

the student's supervisory Committee. A written proposal must be submitted to the student's committee before the project can be initiated. This proposal should normally be submitted at the end of the second semester of study. Credit for the project will require a research paper (minimum length 30 pages).

By way of example, the project could involve working with a UNLV science researcher to learn a new technique or to contribute to a field study, or library research on an aspect of science that is new, or the design of a computer program that incorporates recent developments in graphics and software.

Upon completion of the program, the candidate will be required to pass a comprehensive oral exam administered by the supervisory committee. At the time of the oral exam, the student will present the final research paper. The committee will question the student on the project as well as on a broad base of knowledge of major area. The committee will report the result of this exam to the Deans of the Graduate College and College of Sciences.

5. Also, not more than six credits can be earned through independent studies. Graduate credits (minimum acceptable grade of B (3.00)) may be transferred into the program from another accredited institution. However, at least two-thirds of the minimum number of credits required for the graduate degree must be taken at UNLV (not including credits for project/paper).

A student will be placed on academic probation if a minimum 3.00 grade point average is not maintained in all work taken in the degree program.

Chemistry

Chair

Lindle, Dennis W. (1991), Professor; B.S., Indiana University; Ph.D., University of California, Berkeley.

Graduate Coordinator

Hatchett, David W. (1999), Associate Professor; B.S., California State University, Stanislaus; Ph.D., University of Utah.

Graduate Faculty

Abel-Santos, Ernesto (2006), Associate Professor; B.S., Autonomous University of Santo Domingo, Dominican Republic; Ph.D., Washington University School of Medicine, St. Louis.

Bae, Chulsung (2004), Assistant Professor; B.S., Inha University, Korea; M.S., University of Massachusetts, Lowell; Ph.D., University of Southern California.

Bhowmik, Pradip (1998), Associate Professor; M.S., University of Dhaka, Bangladesh; M.S., University of Massachusetts at Dartmouth; Ph.D., University of Massachusetts at Amherst.

Carper, Stephen W. (1991), Professor; B.S., Eastern Oregon State College; Ph.D., Utah State University.

Czerwinski, Kenneth R. (2003), Associate Professor; B.A., Knox College; Ph.D., University of California, Berkeley.

Gary, Ronald K. (1999), Associate Professor; B.S., University of California, Irvine; Ph.D., Cornell University.

Heske, Clemens (2004), Associate Professor; Diploma, TH Darmstadt, Germany; Ph.D., University of Wurzburg, Germany.

Hodge, Vernon F. (1982), Professor; B.A., M.S., San Diego State University; Ph.D., University of California, San Diego.

Lee, Dong-Chan (2005), Assistant Professor; B.S., M.S., Kyungpook National University, Korea; Ph.D., University of Massachusetts, Lowell.

Lindle, Dennis W. (1991), Professor; B.S., Indiana University; Ph.D., University of California, Berkeley.

Nadualath, Balakrishnan (2002), Associate Professor; M.S., University of Calicut, India; Ph.D., Indian Institute of Technology, Kanpur.

Nicol, Malcom (1998), Professor; B.A. Amherst College; Ph.D., University of California, Berkeley.

UnivOrgill, MaryKay (2003), Assistant Professor; B.S. Brigham Young University; M.S., Ph.D., Purdue University.

Robins, Kathleen A. (1991), Associate Professor; B.S., University of Illinois, Champaign-Urbana; M.A., Ph.D., University of California, Santa Barbara.

Spangelo, Bryan L. (1994), Professor; B.S., Keene State College; Ph.D., George Washington University Medical Center.

Steinberg, Spencer (1989) Professor; B.A., Ph.D., University of California, San Diego.

Tirri, Lawrence J. (1977), Assistant Professor; B.S., Fairleigh Dickinson University; Ph.D., Fordham University.

Professors Emeriti

Alsup, William M. (1964-1991), Emeritus Associate Professor; B.S., M.E., Ph.D., University of Wyoming.

Billingham, Edward J., Jr. (1965-1988), Emeritus Professor; B.S., Lebanon Valley College; Ph.D., Pennsylvania State University.

Earl, Boyd (1976), Professor; B.S., University of Idaho; M.S., Ph.D., University of California, Berkeley.

Emerson, David W. (1981-1998), Emeritus Professor; B.A., Dartmouth College; M.S., Ph.D., University of Michigan.

Grenda, Stanley C. (1967), Associate Professor; B.S., DePaul University; M.S., University of Arizona; Ph.D., Lehigh University.

Titus, Richard L. (1967-1997), Emeritus Professor; B.A., DePaul University; Ph.D., Michigan State University.

The Chemistry Department offers the Ph.D. in Chemistry or Radiochemistry and the M.S. in Chemistry or Biochemistry. Students may supplement their programs with appropriate courses from other science departments, with the approval of their graduate committee. Research may include projects conducted in the Chemistry Department, the Harry Reid Center, the Desert Research Institute, or the Environmental Protection Agency.

For additional information contact: David Hatchett (Graduate Coordinator) at (702) 895-3509. Web address: can be accessed through the UNLV home page at www.unlv.edu.

Admission Requirements for the Ph.D.

Admission to the Ph.D. degree program in Chemistry requires a B.S. degree or a M.S. degree in Biochemistry, Chemistry, Biology, or a related discipline. A minimum grade point average (GPA) of 3.00 for all undergraduate or graduate work is necessary for admission to the program. The Graduate College requires a completed application and official transcripts. The Department of Chemistry requires a statement of interest from the applicant. In addition, three letters of recommendation from persons familiar with the academic record of the applicant should detail the potential of the applicant for advanced graduate work in Chemistry or Biochemistry. The GRE General Aptitude Test results must be received by the department prior to regular admission.

Individuals with apparent academic deficiencies may be required to enroll in CHEM courses in addition to those required by the program.

Degree Requirements for the Ph.D.

Doctoral students are required to complete a minimum of 60 credit hours beyond the baccalaureate degree. Course selection will be based on students' academic records and fields of interest, e.g., Materials and Molecular Science, Biochemistry, Organic Chemistry, Physical Chemistry, or Environmental Chemistry. All students are required to complete and defend a dissertation describing their research.

Admission Requirements for the M.S.

Admission to the program requires an undergraduate degree in chemistry, chemical engineering, biology, biochemistry or a related discipline, with a cumulative GPA of 2.75, or of 3.00 for the last two years of undergraduate work. An application must be submitted to the Graduate College, with official transcripts of all college-level work. Two letters of recommendation from individuals able to assess the applicant's potential as a graduate student should be sent directly to the department along with an additional set of transcripts. The GRE General Aptitude Test results must be received by the department prior to regular admission.

Individuals with apparent deficiencies in their undergraduate background may be required to enroll in selected courses in addition to those listed in the following section to satisfy M.S. degree requirements.

Degree Requirements for the M.S.

1. A minimum of 30 graduate credits is required, of which 10-13 must be in CHEM 795 and CHEM 798 (a minimum of six) and two in CHEM 791. At least 12 of the remaining credits must be in courses at the 700 level, excluding those course numbers listed above. The Biochemistry Program should include CHEM 770, 771, 772, 773, 672, and BIO 701. A grade point average of at least 3.00 must be achieved in all course work required for the degree. No grade lower than C is acceptable, and only one grade below B- is permitted.
2. Research and course work specializations are available in analytical chemistry, biochemistry, organic chemistry, and physical chemistry. The individual student's program of course work must be selected in consultation with and approved by the student's committee, and may include courses from selected disciplines other than chemistry, such as biology, physics, civil and environmental engineering, or water resources management.
3. Students are expected to select a research advisor by the end of their first semester.
4. Each student is required to present a departmental seminar on the student's research prior to graduation. This requirement is in addition to the two credits in CHEM 791. Students are expected to attend weekly departmental seminars.
5. Each student is required to meet at least once per semester with the student's examination committee. At the meeting in the semester prior to the expected term of graduation, the student will be asked to make a detailed presentation on research progress. The committee will then make recommendations to be addressed by the student during the remainder of the student's research program, in writing the thesis, and in the final examination. The committee may request another meeting prior to the final exam if deemed necessary.

It is expected that each student be a teaching assistant for a minimum of two courses prior to graduation. It is also expected that each student publish at least one research-based manuscript in a peer-reviewed journal.

Radiochemistry Ph.D. Program

The Radiochemistry Ph.D. Program is a student-driven research intensive program stressing fundamental aspects of radiochemistry science. It was established by the Departments of Health Physics and Chemistry and includes participants from the Harry Reid Center, Nuclear Science and Technology Group. The program is administered by the UNLV Graduate College. The Ph.D. program requires 60 credits of research and courses beyond the baccalaureate degree. Credit is required for four courses in nuclear chemistry, radiochemistry, detectors, and laboratory. The remaining courses are based on the area of interest of the student and include laboratory research. Students are obliged to maintain a B average and show progress in their research.

To advance to candidacy, students are required to pass an oral exam on their research and an outside topic related to radiochemistry. The curriculum and research provides a comprehensive and interdisciplinary examination of

topics and experiences necessary to produce graduates who are ready to secure employment and participate in radiochemistry research. An example class schedule for incoming students with a baccalaureate appears below. Representative program for B.A. student entering UNLV radiochemistry program:

Fall semester – Year 1 (8 credits)

RDCH 701	Nuclear Chemistry	(3)
RDCH 702	Radiochemistry	(3)
RDCH 750	Radiochemistry Laboratory Research	(2)

Spring semester – Year 1 (9 credits)

HPS 604	Radiation Measurement and Detection	(3)
HPS 714	Radiation Detection and Radiochemistry Laboratory	(3)
HPS 750	Radiation Risk Assessment	(3)

Fall semester – Year 2 (10 Credits)

RDCH 710	Actinide Chemistry	(3)
HPS 670	Environmental Health Physics	(3)
MEG 656	Radioactive Waste Management	(3)
CHEM 791	Chemistry Seminar	(1)

Spring semester – Year 2 (7 Credits)

CHEM 655	Instrumental Analysis	(3)
MEG 655	Fundamentals of Nuclear Engineering	(3)
HPS 791	Health Physics Seminar	(1)

Fall semester – Year 3 (7 Credits)

RDCH 799	Doctoral Dissertation	(3)
GEY 708	Isotope Geochemistry	(3)
HPS 791	Health Physics Seminar	(1)

Spring semester – Year 3 (6 Credits)

CHEM 799	Doctoral Dissertation	(5)
CHEM 791	Chemistry Seminar	(1)

Fall semester – Year 4 (7 Credits)

CHEM 799	Doctoral Dissertation	(4)
CHEM 795	Independent Study	(2)
CHEM 791	Chemistry Seminar	(1)

Spring semester – Year 4 (6 Credits)

CHEM 799	Doctoral Dissertation	(6)
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Chemistry

CHEM 710 3 credits

Environmental Aquatic Chemistry

Study of the chemistry of natural waters, emphasizing chemical speciation and the interaction of aqueous media with soil and air. Considerable attention given to the use and limitations of thermodynamic equilibrium models of chemical speciation. Prerequisite: Graduate standing or consent of instructor.

CHEM 715 3 credits

Environmental Organic Chemistry

Organic chemistry of natural waters, soils and the atmosphere, emphasizing chemical reactions, sorption, bio-concentration and fate and transport. Use and limitation of thermodynamic and kinetic models and the extrapolation of laboratory data to environmental conditions. Prerequisites: Graduate standing in chemistry or consent of instructor.

CHEM 725 3 credits

Advanced Organic Chemistry

Advanced study of structures and reactions of organic compounds. Reactive intermediates, reaction mechanism, stereochemistry, and synthesis examined. Prerequisites: CHEM 242 and 421.

CHEM 726 3 credits

Organic Synthesis

Study of the synthesis of complex organic molecules. Stereochemistry, use of organometallic reagents and chiral auxiliaries stressed, with considerable emphasis on current literature. Prerequisites: CHEM 242, 421.

CHEM 728 2 credits

Organic Synthesis Laboratory

Some reasonably challenging syntheses undertaken to include reactions requiring rigid exclusion of air and moisture. Products characterized by modern spectroscopic methods. Eight hours laboratory per week. Prerequisites: CHEM 242, 421, 447 or consent of instructor.

CHEM 735 3 credits

Advanced Physical Chemistry

Statistical and quantum mechanics and their use in calculating thermodynamic properties. Prerequisites: CHEM 421 and 428.

CHEM 745 3 credits

Instrumental Analysis-Inorganic

Theory of modern analytical instrumentation as it pertains to inorganic analysis. May include atomic emission and absorption, x-ray, radioactivity and mass spectroscopic methods.

CHEM 746 3 credits

Instrumental Analysis-Organic

Theory of modern analytical instrumentation as it pertains to organic analysis. May include gas chromatography-mass spectrometry, supercritical fluid chromatography, nuclear magnetic resonance, Fourier transform infrared methods and fluorescence techniques.

CHEM 749 3 credits

Polymer Chemistry

Polymer structure; classification of polymerization reactions, step-growth and chain-growth polymerization reactions; condensation, radical, cationic, and anionic polymerization reactions; physical properties and characterization of polymers. Prerequisite: Consent of instructor.

CHEM 750 **3 credits**
Quality Assurance and Statistics

Purpose, theory, and applications of quality assurance/quality control. Experimental design including development of sampling protocols. Statistics relating to the evaluation of data quality covered. Not a theoretical statistics course. Prerequisites: STA 161 and CHEM 455.

CHEM 752 **3 credits**
Chromatography

Theory and applications of chromatography as the basis of analytical separations for inorganic and organic analyses. Separating power, selectivity, efficiency, and limitations of the various methods discussed. Prerequisites: CHEM 241, 422, and 455.

CHEM 755 **3 credits**
Sample Preparation and Analysis

Collection, preparation, and analysis of gaseous, soil, and water samples using approved standard methods. Techniques used may include gas chromatography, gas chromatography-mass spectroscopy, high performance liquid chromatography, atomic absorption spectroscopy, and inductively coupled plasma atomic emission spectroscopy. One hour lecture and six hours laboratory. Consult instructor(s) prior to enrollment. Prerequisite: Graduate standing in chemistry.

CHEM 760 **3 credits**
Environmental Radiochemistry/Radiation Safety

Practical applications of radiochemistry to topics of current and future concern, such as the temporary and permanent storage of radioactive wastes, nuclear utilities, nuclear medicine and isotope geology. Includes advanced radiochemical techniques and radiation safety training. Prerequisites: CHEM 421 and 422 or equivalent, or consent of instructor.

CHEM 765 **3 credits**
Inorganic Chemistry

Physical approach to inorganic compounds, mainly of the transition elements including bonding, stereochemistry, and electronic properties with use of symmetry and elementary group theory. Prerequisite: CHEM 422.

CHEM 770 **3 credits**
Protein Chemistry

Practical applications of protein purification, including gel electrophoresis, gel filtration and ion-exchange chromatographies. In addition, aspects of enzymology (kinetics, regulation) presented. Prerequisite: CHEM 475.

CHEM 771 **3 credits**
Metabolism and Energetics

Biochemical pathways of carbohydrate, lipid, nucleic acid and amino acid metabolism and the mechanism of mitochondrial ATP synthesis. Prerequisite: CHEM 475.

CHEM 772 **3 credits**
Nucleic Acid Chemistry

Structure, function, and regulation of nucleic acids. Synthesis, transport, and degradation of proteins encoded by nucleic acids. Prerequisite: CHEM 475.

CHEM 773 **3 credits**
Physical Biochemistry

How physical chemical methods may be applied to the problem of the structure and interaction of biochemical macromolecules. Includes discussion of application of radioactivity, electrophoresis, chromatography, various forms of spectroscopy, and polymer methods such as sedimentation and viscosity measurements. Prerequisite: CHEM 475.

CHEM 775 **3 credits**
Bioanalytical Environmental Toxicology

Principles of toxicology. Study of the interaction of toxicants with biochemical pathways. Emphasis on toxic chemicals of environmental interest. Prerequisite: CHEM 475.

CHEM 783 **3 credits**
Spectral Interpretation

Spectroscopic data obtained from the techniques of nuclear magnetic resonance (NMR), mass spectrometry (MS), infrared (IR) and ultraviolet-visible (UV-VIS) spectrophotometry used to establish structural features of organic molecules. Emphasizes strategies, interpretation, modern techniques, and problem solving. Prerequisite: Consent of instructor.

CHEM 784 **1 credit**
Spectral Interpretation Laboratory

Identification and characterization of an organic compound using infrared, ultraviolet, mass, and NMR spectrometers. Proton, carbon-13, and two-dimensional NMR spectra used to fully determine the structure. Corequisite: CHEM 683.

CHEM 790 **1 credit**
Directed Readings

Directed readings in the primary literature supportive of the dissertation prospectus. May be repeated, but only three credits are applied to the academic program. Prerequisites: Enrollment in the Chemistry or Radiochemistry doctoral program.

CHEM 791 **1 credit**
Graduate Seminar

Attendance and participation in seminar presentations. Includes student presentations. For master's students, enrollment is required. Two presentations are required. May be repeated for a maximum of five credits. Prerequisite: Graduate standing in Chemistry or Radiochemistry.

CHEM 792 **3 credits**
Research Seminar

Public defense of a graduate research project in the Ph.D. program. Prerequisite: Graduate standing in Chemistry or Radiochemistry.

CHEM 793 **3 credits**
Special Topics

Study of topics of common interest in relation to environmental analytical chemistry at an advanced level. Topics published in the class schedule. May be repeated to a maximum of twelve credits in different topics. Prerequisite: Graduate standing in chemistry.

CHEM 795 **1-3 credits**
Independent Study

Individual directed study of a topic not covered in other courses. May be repeated once for credit. May be repeated to a maximum of six credits. Prerequisites: Graduate standing in chemistry and consent of instructor.

CHEM 796 **1 credit**
Dissertation Prospectus

Development of a prospectus and its defense before the Ph.D. examination committee. Prerequisite: Enrollment in the Chemistry or Radiochemistry doctoral program.

CHEM 797 **1-6 credits**
Directed Research

Supervised research in the doctoral program. May be repeated for a maximum of twelve credits. Prerequisite: Enrollment in the Chemistry or Radiochemistry doctoral program.

CHEM 798 **3-6 credits**
Thesis

May be repeated, but only nine credits applied to the student's program. S/F grading only. Prerequisites: CHEM 745 or CHEM 746 and consent of instructor.

CHEM 799 **3-6 credits**
Dissertation

Research, analysis, and writing toward completion of dissertation and subsequent defense. May be repeated but a minimum of eighteen credits and a maximum of twenty four credits will be applied toward fulfillment of degree requirements. S/F grading only. Prerequisites: Graduate standing in Chemistry or Radiochemistry and consent of instructor.

Graduate credit may be obtained for courses designated 600 or above. Full descriptions of these courses may be found in the *Undergraduate Catalog* under the corresponding 400 number. Credit at the 600 level normally requires additional work.

CHEM 602	Scientific Software for the Microcomputer
CHEM 621	Physical Chemistry I
CHEM 622	Physical Chemistry II
CHEM 628	Quantum Chemistry
CHEM 655	Instrumental Analysis
CHEM 672	Biochemistry Laboratory
CHEM 678	Endocrinology

Radiochemistry

RDCH 701 **3 credits**
Nuclear Chemistry

Introduces nuclear properties in radiation and radiochemistry. Concepts of the nuclei, radioactive decay, and nuclear reactions examined. Use of quantum mechanics in development of nuclear models and equations. Physics involved in interaction of radiation with matter. Prerequisites: General physics, graduate standing in Radiochemistry program.

RDCH 702 **3 credits**
Radiochemistry

Introduces chemical properties in radiation and radiochemistry. Use of stability constants and relationship between speciation, kinetics and thermodynamics. Influence of radiolysis on chemistry of radioisotopes. Radioisotope production and use. Radiochemical separations. Prerequisites: Inorganic chemistry, physical chemistry, graduate standing in Radiochemistry program.

RDCH 710 **3 credits**
Actinide Chemistry

Basis for unique chemistry of actinide elements described and related to oxidation-reduction, complexation, f-orbital interaction, and spectroscopy. Using nuclear properties in understanding actinide chemistry covered. Presentations on exploiting chemical behavior of actinides in separation, nuclear fuel cycle, environmental behavior, and materials. Prerequisites: RDCH 702, graduate standing in Radiochemistry program.

RDCH 750 **3 credits**
Radiochemistry Laboratory Research

Experimental laboratory research conducted by the student under supervision. The student supplies research topic and provides suitable literature and background information. Research plan developed in conjunction with instructor. The student obtains experience in performing radiochemical laboratory research. Prerequisites: Undergraduate chemistry laboratory experience, graduate standing in the Radiochemistry program.