Washington University in St. Louis
ARTS & SCIENCES

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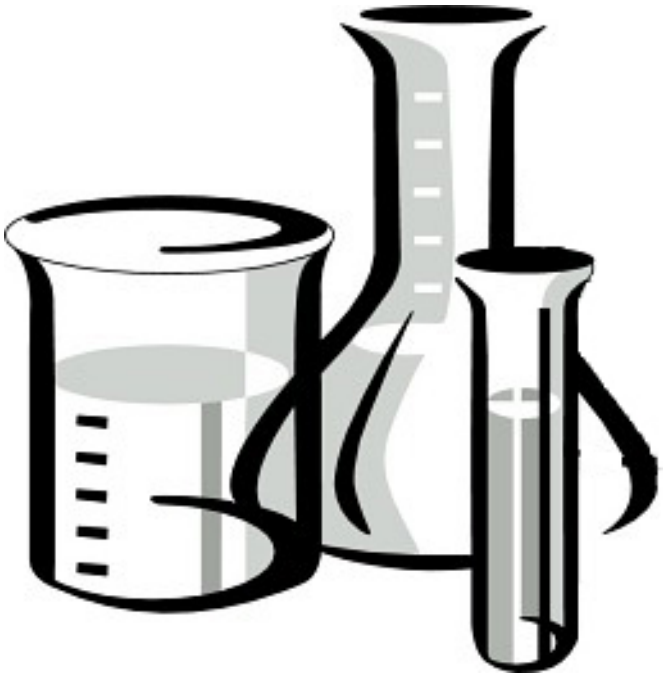
Handbook for Chemistry Majors



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The Undergraduate Major In Chemistry At Washington University

Chemistry is a central, multi-faceted science, extending in one direction into physics and mathematics, in another direction into biology and medicine, and in yet another into business and commerce. In its major role, chemistry involves the exploration of the structure and constitution of the microscopic world of atoms and molecules, the chemical and physical transformations that occur in it, and the principles that govern these changes. Such investigations yield deep insights into nature, new methods for creating novel compounds and useful materials, and new ways for meeting the needs of a technological society. Modern research in chemistry has provided new insights resulting in the synthesis of a vast array of compounds useful in medicine, industry, and agriculture such as superconducting materials, solar cells, chemical memory devices, and new drugs for treatment of some of our most devastating diseases.

The Department of Chemistry of Washington University has a tradition of excellence, combining a deep commitment to fundamental research with an equally deep commitment to classroom teaching. Supported by funds from the University, from the Government, and from Industry, it has created a close-knit group of teacher-scientists who provide the opportunity to well-motivated undergraduate students to obtain a superior education in science. Currently, the Department includes 21 full-time faculty members and four who hold adjunct appointments. In addition to these faculty members involved in teaching, there are 3 full-time research faculty members, 3 Ph.D. staff instructors who assist with General Chemistry, and 2 Ph.D. undergraduate laboratory supervisors. The student body includes ~ 100 undergraduate chemistry majors, 120 graduate students and 30 postdoctoral associates.

Teaching And Research Areas In Chemistry

- Bioorganic
- Biophysical
- Environmental
- Inorganic
- Materials
- Nuclear
- Organic
- Organometallic
- Physical
- Physical Organic
- Polymer
- Theoretical

Additional areas of strong specialization within the Department include:

- Archeometry
- Biopolymers
- Catalysis
- Computer Modeling
- Drug-Receptor Interactions
- Electrochemistry
- EPR Spectroscopy
- Femtosecond Laser Spectroscopy
- Heterocyclic Chemistry
- Infrared Spectroscopy
- Isotope Effects
- Mass Spectrometry
- Materials Chemistry
- Membrane Chemistry
- Natural Products
- NMR Spectroscopy
- Nuclear Reactions
- Nuclear Structures
- Organic Electrochemistry
- Photochemistry
- Polymer Dynamics
- Polymer Synthesis
- Polypeptide and Protein Folding
- Radiopharmaceuticals
- Silicon Chemistry
- Statistical Mechanics
- Synthetic Organic
- Transition State Structure

Chemistry Department faculty actively collaborate with members of the Departments of Biology, Earth and Planetary Sciences, Physics, and a number of departments in the Schools of Engineering and Medicine. For example, interactions with faculty members in the School of Medicine involve the application of NMR techniques to a variety of biochemical problems and the use of short-lived radioactive isotopes in nuclear medicine.

The Curriculum

A primary goal of the undergraduate Major program in chemistry is to provide a quality educational foundation for productive and creative careers in chemistry and in such related professions as biochemistry, medicine, and engineering. Many graduating chemistry majors proceed to graduate work in chemistry or biochemistry, to medical school, or occasionally to business school or law school. Other graduates choose to proceed directly to positions in government, industry, or education.

To satisfy the needs of those interested in this most central of sciences, the Department of Chemistry offers a broad range of courses and two slightly different degrees. A student may elect to pursue a regular chemistry major or to concentrate in the area of biochemistry. The course offerings and requirements for these degrees are detailed in the following pages. Advanced undergraduates may elect to take one or more graduate courses (500 level) if the prerequisites are fulfilled.

In order to qualify for graduation with Latin honors (*cum laude*, *magna cum laude*, *summa cum laude*), a student must follow a more rigorous program. The course requirements for honors eligibility are provided on the following pages. Aside from fulfilling the course requirements and achieving an appropriately high grade point average, performance in undergraduate research is an important consideration for awards and Latin honors.

It is emphasized that taking and passing one of the course programs outlined below merely qualifies the student to be considered for Latin honors. Granting these honors is at the discretion of the Department and depends on the distinction of the student's entire record.

A checklist of the Chemistry Major programs and options is provided for convenience on the last page of this handbook.

Chemistry Course Offering

General and Analytical Chemistry

111A General Chemistry I
112A General Chemistry II
151 General Chemistry Lab I
152 General Chemistry Lab II
181 Freshman Seminar in Chemistry

Organic Chemistry

261 Organic Chemistry I
262 Organic Chemistry II
358 Organic Chemistry Laboratory II
451 Organic Chemistry III
452 Synthetic Polymer Chemistry
5511 Mechanistic Organic Chemistry
554 Molecular Orbital Theory
555 Special Topics in Organic Chemistry
556 Kinetics and Mechanism
557 Advanced Organic Synthesis
558 Spectral Methods in Organic Chemistry
559 Organic Chemistry Seminar

Inorganic Chemistry

459 Organometallic Chemistry
461 Inorganic Chemistry
465 Solid-State and Materials Chemistry
470 Inorganic Chemistry Laboratory
540 Inorganic/Organometallic Seminar
541 Advanced Inorganic Chemistry
542 Special Topics in Inorganic Chemistry

Biological Chemistry

Bio 4522 Protein Biochemistry Lab
Bio 437 DNA Manipulations Lab
464 Inorganic Biochemistry
475 Chemical Biology
481 Biochemistry I
482 Biochemistry II
520 Nucleic Acid Chemistry

Physical Chemistry

400 Physical Science in 12 Problems
401 Physical Chemistry I
402 Physical Chemistry II
405 Spectroscopic Analysis
445 Instrumental Methods in Physical Chemistry
500 Independent Work
550 Mass Spectrometry
562 Statistical Thermodynamics
571 Quantum Chemistry and Spectra
578 Nuclear Magnetic Resonance Spectroscopy
581 Advanced Quantum Chemistry
584 Molecular Spectroscopy
588 Advanced Nuclear Magnetic Resonance

Nuclear and Radiochemistry

435 Nuclear and Radiochemistry Laboratory
436 Radioactivity and its Applications
437 Radioactivity and Radiation Safety
438 Radiopharmaceutical Chemistry

Additional Chemistry Courses

290 Freshman & Sophomore Research
490 Introduction to Research
495 Advanced Undergraduate Research in Chemistry
500 Independent Work
590 Research

Advanced Placement

By AP Scores. Entering students who receive a score of 5 on the CEEB Advanced Placement Test in chemistry receive 6 units of credit, 3 units each for Chem 103 and 104. Entering students who receive a score of 4 on the Advanced Placement Test in chemistry receive 3 elective units for Chem 103. Units for Chem 103 or 104 do not replace Chem 111A or 112A and a student who receives a 4-5 must complete Chem 111A and 112A before enrolling in Chem 261. As with all students who have taken a challenging high school chemistry course and wish to do so, these students may take the chemistry placement exam during Orientation Week.

By I B Scores. Entering students who receive a 6 or 7 on the International Baccalaureate Exam receive 6 units of elective credit. These units do not replace Chem 111A, 151, 112A, or 152.

By Department Exam. The placement examination for Chem 111A, 112A, 151, and 152 will be given by the Department of Chemistry during Orientation Week. Students who pass the Chem 111A/112A placement exams will receive 3 units of credit each for Chem 111A and Chem 112A and 2 units each for Chem 151 and Chem 152.

Students must inform the departmental secretary in McMillen 525 of their plans to take the placement test (5-6530).

Part-Time Employment Opportunities

Limited part-time employment opportunities for undergraduates also exist within the Department. These include positions as laboratory and storeroom technicians, exam graders, and teaching assistants in the undergraduate laboratories. Summer positions are also avail-

able occasionally. Further information on employment may be obtained from the department administrative officer, Dr. Edwin Hiss, in McMillen 519.

Handicapped Students

Services for students with hearing, visual, orthopedic, learning, or other disabilities are coordinated through the Disability Resource Center. Since information about a student's disability is not obtained in the admission process, handicapped students must voluntarily identify themselves to this office in order to obtain services. To the greatest extent possible, handicapped students are integrated as equal members of the total student population. Services provided for handicapped students may include (but are not limited to) readers, note takers, special parking, tutoring, counseling, appropriate academic accommodations (e.g., alternate testing conditions) and referral to community resources.

Students with either a temporary or permanent disability should contact the Disability Resource Center at (314) 935-5970 (voice and TTY). The office is located in Gregg Hall on the South Forty.

Requirements For The Major In Chemistry

In preparing for a prospective major in the Department, and satisfying prerequisites for required upper-level chemistry courses, the student must take Chem 111A, 112A, 151, 152, 261, 262, Phys 117A, 118A or 197, 198 (Physics 197 and 198 are recommended), and Math 131, 132, and 233. Further physics (e.g. Phys 217 and 218) and mathematics courses (e.g. Math 308) are encouraged. Chem 181, a seminar to introduce freshmen to the research activities of the Chemistry department, is recommended.

A major may follow either of two paths: the regular chemistry major or the chemistry major with a concentration in biochemistry. Each path has an honors-eligibility program of

coursework, which makes the student eligible for Latin honors. The honors programs are strongly recommended for students planning to continue their interests in graduate school. A working knowledge of a foreign language is encouraged of majors, but not required. A working knowledge of computer programming (and applications to problems in chemistry) is strongly encouraged.

Regular Chemistry Major. Departmental requirements for the regular major specify a minimum of 18 units in advanced courses in chemistry, among which must be included Physical Chemistry (Chem 401 and 402), Inorganic Chemistry (Chem 461), an advanced laboratory course (chosen from Chem 358, 435, 445 or 470), plus 6 additional units of chemistry elective courses at the 300 level or above. Neither Chem 490 nor Chem 495 can be used to satisfy the advanced laboratory or elective credits.

Regular Chemistry Major with Honors Eligibility. In order to be eligible for Latin honors, a student must take a minimum of 21 units in advanced courses in chemistry. The advanced courses must include Physical Chemistry (Chem 401 and 402), Inorganic Chemistry (Chem 461), one synthetic chemistry laboratory course (either Chem 358 or 470), one physical-based chemistry laboratory course (either Chem 435 or 445), and 6 additional units in chemistry elective courses at the 300 level or above. Chem 490 cannot be used to satisfy the advanced laboratory or elective requirements. Chem 495 can be used to satisfy the advanced elective but can not replace an advanced laboratory course.

Chemistry Major: Concentration in Biochemistry. Departmental requirements for the chemistry major with concentration in biochemistry add Bio 2960 and 2970 as prerequisites to the major and specify a minimum of 18 units in advanced courses in chemistry and biology.

The advanced courses must include Physical Chemistry (Chem 401 and Chem 402), Inorganic Chemistry (Chem 461), Biochemistry (Chem 481), Cell Biology or Microbiology (Bio 334 or 349), and an advanced laboratory course (chosen from Chem 358, 435, 445, 470 or Bio 437 or 4522). Neither Chem 490 nor 495 satisfy the advanced laboratory requirement. The second semester of Biochemistry (Chem 482) is strongly recommended.

***Chemistry Major with Honors Eligibility: Concentration in Biochemistry*.** Departmental requirements for eligibility for the degree with Latin honors raises the minimum units to 21 units of advanced courses along with adding Bio 2960 and, 2970 as prerequisites. The advanced courses must include Physical Chemistry (Chem 401 and 402), Inorganic Chemistry (Chem 461), Biochemistry (Chem 481 and 482), Cell Biology or Microbiology (Bio 334 or 349), an advanced laboratory course (chosen from Chem 358, 435, 445, 470 or Bio 437 or 4522). Neither Chem 490 nor 495 satisfy the advanced laboratory requirement.

Chemistry Major with ACS Certification. In addition to completing the core courses in Chemistry, those seeking an ACS certified degree must complete Chem 401, 402, 461, 470, 481, either Chem 435 or 445, and Chem 495.

Additional Opportunities For Majors

Research. Credit can be obtained for performance of undergraduate research through either Chem 490 (variable credits) or Chem 495 (3 credits). To register for these courses, a student must select a research advisor on the faculty of the Department of Chemistry with whom a mutually agreed upon research project is designed and conducted. Chem 490 represents a credit/no credit course option that permits the student to conduct research in chemistry. The student who registers for this course will get one to six elective units (typically 3 units) maxi-

mum per semester based on the amount of work performed in the course and agreed to *in advance* by the supervising faculty member. No written documentation or oral examination covering the research performed is required at the end of the semester. Another research option is Chem 495. This is a 3-credit research course that requires the student's commitment to submit to an oral exam at the end of the research experience. This is a graded course. The prerequisites and completion requirements for Chem 495 must be approved by the faculty research advisor prior to enrollment. Prerequisites may include completion of at least one prior semester of research in the same laboratory, for which credit may or may not have been awarded. Enrollment in Chem 495 also requires submission of a form available on the Chemistry Home page (www.chemistry.wustl.edu) or in the Department Office (McMillen 525). Chem 495 qualifies as a capstone experience and counts as an advanced elective toward the chemistry major with honors.

Research experience outside the department may also qualify for research credit (typically under Chem 490). However, to do so, the project must be pre-approved by the Chemistry Department's Undergraduate Work Committee. To obtain this approval, students are required to submit a brief (no more than 2 pages) description of the project. This description must present the research objectives, provide details of the techniques to be used, and must be signed by both the student and the research director. The project description can be submitted to the student's departmental advisor who can grant tentative approval, but will forward the description to the Undergraduate Work Committee of the Chemistry Department for a final decision.

Capstone Experiences. At the present time, two capstone experiences are available to students through the Department of Chemistry. One is Chem 495, Advanced Undergraduate Research in Chemistry, and the other is Chem 500, Independent Work. Proposals for alternate capstone experiences will be considered but must be submitted in writing a full semester in advance of registration to the Undergraduate Work Committee. The proposal must address

the objective of the experience, the breadth of the experience, and describe a method of faculty evaluation. A form describing the plan for the completion of Chem 495 is available for download on the department website.

Writing Intensive. Students may complete the College's requirement of a writing intensive course in any one of three advanced laboratory courses in Chemistry (Chem 358, 445, or 470), or in a writing-intensive course in another department.

Study Abroad. Study Abroad programs are available both for chemistry and pre-medical studies. Details of these programs can be found at the Overseas Programs web site: http://www.artsci.wustl.edu/~overseas/. For chemistry programs, it is highly unlikely that you will receive credit for required chemistry classes taken overseas. It is more likely that you will receive elective chemistry class and research (chem. 490) credit. It is strongly advised that you contact the Department of Chemistry Study Abroad Advisor, Prof. Richard Mabbs (mabbs@wustl.edu) as soon as possible after you declare your major to discuss study abroad plans.

Program Assessment. In an effort to develop an annual program evaluation in cooperation with the North Central Accreditation Commission, the Department of Chemistry has decided to offer an exit exam to all graduating seniors as part of that assessment. At the present time, the exam that has been selected is the ETS Major Field Exam in Chemistry, two hours in length, that includes questions with multiple choice answers in four key areas of chemistry: physical, organic, analytical, and inorganic chemistry. Beginning with the graduating class of 2006, this exam has been mandatory. The performance on this exam does not affect the student's transcript or GPA. The exam is tentatively scheduled during Commencement Week.

Typical Program For Regular Chemistry Major

		Units	
First Year:		Fall	Spring
General Chemistry	111A, 112A	3	3
General Chemistry Lab	151, 152	2	2
Mathematics (Calculus)	131, 132	3	3
Physics (or Elective)	117A, 118A or 197, 198	4	4
English Composition	100	3	
Freshman Chemistry Seminar	181	1	
Elective			3
		16	**15**
Second Year:			
Organic Chemistry	261, 262	4	4
Mathematics	233	4	
Elective (or Physics)		4	4
Electives		3	6
		15	**14**

NOTE: Math and Physics requirements should be completed prior to the third year, since they are prerequisites for Physical Chemistry.

Regular Chemistry Major

Third and Fourth Years:

Physical Chemistry	Two courses	Chem 401 and 402
Inorganic Chemistry	One course	Chem 461
Advanced Laboratory	One course from	Chem 358, 435, 445, 470
Electives	Two courses from	Chemistry courses 300 and above including courses listed above not used to fulfill previous requirements. Neither Chem 490 nor Chem 495 may be used as an elective.

Regular Chemistry Major With Honors Eligibility

Third and Fourth Years:

Physical Chemistry	Two courses	Chem 401 and 402
Inorganic Chemistry	One course	Chem 461
Adv. Synthetic Laboratory	One course from	Chem 358 or 470
Adv. Physical Laboratory	One course from	Chem 435 or 445
Electives	Two courses from	Chemistry courses 300 and above including courses listed above not used to fulfill previous requirements. Chem 495 but not Chem 490 may be used as an elective.

Typical Program For Chemistry Major With Concentration In Biochemistry

		Units	
First Year:		Fall	Spring
General Chemistry	111A, 112A	3	3
General Chemistry Lab	151, 152	2	2
Mathematics (Calculus)	131, 132	3	3
Biology	2960		4
English Composition	100	3	
Freshman Chemistry Seminar	181	1	
Elective		3	3
		15	**15**
Second Year:			
Organic Chemistry	261, 262	4	4
Biology	2970	4	†
Mathematics	233	4	
Physics	117A, 118A or 197, 198	4	4
Electives			6
		16	**14**

NOTE: Math and Physics requirements should be completed prior to the third year, since they are prerequisites for Physical Chemistry.

† Students may consider taking Cell Biology (Bio 334) as an elective this semester after consultation with your advisor.

Chemistry Major With Concentration In Biochemistry

Third and Fourth Years:

Biochemistry	One course	Chem 481
Cell Biology	One course from	Bio 334 or 349
Physical Chemistry	Two courses	Chem 401 and 402
Inorganic Chemistry	One course	Chem 461
Advanced Laboratory	One course from	Chem 358, 435, 445, 470, Bio 437 or 4522

Chemistry Major With Concentration In Biochemistry And Honors Eligibility

Third and Fourth Years:

Biochemistry	Two courses	Chem 481 and 482
Cell Biology	One course from	Bio 334 or 349
Physical Chemistry	Two courses	Chem 401 and 402
Inorganic Chemistry	One course	Chem 461
Advanced Laboratory	One course from	Chem 358, 435, 445, 470, Bio 437 or 4522

Minor in Chemistry. A student planning to complete a minor in chemistry must enroll in the prerequisite courses for the major: Chem 111A, 112A, 151, 152, 261, 262, Phys 117A, 118A (or 197, 198), and Math 131, 132, and 233. Nine units of chemistry encompassing three courses in at least two subdisciplines are required at the advanced level. These can be chosen from the following group: Chem 358, 401, 402, 435, 436, 445, 451, 459, 461, 464, 470, 481, 482, and chemistry courses at the graduate (500) level. Chem 490 and 495 are specifically excluded from the minor. Deviations from these requirements will be handled on an individual basis.

Double Major with Teaching Certification. For those students who are interested in pursuing careers as chemistry instructors, a curriculum has been developed in cooperation with the Department of Education. These students complete the degree requirements for a B.A. in both Chemistry and Education. In addition to degrees in both disciplines, they receive State of Missouri Teaching Certification in Chemistry. The science requirements for this major include completion of the chemistry core sequence of Chem 111A, 112A, 261, and 262 and the two basic labs, Chem 151 and 152 ; Math 131, 132, and 233; Physics 117A and 118A (or 197, 198); in addition to Bio 2960. The students are also required to take two semesters of Physical Chemistry (Chem 401 and 402), Inorganic Chemistry (Chem 461), Biochemistry (Chem 481), one advanced laboratory (Chem 358, 435, 445, 470), and one additional elective course in order to complete the minimum of 18 units in advanced courses. The elective course may be any 400- or 500-level Chemistry course, as well as Bio 334, 337, 3371, 349, 4522, or 5325, plus any of the courses listed above not used to fulfill other requirements.

Chemistry Faculty And Their Research

Faculty research home pages may be found at: www.chemistry.wustl.edu

Joseph J. H. Ackerman, William Greenleaf Eliot Professor and Chairman; Ph.D., Colorado State, 1977. **Physical/Biophysical chemistry:** nuclear magnetic resonance spectroscopy and imaging studies of a biophysical and biomedical nature, including *in vitro* and *in vivo* studies of intact biological systems, from cultured cells to genetically-engineered mice to men.

Carolyn J. Anderson, Professor (joint appointment with Medical School); Ph.D., Florida State University, 1990. **Inorganic Chemistry, Chemical Biology, Radiochemistry:** development of radiopharmaceuticals for cancer imaging and therapy using metal radionuclides, including synthesis, radiochemistry, bioassays, in vitro and in vivo evaluation.

Vladimir B. Birman, Assistant Professor; Ph.D., University of Chicago, 2000. **Synthetic Organic chemistry**: total synthesis of bioactive natural products, rational design of catalysts for asymmetric transformations.

Robert E. Blankenship, Professor; Ph.D., University of California, Berkeley, 1975. **Biochemistry**: Energy transfer and primary photochemical reactions of photosynthesis, evolution of biological energy conserving systems, biological electron transfer reactions, metalloenzymes involved in electron transfer processes.

John R. Bleeke, Associate Professor; Ph.D., Cornell, 1981. **Organometallic chemistry:** synthesis of transition-metal complexes, particularly those containing pentadienyl and hetero-pentadienyl ligands; development of selective homogeneous catalysts; mechanistic studies of transition-metal-catalyzed reactions; metallabenzenes and other aromatic metallacycles.

William E. Buhro, Professor; Ph.D., UCLA, 1985. **Inorganic/Materials chemistry:** synthesis of transition-metal-phosphorus complexes containing phosphido, phosphinideno, and phosphide ligands; intramolecular dynamics and rearrangement mechanisms; materials chemistry.

Peter P. Gaspar, Professor; Ph.D. Yale, 1961. **Physical-Organic chemistry:** reaction mechanisms; gas-kinetics and reactive intermediates; organosilicon chemistry; radiochemistry; hot-atom reactions; archeometry.

Lev D. Gelb, Associate Professor; Ph.D. Cambridge University, 1995. **Theoretical chemistry**: molecular simulation of nanoscale systems, including nanostructured materials, nanophase fluid phenomena, and nanomachines; statistical mechanics; algorithms and implementation.

Michael L. Gross, Professor; Ph.D. Minnesota, 1966. **Analytical chemistry:** Analytical chemistry, Biochemistry: protein mass spectrometry, proteomics, properties of gas-phase ions, instrument and method development.

Richard W. Gross, Professor (joint appointment with Medical School); M.D. New York University, 1976; Ph.D., Washington (St. Louis), 1982. **Biophysical chemistry:** phospholipid dynamics and membrane structure-function relationships, enzyme kinetics of biphase membrane systems.

Sophia E. Hayes, Associate Professor; Ph.D. University of California Santa Barbara, 1999. **Inorganic/Materials chemistry**: Physical Inorganic Chemistry: application of solid-state NMR to problems in materials science, in particular semiconductors and the photochemistry of organic single crystals and polymers.

Dewey Holten, Professor; Ph.D., Washington (Seattle), 1976. **Physical/Biophysical chemistry**: ultrafast laser spectroscopy, primary electron-transfer processes in photosynthesis, photophysics of tetrapyrrole chromophores and arrays for biomedical and solar-energy applications.

Tien-Sung Tom Lin, Professor; Ph.D., Pennsylvania, 1969. **Physical chemistry**: magnetic and electric field spectroscopy of molecular crystals, electronic structure of organic molecules, electron paramagnetic resonance, photophysical and photochemical processes, spin dynamics.

Richard A. Loomis, Associate Professor; Ph.D. University of Pennsylvania, 1995. **Physical chemistry:** probing and controlling of reaction dynamics within small radical-molecule clusters; femtosecond to nanosecond time scale linear and non-linear laser spectroscopy; quantum wave packet dynamics; intramolecular and intermolecular energy redistribution.

Ronald A. Lovett, Professor; Ph.D., Rochester, 1966. **Theoretical chemistry**: statistical mechanics.

Richard Mabbs, Assistant Professor; Ph.D., University or Nottingham, 1995. **Physical chemistry:** Time resolved (fs) photodissociation dynamics and electronic structure evolution in anionic species and clusters. Time resolved electron transfer/collision induced dynamics in mass selected, molecular assemblies. Solvation effects on electronic structure through photoelectron imaging. Photochemistry and photophysics of heteroaromatic compounds.

Edward S. Macias, Professor and Executive Vice Chancellor, Dean of Arts & Sciences, Barbara and David Thomas Distinguished Professor in Arts & Sciences; Ph.D., MIT, 1970. **Environmental/Nuclear chemistry**.

Joshua A. Maurer, Assistant Professor; Ph.D., California Institute of Technology, 2003. **Organic Chemistry/Chemical Biology**: organic surface chemistry; photo-patterning and microcontact printing; neuronal wiring and differentiation; ion-channel biosensor design and device development.

Liviu M. Mirica, Assistant Professor; Ph.D., Stanford University, 2005. **Biological Chemistry, Inorganic Chemistry:** Using inorganic chemistry, organic chemistry, and biological chemistry to address important metal-mediated processes with energy, biological, and medical relevance.

Kevin D. Moeller, Professor; Ph.D., University of California Santa Barbara, 1985. **Organic chemistry**: Organic chemistry; synthetic applications of organic electrochemistry, synthesis of natural products and conformational probes; site-selective synthesis and the use of micro-electrode arrays.

Demetrios G. Sarantites, Professor; Ph.D., MIT, 1963. **Nuclear chemistry:** high-spin phenomena in nuclei, structure of highly deformed nuclei, nuclear reaction dynamics near the Coulomb barrier, 4π charged particle and gamma-ray spectrometry.

Jacob Schaefer, Professor; Ph.D., Minnesota, 1964. **Physical chemistry**: NMR studies of solid polymers and biological solids; development of NMR techniques (sensitivity enhancement, relaxation measurements, high resolution).

Lee G. Sobotka, Professor; Ph.D., Berkeley, 1982. **Nuclear chemistry**: correlations in many-body fermion systems; light- and heavy-ion reaction dynamics; fission and fission-like phenomena; collective nuclear motion; nuclear level densities; structure and decay of nuclei far removed from beta stability; development of novel detectors and electronics for ionizing radiation.

John-Stephen A. Taylor, Professor; Ph.D., Columbia, 1981. **Bioorganic chemistry**: design and synthesis of conformation and structure-specific DNA probes and drugs; synthesis and structure-activity relationships of premutagenic DNA lesions; protein engineering.

Michael J. Welch, Professor (joint appointment with Radiology, Medical School); Ph.D., London, 1965. **Radiochemistry**: hot-atom reactions; chemical kinetics; medical tracers.

Younan Xia, Professor (joint appointment with Engineering) ; Ph.D. Harvard University, 1996. **Biomedical and Biological Imaging**: new chemistry, physics, and technological applications of nanomaterials.

Mark S. Wrighton, Professor and Chancellor; Ph.D., California Institute of Technology, 1972. **Inorganic/Materials chemistry**.

Younan Xia, Professor; Ph.D., Harvard, 1996. **Physical chemistry, materials chemistry, biophysical chemistry:** understanding the nucleation and growth mechanisms involved in the synthesis of nanomaterials; development of surface-enhanced spectroscopic methods for ultrasensitive detection of biomarkers; development of biomedical applications for nanomaterials including imaging contrast enhancement, drug delivery and cancer treatment; and design of new scaffolds for tissue engineering.

Chemistry Major Checklist

For students who have entered as Freshmen before Fall 2007.[#]

Requirement	Regular	Regular with Honors Eligibility	Biochemistry	Biochemistry with Honors Eligibility
C461	3	3	3	3
C401 and C402	6	6	6	6
C456	****	****	3	3
B334/B3371/B349	****	****	3 or 4	3 or 4
C/BC ≥ 300	****	****	3	3
C ≥ 300	6	6	****	****
Lab C358/C470/C435/C445	3	****	****	****
Lab C358/C470/C435/C445 B437/B4522	****	****	****	3 or 4
Synthesis-based lab C470 or C358	****	3 or 4	****	****
Physical-based lab C435 or C445	****	3	****	****
minimum units	18	21	18	21

**** not applicable; C = Chemistry; B = Biology; BC = Biochemistry

[#]Students may also option for the tracks shown on the following page.

Chemistry Major Checklist

For students who entered as Freshman Fall 2007 or later.

(Adopted 11-28-07)

Requirement	Regular	Regular with Honors Eligibility	Biochemistry	Biochemistry with Honors Eligibility
C461	3	3	3	3
C401 and C402	6	6	6	6
C481	****	****	3	3
C482	****	****	****	3
B334 or B349	****	****	3 or 4	3 or 4
C ≥ 300	6	6	****	****
Lab C358/C470/C435/C445	3	****	****	****
Lab C358/C470/C435/C445 B437/B4522	****	****	3 or 4	3 or 4
Synthesis-based lab C470 or C358	****	3 or 4	****	****
Physical-based lab C435 or C445	****	3	****	****
minimum units	18	21	18	21

**** not applicable; C = Chemistry; B = Biology