



Handbook For Undergraduate Chemistry Majors

2010-2011

Table of Contents



Chemistry Majors	page 2
Undergraduate Research	page 2
Faculty Members' Research Interests	page 3
Research Facilities	page 4
Graduation with Honors	page 5
Student Affiliates	page 6
Scholarship and Award Opportunities	page 6
A Pre-med Chemistry Major	page 7

The Chemistry Department has a long tradition of strength in undergraduate instruction. Approximately half of our graduates go on to graduate or professional schools (20% in chemistry) with the remainder working in a wide variety of fields. Students taking the American Chemical Society standardized exam in various areas of chemistry have scored in the upper percentiles nationwide. During 2009, 34 undergraduates participated in mentored research in the chemistry department; four undergraduates were co-authors on research publications and seven were on presentations at professional meetings.

For more information email chemug@wfu.edu or see the Department of Chemistry web page at <http://www.wfu.edu/academics/chemistry> or contact Department Chair: Dr. Christa Colyer, Salem 207C, 336-758-4936, colyercl@wfu.edu.

The Chemistry Major at Wake Forest University

The department offers BA and BS degrees in chemistry, with further specialization available through the BS degree with a concentration in either Biochemistry or Materials Chemistry. All BS degrees are certified by the American Chemical Society. A chemistry minor is available also. All chemistry courses and required physics/math courses are open to chemistry majors on a letter-grade basis only. A minimum GPA of 2.0 in the first two years of chemistry is required to declare a chemistry major. Admission to any class is contingent upon satisfactory grades in prerequisite courses, and registration for advanced courses must be approved by the department. Candidates for either degree with a major in chemistry must have a minimum GPA of 2.0 in their chemistry courses numbered 200 or above.

Note: It is recommended that chemistry majors and pre-med students take more than one Division V class each semester. Study abroad is possible, but you must plan ahead!

The department will accept transfer courses taken at four year colleges and universities that offer a major in chemistry. These courses must be equivalent in content and level to courses offered at WFU (as judged by a departmental curriculum committee). Courses taken in summer school elsewhere, or in WFU study abroad programs, must meet these same criteria and receive pre-approval. Advanced courses are typically not transferable except for some pre-approved study abroad programs.

Degree Requirements: The major requirements as stated in the Bulletin of Wake Forest University corresponding to **your year of major declaration** are in effect for your graduation. Please consult the 2010-2011 Bulletin, available on WIN, for this information as well as sample schedules. In addition, note that variations in these schedules are possible to accommodate study abroad and other special circumstances, in which case students should talk with a member of the chemistry faculty.

Undergraduate Independent Research in Chemistry at Wake Forest University

One of the most important experiences for undergraduate science majors is the ability to participate in original research programs. Many of our students publish scientific papers in professional journals, give presentations at national meetings, obtain summer research internships, and win national awards based on their research. Students may receive academic credit (CHM 391 or CHM 392) or scholarships and financial incentives for research projects. Research may be conducted during the summer or the academic year. If you are interested in beginning a research project in chemistry, consult the list of chemistry faculty below. Read their research descriptions and look for areas that match your interests. Individually contact those professors whose work you find intriguing and ask for more information on available research projects.



Undergraduate students completing chemistry lab coursework.

Note that many national scholarships and awards, for both undergraduate and graduate students, are given based on past research accomplishments. For instance, WFU chemistry majors have been awarded National Science Pre-doctoral Fellowships, Rhodes Scholarships, the Barry M. Goldwater Scholarship and Glaxo-Wellcome Undergraduate Fellowships, among other accolades. The earlier in your college career you begin participating in research, the more you will learn and the stronger your application for such awards will be.



Examples of research labs where undergraduate students conduct independent research.

Chemistry Faculty Members and Their Research Interests

Dr. Rebecca Alexander (Associate Professor, Robert P. and Debra Lee Faculty Fellow)
Biochemistry: structure-function analysis of protein-nucleic acid interactions, computational analysis of macromolecular function.

Dr. Ulrich Bierbach (Associate Professor, Z. Smith Reynolds Foundation Fellow) Medicinal and Bioinorganic Chemistry: synthesis and mechanistic study of anti-cancer and anti-infectious agents, metal-DNA interactions, biocoordination chemistry.

Dr. Christa L. Colyer (Professor and Department Chair)
Analytical Chemistry: capillary electrophoresis method development to facilitate bioprobe design, protein determination, and microbe detection for human and environmental health.

Dr. Lindsay R. Comstock (Assistant Professor)

Bioorganic Chemistry: synthesis of cofactor mimics and their application as tools to identify sites of biological modifications.

Dr. Patricia C. Dos Santos (Assistant Professor)

Biochemistry: essential metabolic pathways involving biological formation of metalloclusters and thio-cofactors.

Dr. Willie L. Hinze (John B. White Professor of Chemistry)

Analytical Chemistry: utilization of organized assemblies for chemical analysis and separation science.

Dr. Bradley T. Jones (Professor, Tatum Family Fellow)

Analytical Chemistry: spectrochemical analysis, instrument design and trace metal analysis.

Dr. Amanda Jones (Assistant Professor)

Organic and Organometallic Chemistry: NMR spectroscopy and physical organic studies to elucidate the structure and reactivity of intermediates in synthetic reactions.

Dr. Paul B. Jones (Associate Professor)

Organic Chemistry: photochemical methods to generate synthetically and medically significant products.

Dr. Angela G. King (Senior Lecturer, Wright Family Fellow)

Chemical Education: increasing student engagement with technology and peer-instruction, providing middle and high school teachers with updated content knowledge and hands-on activities.

Dr. S. Bruce King (Professor)

Organic Chemistry: synthesis of new nitric oxide/nitroxyl donors; synthesis of probes of protein redox status, organic methodology.

Dr. Dilip K. Kondepudi (Thurman D. Kitchin Professor of Chemistry)

Physical Chemistry: kinetics and thermodynamics of spontaneous generation and propagation of chiral asymmetry; theoretical study of self-propagating high-temperature synthesis.

Dr. Abdessadek Lachgar (Professor, Bell Faculty Fellow)

Inorganic Chemistry: synthesis and characterization of porous and low-dimensional solids, and their application in catalysis, chemical separation and gas storage.

Dr. Ronald E. Nofle (Professor)

Inorganic and Materials Chemistry: synthesis, electrochemistry, spectroscopy, and structural characterization of new conducting polymers and metal-thiophene frameworks.

Dr. Al Rives (Senior Lecturer)

Chemical Education: development of instructional methods, demonstrations, and laboratory experiments to enhance student understanding.

Dr. Akbar Salam (Associate Professor, Ollen R. Nalley Faculty Fellow)

Theoretical Chemistry: long-range intermolecular forces, single- and multi-photon absorption and emission processes, and molecular chirality.

Dr. John Tomlinson (Lecturer)

Chemical Education: Organic Chemistry lecture and laboratory development. Chemical Separations: HPLC/MS

Dr. Mark E. Welker (William L. Poteat Professor of Chemistry and Vice Provost)

Organic Chemistry: metal mediated cycloaddition reactions and synthesis of cancer chemopreventive agents.

Research Facilities

The Department of Chemistry is fully equipped with the instrumentation and equipment required for cutting edge research. This translates into less time waiting for instrumentation and more time carrying out research. Standard instrumentation for research is available and includes a staffed high field NMR facility (Bruker Avance 300 MHz and 500 MHz NMR instruments), electron paramagnetic resonance spectrometer, Agilent 5890 and 7890 GC-mass spectrometers, Agilent

1100 LC/mass spectrometer, Thermo LTQ high resolution "Orbitrap" mass spectrometer, Agilent 6890 GC-FID, FT-Infrared, Raman, UV-visible, Circular Dichroism, and Fluorescence spectrometers, a staffed x-ray diffraction facility containing both single crystal and powder diffractometer, gas and high performance liquid chromatographic systems, atomic absorption and ICP spectrometers, gel and capillary electrophoretic systems, double manifold vacuum lines, inert atmosphere glove-boxes, and electrochemical and polarographic systems. Additional instrumentation is available at the School of Medicine. Computational facilities include a 128 node Linux Beowulf cluster comprising dual processor Intel Xeon x335 CPU's. Software includes Gaussian 03 and GAMESS electronic structure packages, extensive mathematical libraries and Fortran, C/C++ compilers. The library contains over 225 current journal subscriptions in chemistry and holds complete runs in most chemistry titles. On-line computer searching of over 200 databases is available.

Research Opportunities Elsewhere

National Science Foundation Research Experiences for Undergraduates (REU) Programs

These programs consist of approximately 10 undergraduates from across the country, who work in research programs of the host institution. Each student is assigned a specific research project and works closely with the faculty advisor, and perhaps post-docs and graduate students. Students receive stipends and possibly assistance with housing and travel. For more information see listings on the bulletin board across from the stock room in Salem Hall.

Research Opportunities at the Wake Forest University School of Medicine The WFU School of Medicine offers a summer research experience where students learn basic research lab skills, techniques and technology used in biomedical research through an independent research project led by medical school faculty. Participants receive a stipend and free housing.

Honors in Chemistry

Students who excel in both the classroom and research laboratory at Wake Forest are encouraged to pursue graduation with honors. More information is given below, but majors are encouraged to discuss possibilities with their major adviser as soon as possible.

Requirements for Graduating with Honors in Chemistry (Last updated: Feb. 02, 2010)

1. Students must have a 3.30 GPA in chemistry and a 3.00 GPA overall.
2. A written thesis must be submitted.
3. The thesis will be read by the advisor and two other faculty members. This group will constitute the student's committee and will be appointed as early as possible but no later than the beginning of the student's final semester.
4. The thesis must be presented to the department and defended. After a successful defense, the committee will sign the thesis.
5. The student will have three bound copies of the thesis made- one for the department, one for the advisor, and one for her/himself.
6. Students may carry out their honors work outside the department only if a departmental faculty member is intimately involved and serves as the student's advisor. The committee may include the outside advisor, but must include another faculty member in the Department of Chemistry.

Timetable:

- (i) Students should indicate their intention to carry out honors work with their current or potential research advisors as early as possible. They should then inform the Honors Coordinator of the tentative title of the research project, the names of committee members, and the name of the advisor. The Honors Coordinator will keep records of Honors Students and will schedule their

defense times. Honors work can be started as late as two semesters before graduation but cannot be started in the last semester before graduation.

- (ii) The defense will be scheduled for the annual Honors Symposium held in the Spring. The date will be announced early each spring semester.
- (iii) The thesis must be submitted to the advisor one week before it can be presented to the full committee. The committee must then have an additional week to read the thesis before the defense. Students may not present their defense during the final exam period, or the period before commencement.

American Chemical Society Student Affiliates

The American Chemical Society is a self-governed individual membership organization consisting of 163,000 members at all degree levels and in all fields of chemistry. The organization provides a broad range of opportunities for peer interaction and career development, regardless of professional or scientific interests. The programs and activities conducted by ACS today are the products of a tradition of excellence that dates from the Society's founding in 1876.

The Student Affiliates program gives undergraduate students studying the chemical sciences the opportunity to participate in the ACS. In addition to fostering social interactions among students, the Student Affiliates program gives you the professional edge, lets you network with top professionals, and provides you with scientific meetings and direct access to research. Joining ACS entitles student affiliates to substantial discounts on ACS journals, 17 issues of *Chemical & Engineering News*, four issues of the undergraduate career magazine *in Chemistry*, career and employment services, and the Directory of Experience Opportunities listing co-ops, internships, and summer jobs for undergraduate chemical science students. There are ACS Student Affiliates chapters at over 900 colleges and universities in the United States.

The Wake Forest University American Chemical Society Student Affiliates (WFU ACS SA) is a group of enthusiastic and motivated students who organize a wide variety of activities during the year. The chapter was awarded an Honorable Mention by the National ACS for their efforts. Students meet regularly to coordinate projects, socialize, and participate in discussions with faculty and graduate students. Because of their participation in this organization, the students are able to develop closer relationships with the chemistry faculty and with each other.

Annual activities of the WFU ACS SA include National Chemistry participation in a Project Pumpkin Mad Scientist and outreach activities for elementary school-age children, both on our campus and in the community. Family science nights, science shows and demonstrations, and judging science fairs are some examples of these activities.

Please see the WFU ACS SA web site, <http://www.wfu.edu/academics/chemistry/acs/index.html> or contact the faculty advisor Dr. John Tomlinson (tomlinjt@wfu.edu) for more information.

Scholarship and Award Opportunities Available to Wake Forest University Chemistry Majors

Wake Forest Research Fellowship Program The Wake Forest Research Fellowship Program is designed to encourage individual undergraduate students to collaborate with professors on scholarly research projects. Summer awards include a \$4,000 taxable stipend and free campus housing. Applicants must have a cumulative 3.0 GPA at the time of application and sophomore standing (23/25 or more hours passed) before undertaking research in this program. More information is available at http://www.wfu.edu/undergraduate_college/research-fellowship/

The Barry M. Goldwater Scholarship and Excellence in Education Program The purpose is to provide a continuing source of highly qualified individuals in the sciences or mathematics and provides funds for academic study and research. Students who plan to study medicine are eligible for a Goldwater Scholarship only if they plan a research career rather than a career as a medical doctor in a private practice. For more information see <http://www.act.org/goldwater/>

Blackbyrd Scholarship (in Chemistry) Award Presented annually to an outstanding rising junior BS chemistry major.

Churchill Scholarships Awarded to graduating seniors in engineering, mathematics, physical and natural sciences. The scholarships enable Americans to pursue graduate studies and research at Churchill College, a constituent college of Cambridge University. Wake Forest University may nominate two students per year for these highly competitive scholarships.

Environmental Studies Grants Grants of up to \$3000 from the Wake Forest Environmental Studies Program are available to support undergraduate students of ALL majors in environmental activities, including:

- Environmental work with non-profit, governmental, and industrial organizations,
- Environmental research of your own design,
- Environmental research with Wake Forest faculty or faculty at other institutions,
- Participation in programs with a significant environmental component.

John W. Nowell Award in Undergraduate Chemistry This award is given to a senior Wake Forest chemistry major each year, in recognition of a demonstrated record of ability, leadership and professional promise.

Hypercube Scholar Award in Chemistry Awarded annually to a Wake Forest University chemistry major who will enroll in a science graduate program after graduation.

American Chemical Society Undergraduate Award in Analytical Chemistry Presented to a rising senior to recognize students who display an aptitude for a career in the field.

CRC Press Freshman Chemistry Achievement Award Presented to first year students based on outstanding academic achievement in chemistry classes.

Adapted from Health Professions Program Home Page (<http://www.wfu.edu/~lane/hpp/>) and Wake Forest Bulletin

The information below is provided to students interested in the health careers (allopathic, osteopathic dental, podiatric and veterinary medicine, optometry, physical therapy, physician assistant, nursing medical technology and public health). The course requirements for the latter five disciplines are slightly different, and students should consult with Dr. Gary Miller, in the Health & Exercise Science Department.

The national standardized test for medicine (the MCAT) is an exam based on one year of introductory biology, one year of general chemistry, one year of organic chemistry, one year of introductory physics and one year of English. These courses must be completed, or be in the last stages of completion, by the end of your junior year typically, or before or during the semester you plan to take the MCAT exam. Biochemistry is required, or strongly recommended, by a number of allopathic medical schools and some Physician Assistant programs.

The following courses satisfy most medical school requirements and are the best suited for preparing MCAT and DAT: **All courses listed below must be taken with laboratory**

- All chemistry majors must take the following courses, which are also the chemistry requirements for pre-med students: CHM111 (Fall, Summer), CHM122 (Spring, Summer), CHM223 (Fall, Summer), CHM280 (Spring). Biochemistry (CHM 370) is strongly recommended for pre-med students and also a required course for all chemistry majors.
- Majoring in chemistry means you meet the pre-med requirements in physics and math (PHY113, PHY114; MTH111, MTH112)
- The only pre-med requirement outside of a chemistry major is one year of Biology with labs (at least two of the following: BIO111, BIO112, BIO213, BIO214)

Most students complete the pre-medical requirements by the end of their Junior year. Note that Wake Forest routinely offers the following courses during summer sessions: CHM111, CHM122, CHM223, BIO111, BIO112, MTH111, MTH112, PHY112, PHY113. Students may also seek pre-approval to take courses at other institutions over the summer. Please contact the registrar's office for more information.

Please note that students who enter Wake Forest with AP credit for CHM 111, 111L and 280 may enroll in CHM 123 fall of their freshman year. This greatly increases flexibility in scheduling for pre-med students and chemistry majors who wish to study abroad. In addition, we have found that the AP program is rigorous and students who receive AP credit are very well prepared for CHM 123 and future chemistry classes, as prepared or better prepared for future chemistry classes as students who complete CHM 111. For these reasons, we strongly urge students to not drop AP chemistry credit, but to enroll directly in CHM 123.

Traveling abroad for a semester should be planned ahead, because some chemistry classes have pre-requisites and they are not offered every semester. The most convenient time for chemistry majors to study abroad is likely to be the spring semester of their junior year (although other options are possible). Please note that credit for some upper-level chemistry classes is accepted from abroad institutions. Please talk with your major adviser and the International Studies Office for more details and options.