**Metrics Report: Chemistry**

## I. Program Overview

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A. Department Profile (faculty, students, curriculum)
B. Coordination / Cooperation / Collaborative Relationships

In June 1919 Dr. James Samuel Guy, newly-appointed Professor of Chemistry, loaded all the existing equipment and supplies of Oxford College's Chemistry Department into his car. [1] His destination: a two-story building, on Atlanta's new Emory campus, that would share facilities with the School of Medicine for the next three decades. In 1974, a new Chemistry Building (now Atwood Hall) included room for the James Samuel Guy Chemistry Library. Major building renovations followed in the 1990s; later construction of adjacent Emerson Hall relocated the Cherry L. Emerson Center for Scientific Computation, which had occupied part of the library's footprint since 1991. It is thus no surprise that *interdisciplinary* not only describes current Department research but also provides historical perspective to the space it occupies.

Until 1924, Dr. Guy single-handedly taught all chemistry courses needed for a full chemistry major. Teaching assistants then began supporting the department's three faculty members, who taught 18 graduate students and high school teachers working on their M.A. degrees in chemistry. In 1930, of 181 students enrolled in Emory's Graduate School, 16 were in chemistry. Although no chemistry Ph.D. degrees were granted, Emory "ranked in the upper 5% of nationally accredited universities in the fraction of its chemistry majors who went on to obtain Ph.D.s at other schools" (Frytten Report). In 1924 the *Emory Wheel* noted, "It is recognized throughout the South that Emory offers one of the best courses in chemistry to be found."

An early legacy of excellence and strength is the foundation on which the current Emory Chemistry Department builds its reputation for outstanding teaching and research. In FY 2004 the University led all Georgia research institutions in external research funding; Chemistry, with $8.4 million, was the most-funded department of Emory College (*Emory Report*, 10/18/2004).

[1]: Based on *Emory University, 1915-1965: a Semicentennial History* by Thomas H. English, Higgins-McArthur Co., Atlanta, GA, 1966.]

### Faculty, Lecturers, Senior Research Staff

The department has 22 full-time tenure-track chemistry faculty (15 Professors, 3 Associate Professors, 4 Assistant Professors). There are 4 tenure-track faculty joint appointments (2 Professors with the Biochemistry Department, 1 Associate Professor with the Department of Biomedical Engineering, and 1 Professor with the School of Public Health -- Environmental & Occupational Health). The department has a staff of 7 full-time non-tenure-track lecturers (6 Ph.D.s and 1 M.S.). Among the current research and teaching faculty there are 6 named chair professorships and 2 emeriti professors.

Five specialized research centers supported by 8 Ph.D.s are housed within the Chemistry Department:

- The *Emerson Center for Scientific Computation* conducts major research and provides high-performance computing and scientific software for the Emory community. The Center's Director is Professor Keiji Morokuma (AAAS Fellow ranked among the "Top 50 Most-Cited Researchers in Chemistry"). Two full-time Ph.D.s serve as Principal Scientist/Manager and Associate

Scientist/Systems Manager. The Center's focus on theoretical and computational chemistry, catalysis, and nanotechnology, and the molecular modeling software and methods that support these areas, has fueled collection development in these subjects since the early 1990s. Dr. Morokuma frequently requests monographs, serials, electronic databases, and major treatises.

- The *Mass Spectrometry Center* provides "mass spec" services for the University, including high-resolution Electron Impact (EI) and high-resolution Fast Atom Bombardment (FAB) to confirm elemental composition. The Center is managed by a full-time Ph.D. In the late 1980s and early 1990s the library made major serials and electronic purchases to improve the core collection in mass spectrometry; when faculty relocated and the Analytical Chemistry department was formally dissolved, emphasis shifted to other areas, although monographs in mass spectrometry applications and methodology are still purchased.
- The *Nuclear Magnetic Resonance Spectroscopy Research Facility* provides extensive state-of-the-art facilities in NMR. A Ph.D. Director and a Ph.D. Senior Research Specialist provide full-time expertise. NMR is fundamental to all areas of chemical research at Emory and is a major focus of the collection (although NMR in clinical applications, *e.g.* magnetic resonance imaging in medicine, is outside the scope of Chemistry's holdings).
- A full-time Ph.D. Director and a full-time Ph.D. Electron Microtechnologist staff the *Integrated Microscopy and Microanalytical Facility*, which provides comprehensive microscopy services for Emory's College of Arts and Sciences, the Winship Cancer Center, and the School of Medicine.
- In the *X-ray Crystallography Center* a full-time Ph.D. provides a variety of X-ray facilities to support research conducted primarily by the Emory Chemistry Department. Crystallography monographs are regularly purchased, and the Department administers local access to the Cambridge Crystallographic Database.

## Graduate Students and Curriculum

Emory's chemistry graduate program includes approximately 120 grad students; on average, about 30 join each year, although for 2003-2004 more than 40 were admitted. The grad student body is evenly split by gender, from 23 states and a dozen foreign countries. All admitted students receive stipend support as teaching or research assistants and a full tuition scholarship (some special fellowships are available). Emory's Ph.D. grads hold distinguished faculty positions throughout the U.S. and several foreign countries and are also well-represented in chemical industry. Each fall 12-15 chemical companies send representatives (usually Emory Ph.D. chemists) to interview senior graduate students for Ph.D.-level employment. Graduates are in high demand because of the strength of the research and educational programs.

## Graduate Degree Requirements

- ***Research Group:*** In fall 2002, a 20-week research rotation program (Chem 504) was introduced for first-year grad students to help them make more informed decisions regarding research advisor selections through first-hand experience in the research culture and mentoring styles of different laboratories. Collaboration is encouraged between labs and some students begin working with two research advisors, although historically 95% of students join their first-choice group. Attendance is required at all seminars/student seminars/journal club activities presented in the division and all group seminar activities during the rotation.
- ***Courses:*** Full-time Ph.D. students must take 9 courses (5 or 6 in the first year and special topics during years 2-3); some may be taken in other science departments, including biochemistry and biological sciences, physics, and mathematics and computer science. Students who enter with a masters degree must take only 4 courses for the Ph.D. A one-credit library course (Chem 597) -- three days of lecture in August and a directed research project second semester of the first year -- is required. A three-day ethics course is given at the beginning of the second year.

- ***Teaching:*** As part of Emory's TATTO graduate teaching program, students usually teach one undergraduate lab or lecture course during one semester of their second year, which requires no more than 10 hours per week.
- ***Cumulative Examinations:*** During the first few years, cumulative exams test students' knowledge of current chemical literature and general problem-solving abilities in their general area (biological, inorganic, organic, and physical). This requirement must be completed by the middle of the third year (most students need only two years).
- ***Qualifying Examination:*** In fall semester of the second year, each graduate student prepares a research report and presents their research progress to a committee of three faculty members in the student's general research area. Satisfactory completion of the exam endorses the graduate student as a Ph.D. candidate. One novel aspect of Emory's chemistry graduate program is that this committee meets with the student at least once per year to ensure good progress in research and in intellectual and career development; demonstrating growth to additional faculty is helpful for cultivating future letters of recommendation.
- ***Seminar:*** Each student is expected to attend all seminars in their research area. Emory's proximity to Hartsfield-Jackson Airport allows the department to host several visiting lecturers each week, including the Cherry Emerson Seminar series. Each student also presents at least one "current literature" seminar.
- ***Dissertation:*** Most Emory chemistry grad students complete requirements within 4 to 5 years of admission. Dissertations are defended in a public seminar and in a private session with faculty.

**Undergraduate Students**

The undergraduate chemistry program is one of the 25 largest undergraduate programs in the U.S. The department awards approximately 50 degrees each year. After graduation, many undergrads continue their education in chemistry; attend graduate school, medical school, or other professional schools; or find careers in industry, government, or education.

**Undergraduate Degree Requirements**
(http://www.emory.edu/CHEMISTRY/undergrad/descriptions.html)

- ***Chemistry Major:*** The department offers Bachelor of Science (B.S.) and Bachelor of Arts (B.A.) degrees; a B.A. or B.S. with honors; an American Chemical Society (ACS) certified B.S. degree (higher level electives); and a B.S./M.S. degree (14 graduate-level course hours). Courses are offered in general (1 year), organic (1 year), analytical (1 semester), and physical chemistry (one semester for B.A., two for B.S.). The Biochemistry Department offers graduate biochemistry courses to undergrads. Students with a 3.50 or greater GPA can take one additional graduate course, complete a research project, and write and defend an honors thesis.
- ***Mathematics:*** Calculus required (one semester for Chem B.A., two for B.S.). Additional courses in multivariable calculus, differential equations, and computer science are encouraged.
- ***Physics:*** One year required; an additional calculus-based sequence is encouraged.
- ***Elective Courses:*** **B.A.:** eight hours of elective chemistry courses required, 230 level or higher and **not** research. **B.S.:** two 300-400 level courses, plus four 230 level credit hours.
- ***Joint Degree with Georgia Tech:*** It is possible to obtain a joint, liberal arts/engineering degree with Georgia Institute of Technology after the third year at Emory.

**Undergraduate Research**
The Department encourages its majors to acquire essential laboratory experience; a minimum of eight hours per week is expected for voluntary, progressive research (more time if taken for credit), usually supervised by a grad student or postdoctoral fellow.

**Undergraduate Summer Research**

The **SURE** (**S**ummer **U**ndergraduate **R**esearch at **E**mory) Program allows undergrads to collaborate with a faculty mentor in an independent, supervised research project. Components include training in research methods, analysis of data, ethics discussion, and emphasis on oral and written presentations culminating in a formal research symposium. Stipends are paid for student work.

**Undergraduate Research beyond Emory**
Juniors are encouraged to consider research opportunities sponsored by the National Science Foundation and to search for internships, fellowships, or summer work opportunities in chemistry through the database **EPIC** (**E**xperimental **P**rograms **I**n **C**hemistry).

**Undergraduate Study Abroad**
A summer study abroad program was initiated in 2003/2004 between the Chemistry Department and the University of Siena, Italy, for students with 3.00 GPA or better (minimum 8 course credits).

**Undergraduate Opportunities in Teaching, Tutoring and Mentoring**
Students interested in working as a teaching assistant for a course apply with the faculty member. Emory College Academic Support sponsors free tutoring services; students who have maintained an A/B in the tutored course and communicate effectively are employed. A mentoring program is offered for general and organic chemistry students; paid student mentors meet with faculty weekly and oversee undergraduates in 60- to 90-minute problem-solving sessions.

**Undergraduate Seminar Series**
Each semester three or four speakers present topics of interest to students in evening seminars. Examples of past topics: Everything you always wanted to know about chemistry graduate school; Why study the history of chemistry (1789-1930)?; Non-traditional careers for scientists: writer, journalist, publisher; ABCs of nanotechnology: atoms, bits, and civilization; From the laboratory to the marketplace; A trip through molecular space: visualizing molecules.

**Other Undergraduate Initiatives**
**SPICE** (**S**cience **P**ortal at **I**mperial **C**ollege London and **E**mory University): Collaborative development of an educational website centered on various topics of modern chemistry. Students present and discuss topics; papers are peer-reviewed, finalized, and posted. Web pages are evaluated on scientific content, writing quality, creativity, presentation effectiveness, and participation in collaborative peer review and revision. The program's long-term intent is to establish a more permanent student exchange program between the schools and to allow chemistry students to study abroad at each institution.

**ChEmory** (Undergraduate Chemistry Club @ Emory University)
As the local ACS Student Affiliate, ChEmory's mission is to increase awareness and interest in chemistry at Emory by providing a forum for extracurricular chemistry and science-related activities and to facilitate interaction between faculty and students. Along with Pi Alpha, the Chemistry graduate "fraternity," National Chemistry Week (sponsored by the ACS) is celebrated each year, as is National Mole Day (October 23, i.e. $10^{23}$, a reference to Avogadro's number and the chemical "mole").

In addition, the Chemistry Department has locally coordinated the Science Olympiad for several years.

Discussions have begun with other GETS-M consortium members regarding exploration of shared new electronic resources and the possible sharing of serials storage space.

## II. Description of Material Collected

A. Scope of the Collection

1. Subject Areas

Areas of research specialization within the Chemistry Department are broadly categorized as: analytical, bioinorganic, bioorganic, biophysical, environmental, experimental chemical physics, materials, medicinal, neurochemistry, organometallic, synthetic organic, theoretical/computational, and innovations in education. The interdisciplinary examples show that Chemistry is no longer "just QD"; consider the previously noted connections between university research centers and Chemistry's most recent tenure-track research faculty position advertisements [to "complement our recent growth at the interface of chemistry and biology… and in materials chemistry"]. Emory's science liaisons discuss collection issues within the Science Market Council; the need for increased collaboration with the Health Sciences Library is being addressed.

A "circulation snapshot" taken mid-October 2003 (following the transfer of all Woodruff circulating QD items to Chemistry) shows the continued interest in Chemistry Library books classed in physics, biology, narrow subclasses of physiology, and chemical technology (TP):

| | | Items circulating | | |
|---|---|---|---|---|
| **LC Class** | **Subject Group** | **Gen** | **Chem** | **Total** |
| Q | Science (General) | 266 | 4 | 270 |
| QA | Mathematics | 1159 | 16 | 1175 |
| QB | Astronomy | 92 | 0 | 92 |
| QC | Physics | 416 | 98 | 514 |
| QD | Chemistry | 0 | 909 | 909 |
| QE | Geology | 56 | 0 | 56 |
| QH | Natural history - Biology | 366 | 31 | 397 |
| QK | Botany | 88 | 2 | 90 |
| QL | Zoology | 380 | 0 | 380 |
| QM | Human anatomy | 9 | 0 | 9 |
| QP | Physiology | 181 | 112 | 293 |
| QR | Microbiology | 14 | 0 | 14 |
| R-RZ | Medicine | 791 | 20 | 811 |
| S-SK | Agriculture | 114 | 0 | 114 |
| T-TX | Technology | 483 | 66 | 549 |
| | Totals | 4415 | 1258 | 5673 |

Analysis of all monograph and Reference book orders initiated by Chemistry shows that "non-QD" books accounted for 40% of 1,993 volumes (37% of cost) from 1993-1999, and 44% of 521 volumes (43% of cost) between 2002-2004. The brief glimpse of circulating Chemistry books above shows that 28% are non-QD. *Physics* subareas of interest include (but are not confined to) atomic physics and constitution of matter (QC170-197); thermodynamics (QC311); atmospheric chemistry (QC861.2, QC879.6); spectra of specific substances (QC450-467) and the radiative/magnetic methods (IR, Mossbauer, NMR, lasers, etc.) that produce them (QC490-492; QC688-689.5; QC762). *Physiology* (QP) holdings focus on specific techniques of chromatography and spectroscopy used in animal biochemistry (QP519.7-519.9); proteins, amino acids, nucleic acids, peptides, etc. (QP551-552) and enzymes (QP601); and such topics as inorganic biochemistry, biochirality, metal-ligand interactions, and biomolecular modeling and recognition. A narrow collection in *Medicine* (areas in RM and RS involving drug design and medicinal, pharmaceutical, and combinatorial chemistry) has increased from 2% of volumes purchased in 1987-1989 to 7% in 1993-2004.

Class QD materials focus on general chemistry (9% of all volumes purchased 1993-2004; includes computational chemistry), analytical (7%), inorganic (3%; other specialty areas cover this field), organic (15-20%), physical and theoretical (17-21%), and crystallography (2-3%).

At times the direction of current Chemistry research tends to defy LC classification, thus the library has had to keep many collection "plates" spinning simultaneously.

2. Chronology

Primary collecting interest is in current research. Alchemy and pre-20th century historical chemical works have typically been received and shelved in Woodruff (QD or TP if chemical technology); Chemistry tends not to order reprints of classic (18th-19th century) texts, historical manuscripts, etc. but does purchase contemporary chemical biography. Old and rare works are generally priced outside the scope of our budget.

3. Language

English language monographs are collected. The Reference section has a number of multilingual chemical and technical dictionaries, although these have become less heavily used as English has become the preferred language of published chemistry (and since the consolidation of formerly entrenched European chemical society journals).

4. Date of Publication

Emphasis on current publications, although as faculty enter new research areas some retrospective purchases of monographs (1980s +) are made. In the 1980s-1990s several major back runs of print journals were acquired, but not recently.

5. Geographic Areas

Chemistry is not classed geographically; the majority of the collection is from the U.S. and Great Britain due to language. Some attention has recently been given to acquiring (at least electronically) access to Eastern European and Asian serials.

B. Formats and Publication Type

1. Monographs and Texts

Ordered through GOBI2 and by generating firm (white slip) orders using publisher's catalogs, review sources, and faculty recommendations. Few QD monographs are automatically received through the Yankee Approval Plan; basic textbooks are not sent (also see exclusions below). Moderate- and advanced-level monographs that might be classified as "texts" are often fundamental works in the area and are thus selected as appropriate. Many monographic series are received on standing order; during 2003-2004, fifteen titles were submitted.

2. Serials
3. Electronic Publications

Journal articles are the primary method of communication for research in chemistry. The library has a strong print serials collection that supports the department; Georgia Tech and Georgia State provide local access to serials in historically unsupported areas, *e.g.* applied chemistry and engineering and other areas of technology, or foreign-language (*e.g.* Russian) titles. Most new serial acquisitions are recommended by faculty in "non-QD" areas such as protein science, nanotechnology, materials science, and structural biology. Usage of established print journal titles has decreased significantly in recent years as electronic access (ScienceDirect, ACS Web Editions, Wiley-Interscience) has brought research to the desktop. The library has actively pursued the purchase of electronic backfiles and archives in standard (Royal Society of Chemistry Archive), fundamental interdisciplinary (American

Institute of Physics, American Physical Society PROLA), and expanding (Wiley-Interscience Polymer Backfile; Biotechnology, Biochemistry and Biophysics Backfile) research areas.

Current surveys address critical library space concerns and the role of print and e-journals in supporting the Department. Electronic books and major treatises (handbooks, encyclopedias) are thus becoming more attractive and have been identified as a priority (see "Next Steps").

Electronic access to *Chemical Abstracts*, the premier indexing tool in the field, is now provided by *SciFinder Scholar*; in the past, the Department often submitted search forms to the library for mediated online searching. Identifying chemistry-specific databases for subscription or one-time purchase continues.

4. Microforms

Not a priority, although microfilm options are being considered as part of the ongoing "space needs" project. Material supplementing ACS journal articles, formerly received on microfiche, became available on the Internet in 1999. As the print *Chemical Abstracts* is now less heavily used (see above), the subscription was converted to microfilm in 2004.

5. Multimedia

While audiovisuals have occasionally been considered, their expense and the lack of local hardware support discourages purchase. The Department has not asked the Library to purchase teaching aids for classes and, in fact, administers a multi-purpose computing lab (physically located, ironically, within the Library) that provides course-related access. The Emerson Center also provides the Department with molecular modeling and related software access.

6. Government Publications

Some data-oriented publications are occasionally received in Government Documents, but it's unclear how much the Chemistry Department uses them.

7. Exclusions

Every few years an effort is made to obtain recent editions of selected popular textbooks in fundamental areas (analytical, biochemistry, inorganic, organic, physical chemistry), but overall, undergraduate general chemistry and similar texts are avoided. Our budget does not allow purchasing conference proceedings to any comprehensive degree; in the 1980s and 1990s, plans to create standing orders for the various *NATO ASI* series (Plenum) were halted when prices escalated. Also, the *ACS Symposium Series* monographs, which cover areas outside our scope and thus were purchased selectively, have taken a back seat. Chemical engineering (besides chemical technology) is collected sparsely as Georgia Tech holdings are not far away, thus the lack of *Materials Research Society* and similar proceedings.