Chemistry

ASSOCIATE PROFESSOR **Rice** (Chair). PROFESSORS **Abelt, Bebout (on leave Fall 2008-Spring 2009), DeFotis, Knudson, Kranbuehl, Orwoll , Pike** (Garrett-Robb-Guy Professor, on leave Fall, 2008), and **Thompson.** ASSOCIATE PROFESSORS **Bagdassarian, Coleman, Harbron (on leave Fall 2008-Spring 2009), Hinkle, Landino,** and **Poutsma (Margaret Hamilton Professor).** VISITING ASSISTANT PROFESSOR **Naistat.** PROFESSOR EMERITI **Kiefer, Starnes.** INSTRUCTOR **Putnam**.

Students majoring in chemistry are afforded a variety of options upon graduation. Many go to graduate school in chemistry, biochemistry, engineering, materials science, medical school, dental school, law, or business. Others go directly into professional chemistry as employees of private industry, governmental agencies, or educational institutions. Departmental alumni/ae are university professors, research scientists, medical doctors, lawyers, dentists, executives, directors of research, secondary school teachers, and administrators.

Most majors engage in research projects for credit in association with a member of the department faculty. Normally this is begun during the second semester of the junior year and continued through the senior year. Opportunities exist for many students to work on projects prior to their junior year and/or over the summer through our paid summer research fellowships.

Requirements for Major

Required Credit Hours: 38 (including 29 core credit hours).

Major Computing Requirement: Satisfied by successfully completing required word processing, data and graphical analysis, molecular drawing and modeling, and literature database searching assignments made throughout the core curriculum of the Chemistry major.

Major Writing Requirement: Consists of writing two papers (each at least 2,000 words) with a grade of C or better during the junior and senior years. The first paper is written in Chemistry 320, Introduction to Chemical Research, normally during the junior year; and the second is normally completed through Chemistry 409W or 496W for seniors enrolled for research credit but can be written as part of any 400-level Chemistry course with a "W" designation in which the student is enrolled.

Core Requirements: 29 semester credits of core chemistry courses. These core courses are presented here in a typical schedule of a student intending a major in chemistry.

Year	Fall	Spring
1	General I (Chem 103) Laboratory I (Chem 151)	Organic I (Chem 206) Laboratory II (Chem 252)
2	Organic II (Chem 209 or 307) Laboratory III (Chem 353)	General II (Chem 305 or 308) Laboratory IV (Chem 354 or 356)
3	Physical I (Chem 301) Physical Lab I (Chem 391) Instrumental Analysis (Chem 309)	Physical II (Chem 302) Physical Lab II (Chem 392) Introduction to Research (Chem 320)

In the second year, Chemistry 209, 305, and 356 are recommended for students intending a major in chemistry. Chemistry 307 and 308 are required for biology majors, but they also may be used to satisfy the requirements for a major in chemistry in place of 209 and 305, respectively.

The remaining nine semester credits needed to complete the required 38 must be selected from the elective courses Chemistry 401, 402, 403, 404, 408, 411, 412, 414, 415, 457, and 458. Chemistry 101, 149, 191, 291, 409, 410, 417, 495 and 496 may not be included in the minimum 38, and only six credits can be applied to the degree from 403, 457, or 458. No more than six semester credits in Chemistry 409, 495 and 496 may be applied toward a degree. Credits obtained for Chemistry 291 cannot be used towards an ACS certified degree and the 120 hour graduation credit minimum. Students may not obtain credit for both Chemistry 305 or 308 and Chemistry 335.

In a typical program, majors will have completed Chemistry 103 and the sequence Chemistry 206-209-305 or 206-307-308 plus Mathematics 111, 112, and 212 or 213, and Physics 101-102 before enrolling for Chemistry 301 in their junior year. The laboratory courses Chemistry 151, 252, 353, 354 or 356, 309L, 391 and 392 are taken concurrently with the appropriate lecture courses. Computer Science 141 and Mathematics 211 are valuable courses and recommended in the general education of a chemist.

The Department of Chemistry offers an accelerated program leading to the B.S. and M.S. degree for qualified students. Students in the graduate portion are typically supported with a tuition scholarship and stipend. Chemistry concentrators may apply for formal admission to the joint program in the second semester of their sophomore year.

More information about the Department of Chemistry can be found on our web site at www.wm.edu/chemistry.

American Chemical Society Certification

The department curriculum is accredited by the American Chemical Society. An ACS certified degree in chemistry from William and Mary is awarded if a student's academic program meets additional course criteria within the minimum 38 credit hours of course work previously described plus a minimum of 3 credits of independent research through CHEM 409 or 6 credits in CHEM 495/496. The department currently offers four concentrations leading to ACS certification: chemistry, biochemistry, polymer chemistry, and chemical physics. The specific course requirements for each ACS concentration are summarized below.

Chemistry: CHEM 414, and two additional 400 level courses.
Biochemistry: CHEM 414, 415, 420 and one additional 400 CHEM level course. One upper level biology course selected from BIOL 406, 437, 440, or 442.
Chemical Physics: CHEM 401, 414, and one additional 400 level CHEM course; PHYS 201 and 208; one additional course selected form MATH 302, 413, or PHYS 303, 313, 314, 401, 402, 251-252;
Polymer Chemistry: CHEM 411, 412, 414, and 421.

Additional details for the four concentrations can be found in the department's Handbook for Chemistry Majors and Guide for a Career in Chemistry on the chemistry website.

Research In Chemistry—Summer Fellowship Program

A summer program for chemistry majors affords the opportunity to learn research skills and to apply these skills to a current research problem. Each student is designated a Summer Research Fellow and is associated with and guided by a faculty mentor. This program is supplementary to Chemistry 320, Introduction to Chemical Research, and provides valuable preparation for either Chemistry 495-496, Honors in Chemistry, or Chemistry 409, Senior Research. Admission to the fellowship program is competitive. Stipends and free campus housing are provided. Opportunities for summer research are also possible for rising sophomores and juniors.

Requirements for Minor

Required Credit Hours: 21

Core requirements: Chemistry 103, 151, 206, 252, 209 or 307, one of 305, 335, or 308, 353, 354 or 356, and either 301 or 341. Either 309 or one additional 400 level course must be taken to complete the minor. A declaration-of-intent-to-minor form is available in the department office.

In addition to the chemistry minor, there is also a biochemistry minor which is described under the Catalog heading of Biochemistry.

GER Courses and Advanced Placement Options

Chemistry 101 or 103 may be used to fulfill the GER 2A requirement. Chemistry 101 has been designed for non-science majors. Chemistry 103 is for students majoring in a science and for students intending a career in medicine or a related field. Chemistry 149 is the laboratory course associated with Chemistry 101 and Chemistry 151 is the laboratory course associated with Chemistry 103. Either may be used to fulfill the GER 2A laboratory requirement.

Students entering with AP or IB credit for General Chemistry and planning to major in chemistry are encouraged to take CHEM 335. Students entering with AP or IB credit for only CHEM 103/151 and electing to take CHEM 335 may use this course to satisfy the General Chemistry II requirements (CHEM 305 or 308); however the Chemistry Laboratory IV (CHEM 354 or 356) must still be taken. Students in CHEM 335 are also eligible to apply for CHEM 191 (Freshman Honors Research).

Description of Courses

101. Survey of Chemical Principles.

(GER 2A) Fall (3) Kranbuehl. For non-science majors. (Science majors and pre-medical students should enroll in CHEM103.) Consent of the instructor required if any chemistry lecture courses have been taken.

General chemical principles related to humans and their environment, including the composition of matter, chemical reactions and energy.

103. General Chemistry I.

(GER 2A) Fall (3) Naistat, Poutsma, Thompson. For science majors and pre-medical students.

A study of the nature of atoms and molecules, stoichiometry, states of matter, solutions, reactions, kinetics, and equilibrium.

149. Chemical Principles Laboratory.

Fall (1) Knudson.Corequisite: CHEM 101.

For non-science majors. Science majors and pre-medical students should enroll in Chem151. Laboratory techniques in chemistry. Four laboratory hours.

150. Freshman Seminar.

Spring (3-4) Coleman

A course designed to introduce freshmen to specific topics in the study of and applications of chemistry.

151. General Chemistry Laboratory I.

(Lab) Fall (1) Knudson. Corequisite: CHEM 103 science majors only.

Laboratory techniques in chemistry. Four laboratory hours.

191. Freshman Honors Research.

Fall (1) Poutsma.

Introduction to chemical research with an assigned faculty mentor. Enrollment is competitive and restricted to freshman students concurrently enrolled in Chemistry 335.

206. Organic Chemistry I.

Spring (3) Abelt, Naistat. Prerequisite: CHEM103.

A mechanistic approach to the study of the chemistry of carbon compounds. Particular emphasis is placed on the relationship between structure and reactivity in organic reactions.

209. Organic Chemistry II.

Fall (3) Hinkle. Prerequisite: CHEM 206.

A continuation of the development of the chemistry of organic functional groups started in Chemistry 206. Recommended for students expecting to major in chemistry.

252. Organic Chemistry Laboratory I.

(Lab) Spring (1) Staff. Corequisite: CHEM 206.

Laboratory techniques in organic chemistry. Four laboratory hours.

275W. University Seminar.

Fall and Spring (4) Staff.

A reading-, writing-, and discussion-intensive seminar. Topics vary by semester and by instructor. Restricted to transfer students and co-enrolled students Students receiving a grade of "C-" or better in the seminar will have satisfied the lower-division writing requirement. This course does not fulfill the Freshman Seminar requirement.

291. Chemical Research.

(Lab) Fall, Spring (1) Poutsma. May be taken only with the consent of the department.

Introduction to chemical research with an assigned faculty member. Credit obtained cannot be used towards an ACS certified degree and the 120 hour graduation credit minimum. Repeatable for credit.

301-302. Physical Chemistry.

Fall-Spring (3,3) Knudson, Orwoll. Prerequisites: CHEM 305 or CHEM 308 or CHEM 335, PHYS 101, PHYS 102. Corequisite: MATH 212 or MATH 213.

A two-semester sequence in physical chemistry; topics include the states of matter, thermodynamics and its chemical applications, chemical kinetics, quantum mechanics and its application to chemistry, atomic and molecular spectroscopy, and introductory statistical mechanics.

305. Inorganic and General Chemistry II.

Spring (3) Thompson. Prerequisite: CHEM 103.

A study of chemical principles and inorganic chemistry; including acid/base chemistry, bonding, thermodynamics, electrochemistry, solid state structure and a systematic investigation of the chemical elements. Recommended for chemistry majors; also satisfies requirements for premedical students and biology and geology majors.

307. Organic Chemistry II for Life Sciences.

Fall (3) Coleman. Prerequisite: CHEM 206.

A continuation of the development of the chemistry of organic functional groups started in Chemistry 206. Particular emphasis is placed on the role of metals in living systems and the biosynthesis of organic molecules. Recommended for students expecting to major in the life sciences.

308. General Chemistry II for Life Sciences.

Spring (3) DeFotis, Orwoll. Prerequisite: CHEM 103.

A continuation of the study of the principles of chemistry begun in Chemistry 103. Topics include thermodynamics, nuclear chemistry, chemical kinetics, descriptive inorganic chemistry, and acid-base chemistry. Recommended for students expecting to major in the life sciences, geology, and physics.

309. Instrumental Analysis.

Fall (4) Rice. Prerequisites: CHEM 305 or CHEM 308 or CHEM 335, CHEM 354 or CHEM 356.

Principles and applications of analytical methodology and instrumentation to chemical analysis; topics covered include electrochemistry, spectroscopy, mass spectrometry, and chromatography. Three class hours. Four laboratory hours.

320. Introduction to Chemical Research.

Spring (1) Staff.

Individual study on a problem in chemistry under the supervision of a faculty member. This includes instruction in chemical safety, in using the resources of the chemistry library and writing a paper related to the problem under study. Attendance at the departmental seminar is required. Enrollment is restricted to majors in chemistry, normally in their junior year.

335. Freshman Honors Chemistry.

Fall (3) Bagdassarian.

A systematic study of the properties and reactions of chemical elements and their compounds. Enrollment is restricted to

freshmen who receive William and Mary credit for Chemistry 103 with a score of 4 or 5 on the Advanced Placement Examination in Chemistry.

341. Physical Chemistry for Life Sciences.

Spring (3) Bagdassarian. Prerequisites: CHEM 305 or CHEM 308 or CHEM 335, MATH 112 or 113.

Principles in physical chemistry developed for and applied to examples from the biological sciences. Topics include thermodynamics, kinetics and spectroscopy. Course may be used for a chemistry or biochemistry minor but not for a major in chemistry. Offered every odd spring semester beginning in 2007.

353. Organic Chemistry Laboratory II.

Fall (1) Naistat. Prerequisite: CHEM252. Corequisite: CHEM 209 or CHEM 307.

Laboratory techniques in organic chemistry. Four laboratory hours.

354. General Chemistry Laboratory II.

Spring (1) Staff. Prerequisite: CHEM151. Corequisite: CHEM 305 or CHEM 308.

Laboratory techniques in chemistry. Four laboratory hours.

356. Inorganic and Quantitative Laboratory Methods.

Spring (1) Thompson. Prerequisite: CHEM 151.

A second semester general laboratory course designed for chemistry majors. Emphasis on quantitative analysis, inorganic synthesis, and graphing and data analysis.

391-392. Physical Chemistry Laboratory.

Fall-Spring (1,1) DeFotis, Poutsma. Corequisites: CHEM 301-302.

A series of experiments designed to accompany Chemistry 301-302. Four laboratory hours.

401. Advanced Physical Chemistry.

Fall (3) DeFotis. Prerequisite: CHEM 302.

Quantum chemistry and molecular spectroscopy; selected topics in statistical mechanics or chemical kinetics.

402. Advanced Inorganic Chemistry.

Spring (3) Pike. Prerequisite or corequisite: CHEM302.

Principles and applications of symmetry to structural, bonding and spectroscopy; inorganic biochemistry; structure and reactivity of transition metals; and other selected topics.

403. Advanced Organic Chemistry.

Fall (3) Abelt. Prerequisite: CHEM 209 or CHEM 307.

A structure-reactivity approach to reaction mechanisms and modern synthetic chemistry.

404. Advanced Analytical Chemistry.

Spring (3) Poutsma. Prerequisite: CHEM 309.

Advanced topics in chemical equilibria, electroanalytical techniques, and separation science.

408. Computational Chemistry.

Spring (3) Poutsma. Prerequisite: CHEM 302 (not offered Spring, 2009).

Principles and applications of computational methods currently used for the determination of molecular structure and energetics. Topics include: ad initio molecular orbital theory, density functional theory, semi-empirical calculations, and molecular force field methods. Two class hours. Three laboratory hours.

+409. Senior Research.

Fall and Spring (credits to be arranged) Abelt, Bagdassarian, Bebout, Coleman, DeFotis, Harbron, Hinkle, Knudson, Kranbuehl, Landino, Orwoll, Pike, Poutsma, Rice, Thompson. Prerequisite: CHEM 320. May be taken only with the consent of the department.

A course for the advanced student affording an opportunity for individual work on a problem under the supervision of a faculty member. Attendance at the departmental seminar is required.

410. Seminar in Applied Chemistry.

Fall (1) Staff. (Alternate years; Not offered 2008-2009)

A series of seminars by scientists primarily from industry and government. The course is open to students who have completed four semesters of chemistry or by permission of the instructor.

411. Polymer Science I.

Fall (3) Staff. Prerequisites: CHEM 209 or CHEM 307 and CHEM 301.

An introduction to the chemical aspects of polymer science at the molecular level. Topics include the preparation, modification, degradation and stabilization of polymers. Reaction mechanisms are stressed.

412. Polymer Science II.

Spring (3) Kranbuehl. Prerequisite: CHEM 301.

An introduction to the physical aspects of polymer science at the molecular level. Topics include the properties of polymers in bulk and in solution, conformational analysis, viscoelasticity, and rubber elasticity.

414. Biochemistry.

Spring (3) Coleman, Landino. Prerequisite: CHEM 307 or CHEM 209; prerequisite or corequisite: CHEM 305 or CHEM 308 or CHEM 335.

Chemistry listing: "The molecular basis of living processes; the chemistry of important constituents of living matter, biosynthesis, metabolism, bioenergetics, enzyme kinetics, metabolic control, transport mechanisms. Section 01 primarily for life science majors; 02 for physical science majors." (Cross listed with BIOL 414) Biology listing as above but with cross listing to CHEM 414.

415. Advanced Biochemistry.

Fall (3) Landino. Prerequisite: CHEM414 or BIOL 414.

A continuation of the study of biological processes on a molecular level begun in Chemistry 414. Biosynthesis, metabolism, bioenergetics, enzyme kinetics, metabolic control, transport mechanisms.

417. Neurochemistry.

Fall (3) Coleman. Prerequisites: CHEM 414 or BIOL 414

A study of the biochemistry and pharmacology of the nervous system. Topics include excitatory and inhibitory neurotransmitters, structure and function of receptors, reuptake transporters, and second messengers. The biochemical basis of neuro-active drugs, toxins, and diseases will be covered. Recommended for chemistry, biology, and neuroscience majors, and premedical students.

420. Biochemistry Laboratory.

Spring (1) Landino. Prerequisites: CHEM 309 and CHEM 415.

Laboratory techniques of modern biochemistry and molecular biology

421. Polymer Laboratory.

Spring (1) Kranbuehl. Prerequisite or corequisite: CHEM 411 or CHEM 412.

A series of experiments in polymer synthesis, solution characterization, and mechanical and thermal properties of polymers.

457. Organic Synthesis.

Spring (3) Hinkle. Prerequisite: CHEM 209 or 307.

An advanced treatment of organic synthetic methods which includes examples of natural product synthesis.

458. Organic Spectroscopy.

Spring (3) Harbron. Prerequisite: CHEM 209 or 307 and CHEM 309 (not offered Spring, 2009).

Theory and application of spectroscopic methods to the analysis of organic compounds. Topics include absorption, fluorescence, infrared, and proton and carbon nuclear magnetic resonance spectroscopies with an emphasis on structural elucidation and other practical applications.

460. Special Topics in Chemistry.

Fall, Spring (1-3, 1-3) Staff. Prerequisite or corequisite: varies by topic.

Treatment of a selected chemistry topic that is not routinely covered in the regular course offerings.

†495-496. Honors.

Fall, Spring (3,3) Abelt, Bagdassarian, Bebout, Coleman, DeFotis, Harbron, Hinkle, Knudson, Kranbuehl, Landino, Orwoll, Pike, Poutsma, Rice, Thompson.

Requirements include a program of research with readings from the original literature, presentation of an Honors essay, and the satisfactory completion of a comprehensive oral examination in the subject area of the research. Attendance at the departmental seminar is required; otherwise, hours are to be arranged. Refer to the section of the catalog on College provisions governing the Admission to Honors.

Graduate Program

The department offers the degrees of Master of Arts and Master of Science. For degree requirements and a full description of graduate courses in chemistry, contact Dr. Chris Abelt, director of the chemistry graduate program.