruments for chemical analysis with particular reference to applications of interest to medical technologists and other students in the sciences. Emphasis will be placed on optical, electrochemical and separation methods.

**Prerequisites:** CHEM 341WI (with a grade of C- or better).

**CHEM 367 Bioorganic Chemistry Credits: 3**

An examination into the current topics at the interface between chemistry and biology. Emphasis will be on the current literature and will include such topics as nucleic acid chemistry, protein chemistry, and carbohydrate chemistry.

**Prerequisites:** CHEM 320 and CHEM 320L; or CHEM 322R and CHEM 322L (each with a grade of C- or better).

**CHEM 382 Inorganic And Organic Synthesis Credits: 2**

A number of inorganic, organic, and organometallic compounds will be prepared using a variety of synthetic techniques.

**Prerequisites:** CHEM 320 and CHEM 320L; or CHEM 322R and CHEM 322L (each with a grade of C- or better).

**CHEM 387 Environmental Chemistry I Credits: 3**

A survey of how chemical principles can be applied to the environment. Included will be topics in aquatic chemistry, atmospheric chemistry and chemistry of the geosphere and soil.

**Prerequisites:** CHEM 320 and CHEM 320L; or CHEM 322R and CHEM 322L (each with a grade of C- or better).

**CHEM 390 Special Topics In Chemistry Credits: 1-3**

This course will focus on an area of chemistry of contemporary significance. The amount of credit is to be determined by arrangement with the department. May be repeated for credit when the topic varies but no more than three hours of credit may be applied to major course requirements.

Recommended preparation: CHEM 212R and CHEM 212LR (each with a grade of C- or better).

**Prerequisites:** Departmental consent.



**CHEM 392 Chemistry Internship/Practical Training Credits: 1-3**

Practical work in chemistry in an industrial, academic or other professional setting. Prior to the start of work, the department must approve the internship/practical training.

**Prerequisites:** CHEM 212R and CHEM 212LR (each with a C- or better).

**CHEM 395 Directed Readings In Chemistry Credits: 1-3**

Intensive readings in areas of joint interest to the enrolled student and the cooperating faculty member. Readings may not duplicate or substitute for current course offerings. Recommended preparation: CHEM 322R and CHEM 322L (each with a grade of C- or better).

**Prerequisites:** Departmental consent.

**CHEM 399 Intro To Research Credits: 1-3**

Special problems to introduce undergraduate chemistry majors to research methods. A comprehensive written report is required and a copy of the report is to be retained in the chemistry office. Recommended preparation: CHEM 212R and CHEM 212LR (each with a grade of C- or better).

**Prerequisites:** Departmental consent.

**CHEM 410 Chemical Literature Credit: 1**

A systematic introduction to the efficient use of the chemical literature. Topics will include both classical search methods and computer search methods.

**Prerequisites:** CHEM 320 and CHEM 320L; or CHEM 322R and CHEM 322L (each with a grade of C- or better).

**CHEM 431 Physical Chemistry I Credits: 3**

A first course in physical chemistry having a calculus base. This course emphasizes thermodynamics with an introduction to the basic principles of quantum mechanics.

**Prerequisites:** MATH 250; and PHYSICS 220 or PHYSICS 250.

**CHEM 432 Physical Chemistry II Credits: 3**

A second course in physical chemistry having a calculus base. This course emphasizes the quantum mechanics description of atoms and molecules, molecular spectroscopy, statistical mechanics, and kinetics.

**Prerequisites:** CHEM 431 (with a grade of C- or better).

**Co-requisites:** CHEM 437WI.

**CHEM 434 Molecular Spectroscopy Credits: 3**

A theoretical introduction to molecular spectroscopy and its relation to structure. Electronic, vibrational and rotational spectra of chemical systems will be discussed.

**Prerequisites:** CHEM 432 (with a grade of C- or better).

**CHEM 437WI Experimental Physical Chemistry I Credits: 3**

Experimental methods in physical chemistry. One hour lecture and six hours laboratory each week. Satisfies writing intensive requirements for the B.A. or B.S. degree.

**Co-requisites:** CHEM 432.

**CHEM 442R Analytical Chemistry II: Instrumental Analysis Credits: 3**

The experimental and theoretical aspects of optical and electrochemical, chromatographic and other physicochemical methods of analysis.

**Prerequisites:** CHEM 341WI (with a grade of C- or better).

**CHEM 445 Introduction To Principles Of Forensic Investigation Credits: 2**

A survey of the physicochemical forensic techniques employed in the detection, examination, processing, preservation and court presentation of evidence.

**Prerequisites:** CHEM 212R and CHEM 212LR (each with a grade of C- or better).

**CHEM 451R Inorganic Chemistry Credits: 3**

Modern concepts and theories of inorganic chemistry.

**Prerequisites:** CHEM 320 and CHEM 320L; or CHEM 322R and CHEM 322L (each with a grade of C- or better).

**CHEM 471 Introduction To Polymer Chemistry Credits: 3**

Survey of organic and inorganic monomers and polymers; the occurrence, synthesis, structures and properties of natural and synthetic polymers; discussion of general properties of plastics, elastomers, fibers, resins, and plasticizers.

**Prerequisites:** CHEM 320 and CHEM 320L; or CHEM 322R and CHEM 322L (each with a grade of C- or better).

**CHEM 480 Computer Applications To Chemical Problems Credits: 3**

The course will survey the field of computational chemistry, concentrating on methods, programs and general utility to the research chemist. The student will learn the principles of the theory underlying the methods and will use selected software to carry out chemical calculations.

**Prerequisites:** CHEM 320 and CHEM 320L; or CHEM 322R and CHEM 322L (each with a grade of C- or better).

**CHEM 490 Special Topics In Chemistry Credits: 1-3**

This course will focus on an area of chemistry of contemporary significance. The amount of credit is to be determined by arrangement with the department. May be repeated for credit when the topic varies but no more than three hours of credit may be applied to major course requirements.

**Prerequisites:** CHEM 431 (with a grade of C- or better).

**CHEM 495 Directed Readings In Chemistry Credits: 1-3**

Intensive readings in areas of joint interest to the enrolled student and the cooperating faculty member. Readings may not duplicate or substitute for current course offerings. Recommended preparation: CHEM 431 with a grade of C- or better.

**Prerequisites:** Departmental consent.

**CHEM 499 Senior Research Credits: 1-9**

The student is given an original research problem and will be held responsible for all previous experience in working toward its solution. A well-written, comprehensive, and well documented research report is required, and a copy of the report is to be retained in the Chemistry department. Recommended preparation: CHEM 431 with a grade of C- or better.

**Prerequisites:** Departmental consent.

**CHEM 5511 Laboratory Safety And Health I Credit: 1**

An introduction to laboratory safety and health. Topics to be discussed include good laboratory practice; laboratory hazards; safe chemical handling; storage and disposal; first aid; protective equipment; and federal regulations.

**CHEM 5520R Survey Of Organic Chemistry Credits: 3**

An intensive advanced survey of the structure, synthesis and reactions of organic compounds.

**CHEM 5521R Mechanisms Of Organic Reactions Credits: 3**

A comprehensive course in which the mechanisms of organic reactions are discussed in light of modern chemical principles.

**Prerequisites:** CHEM 322R and CHEM 432.

**CHEM 5522 Synthetic Organic Chemistry Credits: 3**

A critical approach to the synthesis and modification of organic molecules; newer methods will be emphasized.

**Prerequisites:** CHEM 322R and CHEM 432.

**CHEM 5529 Selected Topics In Organic Chemistry Credits: 3**

Selected topics from the chemistry and theories of organic structures with particular attention to recent developments.

**CHEM 5530 Systematic Physical Chemistry Credits: 3**

An intensive and comprehensive review of the principles of physical chemistry. This course may either emphasize thermodynamics with an introduction to principles of quantum mechanics or emphasize quantum mechanical description of atoms and molecules, molecular spectroscopy, statistical mechanics and kinetics.

**CHEM 5530A Physical Chemistry I Credits: 3**

This graduate course reviews principles of physical chemistry, focusing on thermodynamics, equilibria and electrochemistry.

**CHEM 5530B Physical Chemistry II Credits: 3**

This graduate course reviews principles of physical chemistry, focusing on quantum chemistry, molecular spectroscopy and structure, and kinetics.

**CHEM 5531 Classical Thermodynamics Credits: 3**

A rigorous treatment of the laws of thermodynamics and their application to ideal and non-ideal equilibrium systems.

**CHEM 5532 Chemical Kinetics Credits: 3**

Empirical analysis of chemical reaction rates. Theories of unimolecular and bimolecular reactions, reactions in solution and complex reactions. Review of modern and classical techniques used to study chemical kinetics.

**CHEM 5533 Quantum Chemistry Credits: 3**

Application of quantum mechanical methods to the study of systems of chemical interest. Exact solutions and approximate methods will be discussed.

**CHEM 5534 Molecular Spectroscopy Credits: 3**

A theoretical introduction to molecular spectroscopy and its relation to structure. Electronic, vibrational and rotational spectra of chemical systems will be discussed.

**CHEM 5535 Statistical Thermodynamics Credits: 3**

A rigorous treatment of the fundamental concepts of statistical thermodynamics, with applications to specific systems that reflect the interests of students participating in the course.

**CHEM 5539 Selected Topics In Physical Chemistry Credits: 3**

Selected topics and recent developments in physical chemistry.

**Prerequisites:** CHEM 5530.

CHEM 5541R Advanced Analytical Chemistry Credits: 3

An intensive review of modern concepts of analytical chemistry.

**Prerequisites:** CHEM 432.

CHEM 5551R Advanced Inorganic Chemistry I Credits: 3

A systematic treatment of bonding, structure, reactions and reaction mechanisms of inorganic compounds, with emphasis on classical transition metal compounds and organometallic compounds.

**Prerequisites:** CHEM 451R.

CHEM 5559 Selected Topics In Inorganic Chemistry Credits: 3

Various special topics in the inorganic area to be offered in different semesters.

**Prerequisites:** CHEM 5551R.

CHEM 5567 Advanced Bioorganic Chemistry Credits: 3

This course examines the organic chemistry and laboratory synthesis of the major biopolymers and organic chemistry related to biological systems. Emphasis is on literature and library research and natural product and solid phase organic synthesis, combinatorial synthesis, bioconjugates and applied bioorganic chemistry.

CHEM 5571R Introduction To Polymer Chemistry Credits: 3

Survey of organic and inorganic monomers and polymers; the occurrence, synthesis, structures and properties of natural and synthetic polymers; discussion of general properties of plastics, elastomers, fibers, resins and plasticizers.

**Prerequisites:** CHEM 432.

CHEM 5580R Computer Applications To Chemical Problems Credits: 3

The purpose of this course is to survey the field of computational chemistry, concentrating on methods, programs and general utility to the research chemist. The student will learn the principles of the theory underlying the methods and will use selected software to carry out chemical calculations.

**Prerequisites:** CHEM 320 / CHEM 320L or CHEM 322R / CHEM 322L with "C-" or better.

CHEM 5587 Environmental Chemistry I Credits: 3

A survey of how chemical principles can be applied to the environment. Included will be topics in aquatic chemistry, atmospheric chemistry and chemistry of the geosphere and soil.

CHEM 5588 Environmental Chemistry II Credits: 3

Discussion of selected topics in advanced environmental chemistry, such as environmental toxicology, environmental risk, the chemistry of hazardous wastes and their treatment, and environmental analytical chemistry.

CHEM 5590 Directed Studies Credits: 1-3

Intensive readings and/or research in an area selected by the graduate student in consultation with the instructor.

CHEM 5598 Research Methodology Conference Credits: 3

Student will meet on an individual basis with two faculty members who are involved in research. The student's adviser will coordinate this course.

CHEM 5599 Research And Thesis Credits: 1-9

Research for thesis.

CHEM 5611 Chemistry Seminar Credit: 1

Presentation and discussion of topics currently appearing in United States and foreign literature.

CHEM 5699 Research And Dissertation Credits: 1-16

Research for dissertation.

CHEM 5899 Required Graduate Enrollment Credit: 1

CHEM H206 Human Nutrition Credits: 3

Introduction to nutrition for health and wellness and the use of chemical energy in the breakdown and synthesis of biomolecules. Nutrition as it applies to a variety of life situations from infancy to older adults. Learning encompasses elements of anatomy and physiology related to nutrition and health.

CHEM H212R Honors: General Chemistry II Credits: 4

Liquids and solids, solutions, equilibrium, kinetics, electrochemistry and thermodynamics. Introductory course to all advanced work in chemistry.

CHEM H321 Honors: Organic Chemistry I Credits: 3

The two terms (CHEM H321, CHEM H322R) constitute an integrated unit in which the chemistry of aliphatic, aromatic, and some heterocyclic compounds are studied. The study begins with simple monofunctional compounds and ends with polyfunctional natural products.

CHEM H321L Organic Chemistry Laboratory I - Honors Credit: 1

Introduces the student to basic techniques and procedures in isolation, purification, and characterization of organic compounds and simple reactions used in the organic chemistry laboratory. The student will also be trained in the proper way to write a scientific laboratory report.

CHEM H322L Organic Chemistry Laboratory II Credit: 1

An extension of CHEM 321L. This course builds from the basic techniques, procedures, and writing to more advanced organic operations.

**Prerequisites:** CHEM 321 and CHEM 321L (each with a C- or better).

**Co-requisites:** CHEM 322R.

CHEM H322LR Organic Chemistry Laboratory II-Honors Credits: 2

A more intense version of CHEM 322L. See course description for CHEM 322L.

**Prerequisite:** CHEM 321L.

CHEM H322R Honors: Organic Chemistry II Credits: 3

CHEM H399 Introduction To Research Credits: 1-3

Special problems to introduce undergraduate chemistry majors to research methods. A comprehensive written report is required and a copy of the report is to be retained in the chemistry office. May be taken only after consultation with a member of the chemistry staff.

**Prerequisites:** CHEM 212R.

CHEM H499 Senior Research - Honors Credits: 1-9

Course frequency subject to enrollments, staffing and financial exigency.