Graduate Program Review

Department of Chemistry and

Biochemistry

2007-2014
EXECUTIVE SUMMARY

The chemistry graduate program accepted its first class with two M.S. seeking candidates in the fall of 1989. Currently, approximately 38 degree seeking students are enrolled in the resident program with an additional 45 distance MS students. The objective of the program since its inception is to give students who have an undergraduate foundation in chemistry the opportunity to engage in advanced course work, in–depth study, and independent scholarly activity. Our program provides students with a strong, research-based graduate study that prepares them for employment in the chemical industry and for further graduate education. We offer graduate students a diversity of research areas from which to choose within the traditional bounds of chemistry such as inorganic, analytical, organic, computational, biochemistry and physical chemistry. We also offer students the opportunity to conduct research in several non-traditional chemistry research programs including environmental chemistry, marine chemistry and chemical education.

The chemistry graduate program saw significant growth during its first decade in both the quantity and quality of its graduate research. This growth has become somewhat stagnant since the last review report in 2007 for a variety of reasons. Foremost among these are the dollar amounts of teaching assistantships and tuition scholarships. Our financial offers to prospective students are inadequate to attract and retain superior students or to be competitive with other universities who offer more lucrative packages. The limited number of tuition remissions available in the department also means we will remain predominately an in-state program which reduces student diversity. Although we have made significant gains in garnering external support, the chemistry faculty also needs to generate more external funding in order to support the growing number of graduate students in our program. We have also exceeded the capacity of
research space for graduate students and research active faculty in Dobo Hall. Finally and perhaps most significantly we need an equitable revenue sharing plan for funds garnered from our distance program that does not change as each new administration is put into place. This long term fiscal plan is paramount for the planning and continued success of our resident program in the light of dwindling state and federal support of academic research endeavors.

The following report is a detailed review of the chemistry graduate program, past, present and future. It is divided into several sections, the first of which contains information regarding the 2000 program review (a review report was generated but no external review was conducted in 2007), recommendations from this review, and our responses. The remainder of this document is a summary of the chemistry graduate program characteristics for the period from 2007-2014 and an evaluation of the strengths, weaknesses, opportunities and threats (SWOT analysis) of the program. In conclusion, we have made great strides in our chemistry graduate program since its inception in 1989 and we see great potential for its growth and continued success in the coming years.
1. UNCW GRADUATE PROGRAM IN CHEMISTRY

General characteristics of and brief history of the academic unit

Chemistry courses have been taught at UNCW since the inception of the institution as Wilmington College in 1947. The chemistry B.A. and B.S. programs were initiated in 1963 when the school became a four-year college. A total of 43 bachelor’s degrees were awarded during the ten-year period 1965-74. During this time, the American Chemical Society approved the Department of Chemistry and its B.S. program. The total number of B.A. and B.S. degrees awarded grew rapidly after approval by the ACS and now the department graduates approximately 60 chemistry majors per year. This makes UNCW's chemistry program one of the largest producers of bachelor's level chemists in the country.

The department sends a required report to ACS annually, and a thorough review by ACS of the curriculum, faculty, and facilities takes place every five years. The physical facilities, scientific equipment, and number of faculty also have grown significantly over the years. In 1996 the department moved into half of a new 100,000 ft² science building. The chemistry faculty has also shown significant growth from 5 full-time members in 1965 to 28 in 2014 although growth in tenure track faculty has slowed significantly in recent years because of a lack of research laboratories and office space.

Expanding on the successes of its undergraduate program, the department began graduate instruction in the fall of 1989 with one graduate student and almost no external research support. From these relatively modest beginnings the program has grown substantially both in the quantity and quality of its graduate research. This growth is reflected by large increases in
external funding received by our faculty, which has increased more than 100 fold since the early 90’s. Significant growth in the graduate program is also reflected in the total number of graduates produced and large increases in the number of peer-reviewed publications and presentations made by faculty and students each year.

Graduates of our Master’s program receive rigorous chemical training and a first class education. Many students are part of large research teams composed of several faculty members, postdoctoral fellows and undergraduates. This team-based approach is beneficial both from an educational and research productivity viewpoint and also provides students with valuable team-working skills vital in today’s global society. Students are also encouraged to consult with different faculty members outside their research team to gain new insights into their research problems. Our highly qualified graduates are sought after both by doctoral granting institutions and the chemical industry.

Mission statement

The mission of the UNCW Department of Chemistry and Biochemistry is aligned with the mission of the University and the College of Arts and Sciences. The Department of Chemistry and Biochemistry is committed to providing exemplary programs incorporating modern technologies that lead to the Bachelor of Arts, Bachelor of Science, and Master of Science degrees in chemistry. The Department of Chemistry and Biochemistry is devoted to the development and recognition of outstanding teaching, learning, research and creative accomplishments, professional service by faculty and students, and faculty and staff development. Recognizing the unique coastal environment in which it resides, the Department
of Chemistry and Biochemistry encourages instruction and research in the areas of marine and environmental sciences.

**Departmental goals**

The Department of Chemistry and Biochemistry offers a program of study leading to the Master of Science degree in chemistry. The objectives of this program are to give students who have an undergraduate foundation in chemistry the opportunity to engage in advanced coursework, in-depth study, and independent research, in order to acquire the skills of assimilating known information and generating new knowledge. These problem-solving skills will provide the foundation for future contributions by the graduates in various areas of chemistry, whether they seek employment directly or choose to undertake further graduate study elsewhere.

**Dates new degree programs were established or major changes in the orientation of the academic program**

The chemistry graduate program was begun in the fall of 1989. Since that time there have been no new graduate degree offerings in the department. There have been significant additions to the existing graduate program including the distance MS degree that will be discussed in greater detail later in this document.

**2. Findings of previous reviews**

This report documents the response of the Department of Chemistry and Biochemistry to the report of the Graduate Program Review team in 2001. The team, comprised of Dr. Christopher Martens from the University of North Carolina at Chapel Hill and Dr. Fred Hawkridge from Virginia Commonwealth University, visited the department on April 4-6, 2001. The review consisted of interviews with faculty and graduate students as well as interviews with
the Provost, Dean of the Graduate School, Dean of the College of Arts and Sciences, and the department chair. The team also inspected facilities for graduate teaching and research in both Dobo Hall and the Center for Marine Science. The department believes that the visiting team conducted an exceptionally thorough review given the limited time available to them and it appreciates the carefully considered recommendations made by the team in their report.

The department agrees with most of the recommendations found in the report of the Graduate Program Review team and does not substantially disagree with any of them. What follows is an item-by-item response to each of the twelve recommendations made by the team.

**Recommendation 1: Increase faculty research productivity and faculty development including implementation of competitive internal faculty grants that can act as seed money**

All full-time faculty members in the Department of Chemistry and Biochemistry are research active. The level of research activity varies from one person to the next as some faculty assume a larger role in the teaching function of the department while others commit more of their time to necessary service activities. This is a typical situation in a Comprehensive university and is not considered by the department to be undesirable. There are several ways, enumerated below, in which the department has fostered higher levels of research productivity among certain faculty since the previous review.

1. Faculty have been encouraged to apply for research reassignments in order to broaden their research base and attract external funding.
2. Additional technical staff has been hired to relieve faculty from the responsibility of laboratory preparation and instrument maintenance.
3. An internal competitive grant program was initiated in fall of 2013 to fund faculty and graduate student research initiatives. These funds can be used as “seed money” to encourage application for larger grants from external sources and/or to keep research productivity high for periods between grants. This money is to be repaid by faculty to the department once the faculty member receives an award.

**Recommendation 2:** There is unevenness of external funding across the faculty. All faculty should be encouraged to actively pursue extramural support of their research.

The uneven external funding among faculty is a situation fostered by a university reward structure that is too heavily biased in favor of journal publication instead of grant writing. For example, the department’s criteria for Graduate Faculty status is based almost entirely on publications and does not consider success in obtaining external funding for research. The department has begun discussing this issue and some of the ideas being considered include: a) limiting the number of graduate students a faculty member can accept if they do not have external support for their research, b) better educating new graduate students on the importance to their progress of selecting research advisors and projects which have extramural funding, and c) changing the criteria for Graduate Faculty status to better reflect the importance of grant writing.

**Recommendation 3:** The department should develop a Non-thesis M.S. degree.

The Department began offering a new non-thesis MS degree in the fall of 2014 which will be discussed in detail in a subsequent section.

**Recommendation 4:** The policy that restricts Graduate Teaching Assistantships and Graduate Research Assistantships to the UNCW maximum level should be terminated and the pay rate increased
This policy was abolished soon after the graduate review. In addition, the Graduate Coordinator and department chair continue to meet with the Dean of the Graduate School to discuss changes in the pay rate for graduate teaching assistant and graduate research assistant stipends. As noted by the review team, the Department of Chemistry and Biochemistry competes for graduate students with some of the top research institutions in the southeast. Without the ability to offer larger graduate TA and RA stipends, the department will find it increasingly difficult to attract sufficient numbers of high quality students.

**Recommendation 5: Opportunities to build on existing and new relationships with local industry should be pursued.**

The most significant changes to the chemistry MS graduate program since the last review are in response to this recommendation. We have added the off campus MS degree and hired an additional staff member with over 20 years experience in the chemical industry to oversee its operation. This program is described in much greater detail later in this document.

**Recommendation 6: The Department of Chemistry should explore all mechanisms for dealing with teaching load requirements with the Dean so as to make overall loads more reasonable than the present 3/3 load for faculty carrying extramural funding.**

Research active faculty members in the department are assigned a teaching schedule of nine contact hours each semester. This consists of either two lectures and a lab or one lecture and two labs. Faculty members supervising large numbers of externally funded M.S. and/or DIS students are assigned the same contact hours as less research active faculty because the department and University have not been able to implement a formal mechanism to reduce their teaching loads due to teaching requirements imposed by expanding enrollment.
Recommendation 7: Increases in the undergraduate should be coupled to plans for expanding the graduate program.

The department chair and Graduate Program Coordinator have worked closely with the Dean of the Graduate School and the Dean of the College of Arts and Sciences to see that increases in undergraduate enrollment are accompanied by increased funding to support graduate teaching assistantships with limited success. The number of graduate TA’s has only increased from 11 during the previous review to 13 currently.

Recommendation 8: The growing research emphasis in the department should be aggressively marketed to all faculty candidates.

The role of a faculty member in a research active comprehensive university is far more complicated than that of similar faculty in research institutions. At an institution like UNCW, faculty must regularly publish their research, they must actively seek and receive external funding for their research, they must teach a significant number of hours each week, and they must do this in an environment that has limited internal funds to support research (e.g. small “startup packages”) and that demands excellence in the classroom. It is easy to see why a faculty recruit might seem to receive mixed messages as they interview with different members of the faculty. However, the increasing emphasis on research in the department, especially the need to seek and obtain external funding for research, is now a common theme delivered by all faculty to those seeking a position in the department.

Recommendation 9: A Graduate Student Handbook should be developed and disseminated to all graduate students.

A Chemistry Graduate Student Handbook is now provided on line to all incoming graduate students that delivers a concise and clear “roadmap” for navigating their way through the graduate program.
Recommendation 10: Faculty in the Department of Chemistry and Center for Marine Sciences should meet regularly.

The departmental faculties with marine science interests are invited to participate in all CMS faculty meetings. In addition, chemistry faculty participate on a regular basis in the CMS internal advisory committee meetings held once a month at CMS.

Recommendation 11: It is recommended that the Department of Chemistry be provided with an Assistant/Associate Chair position to assist in the management and leadership of the department.

The department has created the position of assistant chair in response to this recommendation from the previous review. The faculty member in this position receives a one course teaching load reduction.

Recommendation 12: There should be top down pressure to bring the Departments of Biology and Chemistry closer together at the administrative level.

While the Department of Chemistry and Biochemistry does not perceive any unnatural strain in the relationship with the Department of Biology and Marine Biology, it does acknowledge that a closer working relationship could exist between the two departments. This would improve the ability of the two largest science programs on campus to more effectively speak as one voice on matters affecting science programs and policies. The chairs of the two departments, in addition to other science chairs, now hold monthly meetings to discuss problems of mutual concern and to investigate ways in which the departments can work more closely together for their mutual benefit.

3. General program characteristics
a. Graduate program

The Department of Chemistry offers a program of study leading to the Master of Science degree in chemistry. The objectives of this program are to give students who have an undergraduate foundation in chemistry the opportunity to engage in advanced course work, in-depth study, and independent research, in order to acquire the skills of assimilating known information and generating new knowledge. These problem-solving skills will provide the foundation for future contributions by the graduates in various areas of chemistry, whether they seek employment directly or choose to undertake further graduate study elsewhere.

Specific Goals

1. to offer a diverse course curriculum that draws on existing faculty expertise.
2. to provide students with instrumental expertise in order to increase student employment or additional education opportunities upon graduation. This is achieved by offering specific courses in instrumental analysis as well as integrating modern instrumentation into other courses.
3. to enhance faculty research efforts by collaboration with graduate students. This is achieved by collaborative research efforts with faculty supervisors, and co-authorship of graduate students and faculty on professional publications, presentations, and other scientific efforts (e.g., software development).

Curriculum

There are five core graduate only courses offered each year: Advanced Inorganic Chemistry, Advanced Organic Chemistry, Advanced Physical Chemistry, Advanced Analytical Chemistry and Advanced Biochemistry. Each graduate student must take three of these courses in order to graduate. Each core course builds on material in the undergraduate curriculum that
enables students to think more deeply about fundamental chemical concepts. In addition to core courses, several specialty graduate classes are offered. In cross listed undergraduate courses instructors require graduate students to attend additional lectures, write additional papers, or take more comprehensive examinations.

Required Courses

CHM 501 Introduction to Chemical Research (2)
CHM 595 Graduate Seminar (2)
CHM 599 Thesis (3-6)
And at least three of the following courses:
CHM 516 Advanced Organic Chemistry (3)
CHM 521 Advanced Physical Chemistry (3)
CHM 536 Advanced Analytical Chemistry (3)
CHM 546 Advanced Inorganic Chemistry (3)
CHM 568 Advanced Biochemistry (3)

Additional course offerings:

CHM 512 Mass Spectrometry and Nuclear Magnetic Resonance Spectroscopy (3)
CHM 517 Medicinal Chemistry (3)
CHM 545 Inorganic Chemistry (3)
CHM 574 Aquatic Chemistry (3)
CHM 575 Chemical Oceanography (3)
CHM 576 Chemical and Physical Analysis of Seawater (3)
CHM 579/MSC 579 Role of the Oceans in Human Health (3)
CHM 585 Industrial and Polymer Chemistry (3)
CHM 586 Fundamentals of Heterocycles with emphasis on Pharmaceuticals (3)
CHM 591 Directed Independent Study
CHM 592 Special Topics (1-3)

Course Descriptions

CHM 512. Mass Spectrometry and Nuclear Magnetic Resonance Spectroscopy (3) Prerequisite: Two semesters of organic chemistry. Pre-requisite: CHM 211 and 212 or equivalent. Introduction to advanced structural elucidation techniques using advanced mass spectrometry and NMR. One hour of lecture and two hours of lab per week.
CHM 516. Advanced Organic Chemistry (3) Prerequisite: Two semesters of organic chemistry. Study of contemporary synthetic organic chemistry. Topics may include chiral synthetic
methods, natural products synthesis, bioorganic chemistry, relationships between structure and reactivity and the role of reactive intermediates, with emphasis placed on examples from the recent literature.

CHM 517. Medicinal Chemistry (3) Prerequisite: Two semesters of organic chemistry. Systematic study of the chemistry and biological activity of hormones, vitamins, drugs affecting the nervous system, and other miscellaneous agents.

CHM 521. Advanced Physical Chemistry (3) Prerequisite: CHM 520 (420) or equivalent. The study of quantum statistical mechanical basis of thermodynamics, including the behavior of solids and liquids. Kinetics of chemical reactions, particularly the microscopic picture of chemical reactions based on quantum statistical mechanics.

CHM 536. Advanced Analytical Chemistry (3) Prerequisite: Organic chemistry, quantitative analysis. Application of modern analytical methods to chemical problems. Emphasis upon chemical information, structural and quantitative, obtainable from these techniques. Topics may include modern spectroscopic, chromatographic, electrochemical, bioanalytical or isotropic techniques.

CHM 545. (445) Inorganic Chemistry (3) Prerequisite: Physical chemistry and quantitative analysis, or equivalent. Study of periodic relationships: crystal lattice theory; transition metals and ions; crystal field theory; organometallic structures and reactions; and reaction mechanisms.

CHM 546. Advanced Inorganic Chemistry (3) Prerequisite: CHM 545 or equivalent. Study of contemporary inorganic chemistry. Topics may include organometallic, bioinorganic chemistry, group theory, and/or current topics in contemporary inorganic chemistry.

CHM 568. Advanced Biochemistry (3) Prerequisite: CHM 365 or equivalent and CHM 321. Topics may include protein structure, stability, and visualization, enzyme kinetics and mechanisms including enzyme activators, inhibitors, and inactivators, ligand recognition and binding, and enzyme regulation.

CHM 574. Aquatic Chemistry (3) Prerequisite: Permission of the instructor. The chemistry of aqueous solutions, including use of activity coefficients, acid-base and buffer concepts, gas solubility, results of carbon dioxide dissolution, trace metal speciation, oxidation-reduction processes, photochemistry and mineral solubility. Concepts will be applied to laboratory solutions and natural waters.


CHM 576. Chemical and Physical Analysis of Seawater (3) Prerequisite: Permission of instructor. Study of modern chemical and physical measurements of seawater including salinity, alkalinity, pH, nutrients, and dissolved oxygen. Several class periods may also be devoted to working aboard an oceanographic research vessel while at sea.

CHM 579/MSC 579. Role of the Oceans in Human Health (3) Prerequisite: CHM 212, BIO 110, or consent of instructor. Discovery, structure, and biological activity of marine bioactive compounds, chemotaxonomy, pharmaceutical leads, marine biotoxins, structure, mode of action, regulation and monitoring, the producing organisms, how (biosynthesis) and why these compounds are made. Two lectures per week.

CHM 585. (485) Industrial and Polymer Chemistry (3) Prerequisites: Physical chemistry and two semesters of organic chemistry. Properties, synthesis, and reactions of major industrial
chemicals; synthetic plastics, soaps and detergents; petrochemicals; paints and pigments; dyes; pharmaceutical and nuclear industries; mechanism of polymerization; copolymerization; physical and chemical properties of polymers; polymer characterization; advances in polymer techniques.

CHM 586 Fundamentals of Heterocycles with emphasis on Pharmaceuticals (3) Prerequisite: 2 semesters of Organic Chemistry. Well over half of all known organic compounds and most pharmaceuticals are heterocycles (containing an atom other than C in the ring). This course will examine their chemistry. Topics include the nomenclature, properties, synthesis, and pharmaceutical applications of heterocycles.

CHM 591. Directed Individual Study (1–6) Directed Independent Study.

CHM 592. Special Topics (1–3) Study of a topic or technique in chemistry not covered in regular courses. May be repeated for credit

CHM 595. Graduate Seminar (1) Discussion by students, faculty, and guest lecturers of research ideas and/or research results. May be repeated two times for credit.


**Program Characteristics**

The graduate program in chemistry enhances several objectives of the department and institution. First, it provides strong, research-based graduate study intended to prepare students for employment and for further graduate education. Second, it strengthens and supports faculty research efforts in the chemical sciences and in interdisciplinary programs. Graduate students are a primary means for performing research supported by both internal and external funding sources. As a corollary, graduate students also assist in the undergraduate education program in the department by serving as teaching assistants (primarily as laboratory instructors and assistants) where they act as role models and mentors for the undergraduates. This service also allows faculty members to devote more time to preparation of undergraduate and graduate coursework, research, and service to the profession and community. Third, the graduate program contributes strongly to interdisciplinary education and research efforts in the department and university. This is reflected in the engagement of graduate students in marine science and environmental research and education, both of which cut across several disciplines, including biology, marine biology, earth sciences, and the marine science program (Center for Marine Science).
Interdisciplinary research is an integral aspect of the graduate program in the Department of Chemistry and Biochemistry. In addition to strong graduate research and educational involvement in the marine and environmental sciences, strong interdisciplinary efforts are ongoing in chemical education (with linkages to the School of Education and departments of Mathematics and Statistics and Physics and Physical Oceanography) and biochemistry (with linkages to the Department of Biology and Marine Biology). Students in the graduate program have, and continue to be involved in research and education efforts that involve collaborations with several other universities and national laboratories.

4. Certification, interdisciplinary and other programs

Off-campus MS degree

One of the recommendations from the Graduate Program Review 1995-2000 was, “Opportunities to build on existing and new relationships with local industry should be pursued.” In 2001, we began a program with a local company to enable students that are working full-time in the chemical industry to obtain a MS in Chemistry from UNCW. At the time of the last review report (2007) we had 16 students employed at 4 different companies taking graduate courses on a distance basis. Today we have 45 students taking online graduate courses. Students from many companies, large and small, have participated in our program. Examples of companies include: PPD, Pfizer, Biogen-Idec, 3M, Exxon-Mobil, BASF, Bayer, Lonza, Milliken, Chevron-Phillips, Arkema, Sabic, Georgia Pacific, Eisai, Metrics and Siemens. Most students are outside North Carolina with Texas, Wisconsin, Minnesota, Virginia, and Georgia as examples. In 2013, we graduated our first international student who was in Saudi Arabia and working for Saudi Aramco, the largest worldwide producer of crude oil with a
workforce of over 50,000. We also have one student from the U.S. Air Force and another from the U.S. Marine Corps. The nature of our course delivery allows these military students to participate in our program despite many geographical moves and even while deployed. We are also positioned to allow students in the other 16 UNC schools to take our courses. This is an advantage because many of these schools do not have the resources to offer a wide breadth of graduate chemistry courses. For example, today we have a student from NCCU taking one of our specialized courses. In 2013, we added a non-thesis option to our MS Chemistry Program. This enables distance students not employed in a research function to complete the MS. One particular need satisfied by this is that of science teachers who previously had been unable to obtain a MS with us because of the thesis requirement. Today, we have 9 teachers in our distance program. Through 2007, we had offered five different online chemistry graduate courses. Since then, we have developed eight more online courses. The off-campus program has strengthened the reputation of UNCW and extended the benefit to the community. The main impetus for the development of the distance education program was to generate additional funds for the resident graduate students in an era of decreasing state appropriations.

5. Facilities

The chemistry department at UNCW is housed in Dobo Hall, which was built in 1996. There are approximately 50,000 square feet of laboratory space for chemistry, including computer laboratory space. Most but not all faculty have an individual research laboratory (eight benches and four fume hoods in total) and a common area with desks that graduate students can share. The department also recently built a large common office suite for first year graduate
students including desks and filing space. Additional facilities include an instrument laboratory, clean room, environmental chamber, and two cold rooms.

The chemistry department also has limited space at the Center for Marine Science facility along the intracoastal waterway on Masonboro Sound south of Wrightsville Beach, North Carolina. The facility has over 70,000 square feet of indoor research space and a 900 ft pier capable of accommodating a 75ft. research vessel as well as a host of other smaller vessels. A flowing seawater facility provides scientists with raw, filtered and treated seawater for a host of research applications. Also included at the Center are a fully equipped diving locker as well as a machine shop, and other logistical support services.

One of the most significant limitations for the continued success of our graduate program is a lack of adequate research facilities for students and faculty. Existing graduate students and faculty currently occupy all available laboratories in Dobo Hall. This is significant because it suggests that no new research space is obtainable for new hires to conduct experimental based research in the chemistry department. This situation is further exacerbated because the next chemistry faculty who retire will free up no additional lab space.

6. Equipment

The table below lists all the equipment within the department that is available for graduate research. What is evident from data presented in the table is that the department has greatly expanded its instrumentation capabilities since the previous review report in 2007 including the acquisition of a UHPLC w/Bruker Microtof-Q II HR Mass Spectrometer and a UHPLC w/ Bruker Amazon SL Mass Spectrometer-MSn which provided LC MS capabilities not
present prior to their purchase. Many of the larger pieces were acquired through external grants awarded to chemistry faculty primarily funded by NSF.

<table>
<thead>
<tr>
<th>Instrumentation</th>
<th>Year Acquired</th>
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<tbody>
<tr>
<td>GC/MS, Bruker Scion Tripl quad (NSF-MRI grant)</td>
<td>2014</td>
</tr>
<tr>
<td>HPLC with DAD and ELSD, Agilent 1200 Infinity</td>
<td>2014</td>
</tr>
<tr>
<td>GC w/ head space injector (Bruker) and TIC and ECD detector</td>
<td>2013</td>
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<tr>
<td>Speed Vac, Thermo-Savant RVT 5150</td>
<td>2013</td>
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<td>Microwave Synthesis, MARS-6</td>
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<td>UV-Vis Spectrophotometers, Ocean Optics (5)</td>
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<td>UV-Vis Spectrophotometers (3) Cary</td>
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<td>ChemDraw 3D Site License</td>
<td>2013</td>
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<td>3D Fluorometer, Horiba Aqualog (NSF Grant)</td>
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<td>Incubator-Shaker, benchtop Thermo MaxQ</td>
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<td>Autoclave, Sanyo portable</td>
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<tr>
<td>Centrifuge, SorvallLegend</td>
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<td>HPLC with UV-Vis and Fluorescent detectors, Agilent 1200</td>
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<td>UHPLC w/Bruker Microtof-Q II HR Mass Spectrometer</td>
<td>2011</td>
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<tr>
<td>UHPLC w/ Bruker Amazon SL Mass Spectrometer-MS^n (NMS-MRI Grant)</td>
<td>2011</td>
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<tr>
<td>Microwave Digester, CEM</td>
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<td>FT-IR with ATR Accessory, Nicolet 6700</td>
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<td>Freeze Dryers (2) Labconco</td>
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<td>E2 Potentiostats w/ C3 Cell Stands (4)</td>
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<tr>
<td>600 MHz NMR Spectrometer, Bruker (NSF-MRI Grant)</td>
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<td>400 MHz NMR Spectrometer, Bruker (NC-Biotech Grant)</td>
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Differential Scanning Calorimeter (NC-Biotech Grant) 2009
Isothermal Titration Calorimeter (NC-Biotech Grant) 2009
ICP-OES, Perkin Elmer Optima 2100 2008
Fluorometer, Turner Designs Trilogy 2008
-80 Freezer 2007
Chirascan Circular Dichroism (Applied Photophysics) 2007
JY Horiba Fluorolog-3 Spectrofluorometer (NIH Grant) 2007
GC/MS Varian Saturn 3800/2200 (NC Biotech Grant) 2005
PQS Quantum Cube linux cluster with PQS and Gaussian 03 software 2004
JY Fluoromax-3 3D Spectrofluorometer 2001
FT-IR, ThermoNicolet IR-1000 2001
SLM Spectrofluorometer Aminco T-format 2000
JY Spectrofluorometer, Stopped flow 2000
Solar Simulator, Spectral Energy 1999
Monochromatic irradiation System, Spectral Energy 1999
UV-Vis Spectrophotometer, Pharmacea 1998
Polarimeter 1997
Salinometer, portable 1996
HPLC Agilent 1100 (3) with VWD and DAD detectors (NSF grant) 1996
Gas Chromatographs with autosamplers Agilent 5890 (3) (NSF Grant) 1996

7. Personnel

Curriculum vitae for the faculty members in the chemistry department are located in Appendix I to this document. In addition to the tenure-track faculty members, the department employs three full time PhD level lecturers, one full-time non-tenure track general chemistry laboratory manager, one full-time non-tenure track organic chemistry laboratory manager, one full-time non-tenure track instrument tech and one full time non-tenure track faculty to oversee the MS NMR facility. The department employs a fulltime coordinator for the distance education
program who, in addition to teaching traditional courses, is also responsible for overseeing all aspects of the DE program. There is also currently one postdoctoral fellow involved in the teaching and research missions of the department. In addition, there are three staff members employed by the chemistry department.

8. Graduate Students

Admission Criteria

Admission to the Chemistry Master of Science graduate program requires a bachelor’s degree with a concentration in chemistry or a related science from an accredited college or university. It also requires a B or better average on chemistry courses, three letters of recommendation, and acceptable scores on the GRE (verbal, quantitative and analytical sections). Other factors considered in admissions decisions include grade improvement in later work, and research experience or employment. Occasionally, students with low GPA or GRE scores are accepted provisionally (or as non-degree seeking students) and are required to prove that they can succeed in our program by earning a B or better on all graduate course work taken during their first semester or year.

One of the strengths of our program is providing a path for students with a bachelor’s degree in a related science, such as biology or environmental science, to earn a Masters of Science in Chemistry after making up required undergraduate chemistry deficiencies. Usually the students take the undergraduate deficiency courses within the first year of their degree-seeking status, and go on to perform extremely well in our program.

Recruiting
Our graduate program web site describes our program and has links to individual faculty web pages and to the Graduate School for direct access to application materials. We also have brochures and a departmental poster describing our program that is mailed out upon request. Our distance program began recruiting by contacting various chemical companies by phone, email and site visits. Today, current distance students are our best recruiters for new students.

Our recruiting and admissions processes are objective with the intent to draw highly qualified students into our program. If a qualified student applies from a minority institution, or indicates minority status on the application, every effort is made to find complete funding for that student, including an assistantship and full tuition support. Every minority student is carefully mentored, as are all our students in this department. Our Department agrees strongly with the UNCW diversity mission to “foster a campus climate of inclusion.” We also strongly agree with the recommendation to “Increase funding for diverse and international student scholarships” especially as it applies to graduate students.

**Advising**

The graduate coordinator initiates student advising as the student is deciding whether to join our program, through e-mail, phone conversations or formal letters. The graduate coordinator also serves as the student’s first official advisor, as the student enters the program. When a student decides on a research area and mentor, the research mentor then becomes the student’s official advisor. Students are provided with an orientation session prior to their first TA assignment or class meeting as well as weekly meetings with faculty responsible for the courses the student is assigned to TA. For the distance program, the distance graduate
coordinator serves as the primary academic advisor throughout the process from recruiting through graduation.

All full time students also enroll in “Introduction to Research” (CHM 501) during their first year. This course serves to inform students of the program requirements and provides them with the appropriate time lines and forms for the various requirements. During this time, the student selects a thesis committee, which also provides the student with advising and mentoring. Through this extended advising network, every effort is made to help students remain in good academic standing and move steadily towards thesis defense and graduation.

Student Support

Inadequate student support is a major barrier in attracting top graduate students. This is one area that is perennially noted as needing improvement during our annual departmental assessment of the graduate program. The Department receives funds for 13 Graduate Teaching Assistantships (GTAs) from the Graduate School each year, which are split between first and second year students. The GTA stipend is $11,000 for the academic year. Additionally, some students are funded by research assistantships provided by faculty with research grants.

Tuition support is provided for several full time students through a combination of scholarships, tuition awards and out-of-state tuition remissions. The Graduate School allocates 4 out-of-state tuition remissions per year to the Department. This year, the Graduate School provided tuition scholarship funding, which was used to award 2 new full time students with tuition and fee support for the fall 2014 semester. A new Scholar Award ($1000), provided by the Graduate School, provides 1 new full time student with some tuition support for the academic year. Additionally, the Chemistry Department awards a Wright Fellowship, a Lewis Nance Fellowship, and a DeLoach Fellowship to outstanding new graduate students.
Summer financial support has been provided to some full time graduate students through a combination of teaching and research assistantships. For the summer of 2013, 14 full time students were provided with teaching assistantships to teach the summer general chemistry and organic labs. Graduate students also receive support for travel to professional meetings to present their research. Last year several students were awarded travel grants from the Graduate School to attend and present their research at the local American Chemical Society meeting. Departmental support of graduate students also includes providing each full time student with an office and access to computers, either directly in their office or in the department’s computer lab.

**Teaching Assistants**

The employment of graduate teaching assistants is well-established practice in the Chemistry Department and is carefully monitored. Chemistry Graduate Teaching Assistants (GTAs) are assigned to teach laboratory sections, assist in laboratory preparations, grade papers, or conduct help sessions. GTAs do not individually conduct classroom instruction. Our graduate teaching assistants are very highly rated by students on anonymous evaluations filled out by the undergraduates and provide faculty with valuable assistance. Most GTAs truly enjoy teaching the labs and find that they learn the chemistry much more thoroughly when they have to teach it to students.

Introductory Chemistry GTAs are supervised by the general chemistry laboratory coordinator and the Chemistry faculty responsible for the course but do not assign final grades or credit. These GTA’s have an orientation with the laboratory coordinator and graduate coordinator at the beginning of every semester. After this orientation GTA’s meet weekly with the faculty responsible for supervision of a particular course in addition to the laboratory coordinator to go over the upcoming weeks laboratory. Student evaluations are collected at the end of every
semester and results evaluated by the graduate coordinator, laboratory coordinator and chair. The evaluations are then disseminated to individual GTA’s and problem areas addressed where necessary.

Some of our graduate teaching assistants for Organic and Quantitative Analysis laboratories do have primary responsibility for teaching a laboratory section for credit and for assigning final grades with close faculty supervision. These are all second year graduate students who have completed the majority of their coursework. Many of our upper level laboratory courses are assigned GTAs to help with laboratory preparation, help students with questions and with operation of instruments during the lab and assist with grading. Graduate students benefit not only from the teaching experience, but from gaining expertise on our instruments.

Needs

The most substantial and pressing need within the chemistry graduate program in addition to research space described above is the lack of competitive student funding. To address this, we have proposed the establishment of an equitable revenue sharing agreement for the funds generated by the distance education program. The agreement must be crafted in such a way that it allows long-term planning and does not need to be completely re-negotiated each time a new university administration is put into place. Currently, the lack of such an agreement threatens the viability of the entire distance program with some faculty proposing that we discontinue the program. The funds distributed need to be substantial commensurate with the significant investment of departmental resources by both the faculty and administrative staff. Without such an agreement the future success of both the resident and distance graduate program is in doubt.
Section 8: Affirmative Action

The Department of Chemistry and Biochemistry, in accordance with University policy, is committed to building diversity among faculty, students and staff. Recruiting for all faculty is done at an international level and every effort is made to invite members of minority or underrepresented groups to apply, interview and join our department when appropriate. The affirmative action statement and the University statement on diversity can be found below. Based on these criteria the Department of Chemistry and Biochemistry has a very diverse faculty (ca. 40%) from nine different countries representing a variety of under represented groups.

COMMITMENT TO EQUAL EDUCATION AND EMPLOYMENT OPPORTUNITY

[41 CFR 60-2.10]

The University of North Carolina Wilmington is committed to and will provide equality of educational and employment opportunity for all persons regardless of race, sex (such as gender, marital status, and pregnancy), age, color, national origin (including ethnicity), creed, religion, disability, sexual orientation, political affiliation, veteran status, or relationship to other university constituents -- except where sex, age, or ability represent bona fide educational or occupational qualifications or where marital status is a statutorily established eligibility criterion for State funded employee benefit programs.

This affirmation is published in accordance with 41 CFR Part 60 and is implemented in accordance with Title VII and Title IX of the Civil Rights Act of 1964, as amended; Executive Order 11246; the Rehabilitation Act of 1973; the Vietnam Era Veterans' Readjustment Assistance Act of 1974; the Civil Rights Restoration Act of 1988; and NC General Statutes Chapters 116 and 126.
To ensure that equal educational and employment opportunity exists throughout the university, a results-oriented equal opportunity/affirmative action program has been implemented to overcome the effects of past discrimination and to eliminate any artificial barriers to educational or employment opportunities for all qualified individuals that may exist in any of our programs. The University of North Carolina Wilmington is committed to this program and is aware that with its implementation, positive benefits will be received from the greater utilization and development of previously under-utilized human resources.

**STATEMENT ON DIVERSITY IN THE UNIVERSITY COMMUNITY**

As an institution of higher learning, the University of North Carolina Wilmington represents a rich diversity of human beings among its faculty, staff, and students and is committed to maintaining a campus environment that values that diversity. The university aims to achieve, within all areas of the university community, a diverse student body, faculty, and staff capable of providing for excellence in the education of its students and for the enrichment of the university community. The university defines diversity in the following ways: 1) The representation of populations shaped by historical circumstances and by cultural identities, or a combination of the two; 2) The representation of populations shaped by varying socio-economic circumstances.

**UNLAWFUL HARASSMENT, DISCRIMINATION, AND RETALIATION**

The University of North Carolina Wilmington affirms that students and employees are entitled to an educational and employment environment free from unlawful harassment or discrimination based on that individual’s race, sex (such as gender, marital status, and
pregnancy), age, color, national origin (including ethnicity), creed, religion, disability, sexual orientation, political affiliation, veteran status, or relationship to other university constituents, and expressly prohibits unlawful harassment or discrimination of any individual among the university community engaged in educational or employment pursuits. Further, no student or employee shall be subject to retaliation for bringing a good faith complaint pertaining to unlawful harassment or discrimination or for protesting such behavior directed against another member of the university community.

For more information concerning ways in which our multicultural learning community may be nurtured and protected or complaint resolution procedures, contact the Office of Campus Diversity, the Office of the Dean of Students, the Office of Academic Affairs, or Human Resources.

9. Summary of research and scholarship of the Chemistry and Biochemistry Department

A. Summary statement

The highlights of the departments’ research and scholarly activity during the preceding seven years, determined by a variety of diverse metrics, is summarized below.

B. Publications

Copies of abbreviated faculty members’ vitae including lists of publications during the preceding five years are included in Appendix I. The chemistry faculty has an impressive publication record during the preceding 7 years. There are on average more than 50 publications per year in the department that translates into an average of 2-3 publications per research active
faculty per year. Many of these publications appear in the most prestigious journals in the field foremost of which are publications of the American Chemical Society that is the largest professional scientific body in the world. In addition, several faculty members have distinguished themselves by publishing in top-flight specialty journals such as *Limnology and Oceanography*, *Atmospheric Chemistry and Physics*, *Marine Chemistry* and *Global Biogeochemical Cycles*, *Organic Letters*, *Biochemistry*, *Inorganic Chemistry* and *Analytical Chemistry*. The impact of the chemistry department is not limited to journal articles, as the department has also published a variety of reports, abstracts, books, book chapters and instructor’s manuals. The breadth and scope of this corpus of scholarly activity is a testament to the high caliber of research conducted by our faculty and graduate students.

C. Funded Projects

The funding received by the chemistry department has been broad-based and spread over several research areas including marine/environmental chemistry, chemical education, theoretical chemistry, biochemistry, analytical chemistry and inorganic chemistry. This wide spectrum of funding indicates both the breadth and depth of our interdisciplinary research programs. Funding has been fairly evenly spread among faculty ranks (assistant, associate, and full professors). In addition, grants have been obtained from a wide array of funding sources including both federal and state agencies. Many of these awards have come from the most competitive programs in the country including, but not limited to, the National Science Foundation, the National Institutes of Health, the Strategic Environmental Research and Development Program (SERDP), the Henry Dreyfus foundation and Research Corporation all of which typically have very low funding success rates.
There rate of external funding awarded to the department since the last review in 2007 has remained fairly constant (Figure 1). There is tremendous variability in the yearly-awarded amount consistent with what is observed at universities nationwide. The total funding level remained essentially unchanged from 2007-2012 despite significantly decreasing success rates for obtaining federal funds, especially for NIH awards (Figure 2). This achievement is even more impressive considering that most faculty who received external grants also teach 3 courses per semester (unless they have other administrative responsibilities) and almost all research is conducted by undergraduate and Masters level students.

Figure 1. Grant dollar amount obtained by the chemistry faculty as a function of year
Figure 2. Success rate of federal funding agencies as a function of year.

D. Presentations at refereed conferences

Chemistry faculty have been extremely active in the presentation of their research findings during the preceding five years. The department averages over 45 presentations per year the vast majority of which have graduate students as co-authors. These presentations were made primarily at national or international meetings such as the American Chemical Society, American Society of Limnology and Oceanography, American Geophysical Union, Goldschmidt and an array of Gordon Conferences in various sub disciplines represented by the department. Many of our faculty members are enthusiastically sought by various professional bodies to present their research. This is evidenced by the relatively large percentage of invited presentations given by our faculty and is a further testament to the high regard their research is given by the outside scientific community.

E/F. Leadership roles/Honors and awards
The chemistry department faculty plays leadership roles in their discipline through a variety of different activities. Several faculty are also associate editors for different scientific journals. Our faculty also plays leadership roles through their presence on a variety of review panels for federal granting agencies such as the National Science Foundation. Because of our strong reputation in the chemical education community, several of our faculty have also been asked to play leadership roles several times during projects such as the General Chemistry Exam Committee of the Examinations Institute of the American Chemical Society and the NC Institute of Chemists Students Awards Committee. Our faculty has also been recognized for their achievements in chemistry through several awards such as Camille and Henry Dreyfus Scholar and Honorary faculty member status in the Phi Eta Sigma national honor society. Faculty have also received a Fulbright award and the Board of Governors award for excellence in teaching given annually to one outstanding faculty in the UNC system. Recent awards include Brooks Avery, UNCW distinguished Scholar award, 2014; S. Varadarajan, distinguished professorship award 2013; Paulo Almeida Distinguished faculty Scholar Award, 2012; Mike Messina UNC Board of Governors Teaching Excellence Award, 2012.

G. Community service related to program goals

The chemistry department is committed to community outreach in our local region. Faculty provides exemplary community related service to southeastern North Carolina consistent with the mission of the university and the department. Many of the projects conducted by chemistry faculty are good examples of science in service to the community. These have included television dialogues with nationally syndicated America Now and three interviews with the local TV stations WECT and WWAY. Faculty have also provided interviews about their
research to the Wilmington Star News daily newspaper and the local public radio station WHQR science Friday series. Faculty have also performed much public outreach service, including several presentations to UNCW College Day, Bald Head Island and serving as science fair judges (Chemistry Olympiad, Ocean Bowl, Regional Science fair) and conduct other program evaluations for several non-profit organizations. The department has also participated in a variety of outreach activities to summer science camp programs including a series of six chemistry camps developed and hosted each summer by the chemistry department. The graduate students play a central role in these camps in the development and publicity during the academic year and as counselors during the summer. The distance program also enables people working full-time to take advantage of our courses and increases the name recognition of UNCW.

10. **SWOT analysis (Strengths Weaknesses Opportunities and Threats)**

**STRENGTHS**

1. The UNCW Department of Chemistry and Biochemistry is routinely in the top 5% of graduate programs in the number of MS degrees awarded.

2. Our graduate program has a high faculty to student ratio that allows for close supervision and interaction of students by faculty in their research. The student and faculty interactions are generally very collegial which provides the necessary atmosphere for the free exchange of new thoughts and ideas. The results of this close supervision of students by faculty are graduates who are well trained and highly sought after by both Ph.D. institutions and industry.

3. We offer graduate students a diversity of research areas from which to choose within the traditional bounds of chemistry as well as several non-traditional research programs. The
research focus areas include atmospheric and marine chemistry, biochemistry, modeling, inorganic and organic synthesis, organometallic chemistry, analytical and chemical education. We also offer the only thesis based Masters’ program in the country that is delivered by distance education. The Department of Chemistry and Biochemistry seeks to maintain these research strengths and industry collaborations by encouraging and valuing the research productivity of its faculty and students.

4. Because of the interdisciplinary nature of several research areas in our chemistry graduate program, we enroll many students who have varied undergraduate backgrounds. Approximately 30% of our full time graduate students do not have traditional undergraduate degrees (BS/BA) in chemistry. Most of these come from marine or environmental science backgrounds. We provide these students the opportunity to pursue their non-traditional chemistry interests in our department by working individually with each student to design a course plan whereby most of their undergraduate deficiencies in chemistry are made up during their graduate studies.

5. The vast majority (> 90%) of our master’s theses result in at least one publication in a top-flight journal (several students’ theses have resulted in two or more publications). The participation of master’s level students in high-quality, state-of the-art publishable research is a real strength of our program and has served to attract and retain highly qualified faculty and students.

6. Each graduate student is provided a desk directly adjacent to the primary research laboratory. Students with an interest in marine science also have access to the Center for Marine Science (CMS) research facility.

7. Many undergraduates work closely with graduate students in the research lab. This gives
graduate students invaluable experience mentoring young scientists in a leadership role that makes them highly sought after by both Ph.D. institutions and industry.

WEAKNESSES

1. Inadequate student support is a major barrier in attracting top graduate students. This is one area that is perennially noted as needing improvement during our annual departmental assessment of the graduate program.

2. We do not have an adequate well defined budget for the allocation of tuition revenues generated by our DE MS program which is used to help support all of our MS students. Our share of the tuition revenue has been declining each year even as tuition costs for both instate and out of state students have increased dramatically.

3. There is no long term commitment for the University to our distance education program.

4. The quality of some of our graduate students is not as high as we would like. This is primarily because the dollar amount of teaching assistantships are inadequate to attract and retain superior students if they are free to go elsewhere where much more lucrative packages await them at comparable master’s level institutions. The limited number of tuition remissions and tuition scholarships also means we will remain predominately an in-state and homegrown program which reduces student diversity.

5. Although we have made significant gains in garnering external support for our research, our graduate program is hampered by inadequate state funds that are often depleted months before the end of the fiscal year. The chemistry faculty needs to continue to generate external funding to support research, including graduate student support for salaries and tuition. Until our external support grows the number of TA’s and tuition
support supplied by the state will limit graduate students enrolled in our program.

6. We are out of both office and research space for graduate students. Dobo hall was built with a capacity for 24 graduate students, however we currently have 44 resident full time Masters Students. The overflow is often housed in the back of research labs, which is not ideal space.

7. The University lacks an adequate plan for replacement of aging scientific equipment, which may prevent some graduate students from consistently having access to the equipment needed to complete their research programs.

OPPORTUNITIES

1. The University can improve funding and long term commitment to chemistry MS program

2. The University administration in collaboration with the department administrators must come up with an equitable distribution of tuition revenue generated by the distance program that increases as tuition costs rise and does not change as university administrations change.

3. The university must implement an executable plan of action which factors into the faculty workload time spent supervising graduate students including the generation of thesis hour credit. Implicit in the faculty workload re-evaluation is the hire of additional faculty that would reduce teaching loads and assist in the mentoring of increasing graduate student populations.

4.
5. University can expand upon the new program begun last year whereby there is a systematic upgrading and replacement of scientific equipment similar to what is already being done for computing needs on campus.

6. Chemistry department can work with the graduate school and graduate dean to increase both the number and dollar amounts of departmental TA’s and tuition support. Continue to encourage additional sources of graduate support through tuition scholarships and fellowships. The Graduate School must recognize that chemistry students are in high demand nationwide, and stipends at UNCW must become more competitive.

7. Department will encourage faculty to submit proposals which include both salary and tuition support for graduate students.

8. The University must develop a plan, in collaboration with the department, whereby more space is allocated to research faculty and their graduate students in Dobo Hall. In the long term the department and University should plan for and construct a new science building.

**THREATS**

The continued success of the graduate program in the present culture of declining state appropriations and increased competition for external funding is dependent on a fair and equitable distribution of the tuition revenues generated by our DE program. These funds help support the resident program including TAs, RAs, local student tuition, as well as a host of other needs no longer met by state resources. If sufficient funds are not provided we will no longer be able to continue to offer the DE program. This will have a ripple effect throughout the department and university including fewer and lower quality
resident graduate students, reduced faculty and student research productivity, fewer peer reviewed publications, reduced external grant submissions and significant decreases in indirect costs generation.