

CHEMISTRY

www.chem.wvu.edu/dept

The Department of Chemistry offers undergraduate degree programs in chemistry and biochemistry. American Chemical Society accreditation is available to B.S. graduates in chemistry. Major graduate and professional schools have readily accepted chemistry and biochemistry graduates from Western.

The Department of Chemistry — in addition to its core of fundamental studies in physical, inorganic, organic, analytical and biochemistry — has added a variety of elective courses that offer diversity in training, study and research at both the undergraduate and graduate levels. Within the department, faculty members are active in many research areas including organometallic chemistry, organic synthesis, photochemistry, protein and nucleic acid biochemistry, molecular biology of viruses, electrochemistry, molecular spectroscopy, reaction kinetics, atmospheric and environmental chemistry, surface chemistry and catalysis, and new areas of computer applications.

Every effort is made to update and modernize course work and teaching methods. The department strives to maintain state-of-the-art instrumentation for both teaching and research activities. Students gain experience in modern analytical methods through hands-on use of the instrumentation. Several faculty members have authored successful textbooks and computer-assisted instructional materials that have found wide usage at major universities. Western's graduates have a long and enviable record of success in Ph.D. programs at major research-oriented universities and in a variety of medical, dental and pharmacy programs.

CHEMISTRY FACULTY

All of the members of the department hold the Ph.D. degree, and most have had post-doctoral experience before coming to Western. The department supports an active undergraduate research program, and students are encouraged to undertake a research project early in their studies.

There is an unusual degree of personal contact between faculty and students in the department. Faculty members are aware of campus policies and resources, and both academic and career counseling is readily available to all chemistry students.

MARK WICHOLAS (1967) Chair and Professor. AB, Boston University; MS, Michigan State University; PhD, University of Illinois.
SPENCER J. ANTHONY-CAHILL (1997) Assistant Professor. BA, Whitman College; PhD, University of California, Berkeley.
MARK E. BUSSELL (1990) Professor. BA, Reed College; PhD, University of California, Berkeley.
CHRISTOPHER DALEY (2002) Assistant Professor. BS, McGill University; PhD, University of Alberta.
STEVEN R. EMORY (2001) Assistant Professor. BS, California Lutheran University; PhD, Indiana University.
STEVEN GAMMON (2002) Professor. BA, Bowdoin College; PhD, University of Illinois at Urbana-Champaign.
LISA N. GENTILE (2001) Assistant Professor. BA, Colgate University; PhD, Brown University.
GEORGE A. GERHOLD (1969) Professor. BS, University of Illinois; PhD, University of Washington.
DONALD M. KING (1966) Associate Professor. BS, Washington State University; PhD, California Institute of Technology.

GEORGE S. KRIZ (1967) Professor. BS, University of California, Berkeley; PhD, Indiana University.
GARY M. LAMPMAN (1964) Professor. BS, University of California, Los Angeles; PhD, University of Washington.
JOSEPH G. MORSE (1993) Professor. BS, South Dakota State College; MS, PhD, University of Michigan.
DAVID L. PATRICK (1996) Associate Professor. BS, University of California, Davis; PhD, University of Utah.
DONALD L. PAVIA (1970) Professor. AB, Reed College; MS, PhD, Yale University.
GERRY A. PRODY (1984) Associate Professor. BS, PhD, University of California, Davis.
SALVATORE F. RUSSO (1968) Professor. BA, Wesleyan University; PhD, Northwestern University.
JAMES R. VYVYAN (1997) Associate Professor. BS, University of Wisconsin, Eau Claire; PhD, University of Minnesota.
JOHN A. WEYH (1968) Professor. BA, College of Great Falls; MS, PhD, Washington State University.
JOHN C. WHITMER (1969) Professor. BS, University of Rochester; MS, PhD, University of Michigan.

PROGRAMS AND CAREER OPPORTUNITIES

The programs of study offered by the chemistry department are diverse and challenging, and provide the following benefits to the student:

- ❑ A wide variety of accredited programs, designed to meet diverse career goals.
- ❑ A faculty committed to excellence in undergraduate education and research.
- ❑ Close student-faculty contact and relatively small classes.
- ❑ Direct access to modern laboratory equipment and instrumentation.
- ❑ Opportunity for research work under the direction of a faculty adviser.

The chemistry department offers three basic degree programs: Bachelor of Science, Bachelor of Arts and Bachelor of Arts in Education. All three programs have a common core of study:

- ❑ One year of general chemistry and one year of college-level calculus
- ❑ One year of organic chemistry, one year of college physics and one quarter of analytical chemistry
- ❑ One year of physical chemistry

This provides the foundation for elective courses in the student's area of interest. Through choice of degree programs and electives, the student can prepare for careers in industry or government, teaching at the secondary level or further study at the graduate level.

Students planning to major in chemistry or biochemistry or to begin university transfer programs involving chemistry courses are advised to consult the department at the beginning of the first year to arrange for proper sequence of courses.

Students planning to transfer to Western after completing two years of college study elsewhere should complete as many of the following program requirements as possible prior to transfer in order to avoid delays in degree work completion:

- ❑ One year of general chemistry
- ❑ One quarter or one semester of analytical chemistry

- One year of organic chemistry
- One year of college-level calculus
- One year of college-level physics

Bachelor of Science. The department offers B.S. programs in chemistry and biochemistry. These are specifically designed for students interested in graduate study or careers in industry and government as laboratory scientists.

Bachelor of Arts. This program provides less intensive training in chemistry but, when combined with a minor in a related area, prepares students for a variety of career opportunities in fields such as:

- Chemical Sales & Marketing
- Computer Sciences
- Technical Writing (Journalism)
- Environmental Sciences
- Secondary School Teaching

Bachelor of Arts in Education. This program provides several program emphases (chemistry-biology, chemistry-mathematics, and chemistry physics). Although requirements within these options differ in detail, the three programs are similar enough that the prospective teacher need not choose among them until the sophomore or junior year. Successful graduates are qualified to teach in their areas of concentration at the middle school or high school level. Prospective teachers with qualifications in more than one area will have a distinct advantage in seeking such positions. Detailed descriptions of each of these degree programs and course descriptions are given below.

BACHELOR OF ARTS

Major — Chemistry

86 credits

- CHEM 121, 122, 123, 333, 351, 352, 353, 354, 355, 375, 441, 461, 462, 463, 464
- MATH 124, 125, 224
- One year of college physics (recommended sequence is PHYS 121, 122, 123, 131, 132, 133)

Minor — Chemistry

30-32 credits

- CHEM 121, 122, 123
- Completion of one of the following tracks:
 - A. CHEM 333, 461, 462, 463
 - B. CHEM 333, 351, 352, 353, 354
 - C. CHEM 351, 352, 353, 354, 375 (or 471)

To obtain minor approval, a minimum of four credits of those required must be taken in chemistry at Western Washington University.

Teaching Endorsement

Students planning on careers as high school teachers must take SCED 370, 491 and 492 plus the secondary education program in addition to the Bachelor of Arts degree. Because certification to teach high school now requires more than four years, advisement prior to or at the beginning of the third year is absolutely necessary to avoid lengthening the program. Students also are strongly advised to complete requirements for a broad area science endorsement by taking BIOL 204, 205, 206 and Geol 211, 212. Courses required for a state

teaching endorsement must be completed with a grade of C (2.0) or above.

BACHELOR OF ARTS IN EDUCATION

Combined Major — Chemistry/Mathematics — Secondary

108-122 credits

This major meets the requirements for Washington state teaching endorsements in both chemistry and mathematics.

- CHEM 121, 122, 123, 333
- Option A or B:
 - A: CHEM 251, 375
 - B: CHEM 351, 352, 353, 354 and 375 (or 471-473)
- CHEM 461, 462
- MATH 124, 125, 224
- MATH 204, 209, 331, 360, 419, 483
- At least two of the following: Math 207, 341, 410
- PHYS 121, 122, 123, 131, 132, 133
- SCED 370, 491, 492

Combined Major — Chemistry/Physics — Secondary

104-117 credits

This major meets the requirements for Washington state teaching endorsements in both chemistry and physics.

- CHEM 121, 122, 123, 333
- Option A or B:
 - A: CHEM 251, 375
 - B: CHEM 351, 352, 353, 354 and 375 (or 471-473)
- CHEM 461, 462
- PHYS 121, 122, 123, 131, 132, 133
- PHYS 119, 201 or 205, 223, 224, 233
- ASTR 315
- 8 upper-division credits in physics and/or astronomy under advisement, to include 2-3 credits of PHYS 491, 492 or ASTR 493
- MATH 124, 125, 224
- SCED 370, 491, 492

Combined Major — Chemistry/Biology

See the biology department section of this catalog.

Teaching Endorsement

The BA/Ed degrees above require completion of the professional secondary teacher preparation program in the Woodring College of Education. Recommendation for teaching endorsement normally requires completion of one of the above majors with a grade point of 2.50 or better in the required major courses. As certification to teach high school now requires more than four years of study, advisement prior to or at the beginning of the third year is absolutely necessary to avoid lengthening the program. Courses required for a state teaching endorsement must be completed with a grade of C (2.0) or above.

BACHELOR OF SCIENCE

Major — Chemistry

106 credits

- CHEM 121, 122, 123, 333
- CHEM 351, 352, 353, 354, 355

- CHEM 375 (or 471, 472)
- CHEM 434, 441, 461, 462, 463, 464, 465
- MATH 124, 125, 224, 204
- PHYS 121, 122, 123, 131, 132, 133
- Advanced electives with prior departmental approval to total 9 credits

NOTE: The Chemistry Department at Western Washington University is approved by the American Chemical Society, and students who complete the Bachelor of Science in chemistry program receive ACS certification of their degree.

A typical four-year program leading to a Bachelor of Science (ACS certified) is described on the department's Web site.

Interdisciplinary Major — Biochemistry/Cellular and Molecular Biology

Admission to the Bachelor of Science major in biochemistry is selective and based upon preparation and prior academic performance. Application may be made through the Chemistry Department (Chemistry Building 270).

Admission to the biochemistry major will be in two phases. Students will be designated Phase I majors until they have completed CHEM 121, 122, 123, 351 and 352 and BIOL 205. Students will be admitted to Phase II based on their performance in Phase I. Students with a grade point average of 3.0 or higher in the Phase I courses will be given preferential admission to Phase II. Students with a grade point average below 3.0 will be considered on a case by case basis for remaining spaces in the major. See the department's Web site for more details.

B.S. Biochemistry

108 credits

This major is part of an interdisciplinary program between the biology and chemistry departments at Western. The B.S. degree in biochemistry (with greater emphasis on the physical chemical theory behind biological chemistry) is offered via the chemistry department, whereas a B.S. degree in cellular and molecular biology (with a different emphasis) is offered via the biology department. The requirements for the B.S. in biochemistry are listed below. For the cellular and molecular biology degree program, see the biology department section of this catalog.

- BIOL 204, 205, 319, 321
- CHEM 121, 122, 123, 333, 351, 352, 353, 354, 461, 467, 468, 471, 472, 473, 474, 475
- MATH 124, 125, 224
- PHYS 121, 122, 123, 131, 132, 133
- Approved electives to total 3 credits

This program is specifically designed for students who seek graduate study or employment in biochemistry or molecular biology.

A typical four-year program leading to a Bachelor of Science degree in biochemistry is described on the department's Web site.

DEPARTMENTAL HONORS

A chemistry major who wishes to graduate with honors in chemistry must complete a one-year program of research, culminating in CHEM 498. The student must also maintain a 3.50 cumulative grade point average, submit a senior thesis and present a public seminar covering the research

topic. Criteria for candidacy for departmental honors are 1) a minimum grade point average of 3.50 at the conclusion of the penultimate year and 2) acceptance for admission to the program by the chemistry department. Students who are in the University Honors Program must also satisfy these departmental requirements.

GRADUATE STUDY

For concentrations leading to the Master of Education or the Master of Science degrees, see the Graduate School section of this catalog.

COURSES IN CHEMISTRY (CHEM)

Courses numbered X37; X97; 300, 400; 417, 445 are described on page 31 of this catalog.

101 CHEMICAL CONCEPTS (4)

Prereq: MATH 102. A survey course for non-science students. Fundamental topics of chemistry such as: atoms and molecules, periodic table, organic and biochemistry, radioactivity. Applications to selected and variable topics. Laboratory included.

115 GENERAL CHEMISTRY (5)

Prereq: MATH 114 or the equivalent score on the intermediate algebra mathematics placement test. Principles and laws of chemistry developed from the properties, structure and reactions of matter; an abbreviated course in general chemistry for students not requiring CHEM 121, 122 in their programs. Laboratory included.

121, 122, 123 GENERAL CHEMISTRY I, II, III (5,5,4)

Prereq: MATH 114 or the equivalent score on the intermediate algebra mathematics placement test. Each course prerequisite to the next. Stoichiometry atomic and molecular structure, states of matter, solutions, thermodynamics, chemical equilibrium, kinetics, electrochemistry. Laboratory included.

201 INDEPENDENT RESEARCH (1-3)

Pre- or co-req: CHEM 351 and permission of instructor. Undergraduate research under supervision. Written report required. S/U grading. Repeatable to a maximum of 9 credits over three quarters.

251 ELEMENTARY ORGANIC CHEMISTRY (5)

Prereq: CHEM 115 or 121. Reactions, nomenclature and uses of carbon compounds; an abbreviated course in organic chemistry primarily for persons not requiring the CHEM 351-354 series.

301 INDEPENDENT RESEARCH (1-3)

Prereq: 30 credits in chemistry and permission of instructor. Undergraduate research under supervision. Written report required. S/U grading. Repeatable to a maximum of 9 credits over three quarters.

308 INTRODUCTION TO POLYMER CHEMISTRY (3)

Prereq: CHEM 115 or 121, 251, Tech 333. Types of polymers, methods of polymerization, and preparation of important commercial thermoplastic and thermosetting plastics. Addition and condensation polymers are prepared in the laboratory.

333 ANALYTICAL CHEMISTRY (5)

Prereq: CHEM 123. Theory and practice of gravimetric, volumetric, potentiometric and spectrophotometric methods of analysis. Selected analytical topics such as ion exchange resins, non-aqueous solvents, chelates, extractions, chromatography.

351, 352, 353 ORGANIC CHEMISTRY (4,4,3)

Prereq: CHEM 123 (or concurrent); each course prerequisite to the next. Chemistry of carbon compounds with emphasis on structural theory, reactions and mechanisms.

354 ORGANIC CHEMISTRY LABORATORY I (2)

Prereq: CHEM 352 or concurrent. Techniques of organic chemistry: reactions, separations and syntheses of organic compounds.

355 ORGANIC CHEMISTRY LABORATORY II (2)

Prereq: CHEM 353 (or concurrent) and 354. Techniques of organic chemistry: reactions, separations; syntheses and introduction to practical spectroscopy.

375 ELEMENTS OF BIOCHEMISTRY (4)

Prereq: CHEM 251 (or CHEM 351, 352, 353). Introduction to the structure and function of proteins, nucleic acid, lipids, and carbohydrates. Enzyme chemistry. Replication, transcription, and translation of genetic information. Metabolism of carbohydrates, the citric acid cycle, electron transport, and oxidation phosphorylation. This course is not intended for students in the bachelor of science-biochemistry program.

401 INDEPENDENT RESEARCH (1-3)

Pre- or co-req: CHEM 461 and permission of instructor. Undergraduate research under supervision. Written report required. S/U grading. Repeatable for a maximum of 9 credits over three quarters.

405 INTENSIVE WRITING IN CHEMISTRY OR BIOCHEMISTRY (1)

Prereq: CHEM 401, 425, 471, 494 or 498 (or concurrent) and permission of instructor. Concentrated study of a topic associated with chemistry or biochemistry. Students are required to write a substantial expository paper. Writing proficiency course.

425 ADVANCED TOPICS IN CHEMISTRY (3)

Prereq: permission of instructor and any additional prerequisites as listed. A series of senior electives in chemistry.

425a Natural Products Chemistry. Prereq: CHEM 353.

425b Organic Reactions. Prereq: CHEM 353.

425d Group Theory and Spectroscopy. Prereq: CHEM 463.

425c Medicinal Chemistry. Prereq: CHEM 353 or permission of instructor; CHEM 471 recommended.

425h Enzyme Chemistry. Prereq: CHEM 463 or 468, 471.

425i Immunology. Prereq: CHEM 473 or BIOL 473.

425m Organometallic Chemistry. Prereq: CHEM 441.

425p Computers in Chemistry. Prereq: CHEM 461 or 467 or PHYS 331 or concurrent or permission of instructor.

425q Atmospheric Chemistry. Prereq: CHEM 333 and 463 (or 466).

425r Surface Chemistry. Prereq: CHEM 463 or permission of instructor.

425s Protein Engineering. Prereq: CHEM 471.

425t Virology. Prereq: CHEM/BIOL 473.

434 INSTRUMENTAL ANALYSIS (4)

Prereq: CHEM 333; CHEM 461 or concurrent. Theory and experimental techniques of optical, electrical and other physical measurements applied to chemical analysis.

441 ADVANCED INORGANIC CHEMISTRY (4)

Prereq: CHEM 462 or concurrent. Bonding, structure and reactivity of inorganic molecules; transition metal and organometallic chemistry; chemistry of the non-metallic elements.

454 ORGANIC SPECTROSCOPY (5)

Prereq: CHEM 123,353 and 355. Identification of organic compounds by spectroscopic methods: infrared, nuclear magnetic resonance, ultraviolet and mass spectroscopy. Laboratory work includes application of spectroscopy in identifying unknowns with confirmation by chemical methods.

455 ADVANCED NMR TECHNIQUES (3)

Prereq: CHEM 454. A lecture/lab course in advanced techniques in nuclear magnetic resonance, including Fourier transformation, multiple pulse sequences, relaxation time measurements, gated decoupling, polarization transfer, pulse sequences and two-dimensional NMR experiments.

461, 462, 463 PHYSICAL CHEMISTRY (4,4,3)

Prereq: one year of college physics, MATH 224 and one year of general chemistry; each course prerequisite to the next. Atomic and molecular structure, states of matter, solutions, chemical thermodynamics and equilibria, chemical kinetics and electrochemistry.

464 PHYSICAL/INORGANIC CHEMISTRY LABORATORY I (3)

Prereq: CHEM 333 and 461; co-req: CHEM 441 and 462. An integrated approach to inorganic synthesis and physical measurement. Includes formal report writing.

465 PHYSICAL/INORGANIC CHEMISTRY LABORATORY II (3)

Prereq: CHEM 464; co-req: CHEM 463. An integrated approach to inorganic synthesis and physical measurement. Includes formal report writing.

467, 468 BIOPHYSICAL CHEMISTRY (3, 4)

Prereq: MATH 224; one year of college physics; CHEM/BIOL 471; CHEM 461, 467 prereq to CHEM 468. Biophysical experimental methods and theory, including classical and statistical thermodynamics, bonding, ligand binding, spectroscopy, transport processes, enzyme kinetics, and X-ray diffraction.

471, 472 BIOCHEMISTRY AND MOLECULAR BIOLOGY (3 ea)

Prereq: CHEM 123, 353 (or concurrent), and BIOL 205; CHEM 333 recommended; CHEM 471 prerequisite to CHEM 472. A consideration of the structure and function of biological macromolecules; intermediary metabolism; membrane structure and function; bioenergetics. Also offered as BIOL 471, 472.

473 MOLECULAR BIOLOGY (3)

Prereq: CHEM 472 and BIOL 321 or permission of instructor. An examination of the structure, replication and expression of genetic information. Also offered as BIOL 473.

474 BIOCHEMISTRY LABORATORY (3)

Prereq: CHEM 123, 354, CHEM/BIOL 472 or concurrent. Modern methods of isolation and characterization of biological macromolecules, especially enzymes and other proteins. Also offered as BIOL 474.

475 MOLECULAR BIOLOGY LABORATORY (3)

Prereq: CHEM/BIOL 473 or concurrent; CHEM/BIOL 474 or permission of instructor. Survey of modern molecular techniques including nucleic acid manipulation, gel electrophoresis, radiolabeling, DNA sequencing and DNA amplification. Also offered as BIOL 475.

494 INDUSTRIAL WORK EXPERIENCE (3)

Prereq: 30 credits in chemistry including CHEM 333 and permission of department. Academic credit awarded for chemical employment in industry or government in areas such as research, development or quality control. Written report and an oral or poster presentation describing the work are required. May be repeated once. See Chemistry Department for information. S/U grading.

498 HONORS RESEARCH IN CHEMISTRY (3)

Prereq: 6 credits of chemistry research courses, advancement to departmental honors candidacy (application required). Oral presentation and honors thesis required. S/U grading.

Graduate Courses

Courses numbered 500; 517; 545; 597 are described on page 31 of this catalog.

Admission to Graduate School or special permission required. See the Graduate School section of this catalog.

501 RESEARCH PROJECT IN CHEMISTRY (2-6)

Prereq: permission of instructor. Advanced individual laboratory projects under supervision. Repeatable to a maximum of 12 credits.

502 TEACHING PRACTICUM (1)

Prereq: permission of instructor. Curriculum and instructional support for teaching the general chemistry laboratory sequence. Repeatable to a maximum of 3 credits. S/U grading.

510 SPECIAL TOPICS (1-3)

Prereq: permission of instructor. Specialized lectures on a conference basis for a particular area of interest. Repeatable to a maximum of 9 credits.

511 ADVANCED LABORATORY METHODS (1-3)

Prereq: CHEM 463. Specialized laboratory on a conference basis for a particular area of interest. Repeatable to a maximum of 9 credits.

534 INSTRUMENTAL ANALYSIS (4)

Prereq: CHEM 333, 461 or concurrent, permission of instructor. Principles of chromatographic, spectrochemical and electrochemical methods of analysis.

540 ORGANOMETALLIC CHEMISTRY (3)

Prereq: CHEM 441. Classes of organometallic compounds; structure, bonding, general patterns of reactivity; reactions; industrial homogeneous catalysis.

552 CHEMISTRY OF NATURAL PRODUCTS (3)

Prereq: CHEM 353 or permission. Isolation, structure, synthesis, biosynthesis and photochemistry of selected classes of natural products.

553 ORGANIC REACTIONS (3)

Prereq: CHEM 353 or permission. Organic chemical reactions as applied to problems in organic synthesis.

554 ORGANIC SPECTROSCOPY (5)

Prereq: CHEM 123, 353, 355. Identification of organic compounds by spectroscopic methods: infrared, nuclear magnetic resonance, ultraviolet and mass spectroscopy. Laboratory work included.

555 ADVANCED NMR TECHNIQUES (3)

Prereq: CHEM 454 or 554. A lecture/lab course in advanced techniques in nuclear magnetic resonance, including Fourier transformation, multiple pulse sequences, relaxation time measurements, gated decoupling, polarization transfer and two-dimensional NMR experiments.

556 MEDICINAL CHEMISTRY (3)

Prereq: CHEM 353 or permission of instructor; CHEM 471 recommended. The chemistry of drug discovery, design, development, and action.

562 GROUP THEORY AND SPECTROSCOPY (3)

Prereq: CHEM 463. Correlation of mathematical group theory with molecular symmetry and application of symmetry groups to the interpretation of molecular spectra. Principle applications will be to infrared and Raman vibrational spectra.

563 COMPUTERS IN CHEMISTRY (3)

Prereq: CHEM 461 or 467 or PHYS 331 or concurrent or permission of instructor. Use of computers in chemistry and biochemistry, including chemistry on the Internet, molecular modeling, visualization, simulation, and the control of laboratory experiments.

564 ATMOSPHERIC CHEMISTRY (3)

Prereq: CHEM 333 and 463 (or 466) and permission of instructor. A review of the physical and chemical characteristics of the atmosphere, with emphasis on chemical kinetics.

565 SURFACE CHEMISTRY (3)

Prereq: CHEM 463 or permission of instructor. Physical chemistry of solid surfaces. Examples drawn from heterogeneous catalysis and environmental chemistry.

573 ENZYME CHEMISTRY (3)

Prereq: CHEM 463 or 468, 471. Preparation and measurement of activities of enzymes; mechanism of enzyme reactions; properties of individual enzymes and coenzymes.

575 IMMUNOLOGY (3)

Prereq: CHEM 473 and permission of instructor. Biochemistry of the immune response, antibody structure and function, origin of antibody diversity, cell-mediated immunity.

578 PROTEIN ENGINEERING (3)

Prereq: CHEM 471. Analysis of protein structure and protein-ligand interactions, protein design considerations, and design of small molecule and protein-based therapeutic agents.

579 VIROLOGY (3)

Prereq: CHEM/BIOLOG 473. Overview of viruses — their structures, life cycles and control. Bacterial, plant and animal viruses will be discussed.

595 SEMINAR (1)

Presentation of contemporary subjects in chemistry. S/U grading. Repeatable to 2 credits.

690 THESIS (1-6)

Research in chemistry under faculty direction terminating in a master's thesis. S/U grading. Repeatable to a maximum of 12 credits.

694 INDUSTRIAL INTERNSHIP IN CHEMISTRY (1-6)

Prereq: advancement to candidacy and permission of graduate adviser. A supervised technical field experience in chemical laboratory practice. The experience may be in an industrial or government laboratory setting in such areas as research and development, chemical sales, manufacturing, process development, clinical chemistry, analytical chemistry, quality control or environmental control. A project report following an approved format is required. S/U grading. Repeatable to a maximum of 12 credits.

