

CHEMISTRY

Chemists, biochemists, and chemical engineers have contributed in myriad ways to the development and utilization of the materials, medicines, foods, and fuels that are the hallmarks of modern life. They have also contributed greatly to the understanding and protection of the natural environment. Working in concert with biologists, geologists, physicists, psychologists and others, chemists continue to play leading roles in the search for solutions to many of society's most pressing problems, including challenges to physical and mental health, pollution and its effects, resource recovery, and energy production and conservation. The study of chemistry at Lawrence thus prepares students for a broad range of opportunities and careers, including academic or industrial research, engineering, secondary or college teaching, medical or veterinary practice, law, business, or public service.

The Lawrence chemistry department is large enough to ensure that all the major areas of chemistry are well represented, and small enough that students can build close working relationships with all the faculty members. The department's five faculty members are all actively engaged in their own research programs, and aspects of those programs find their way into their courses, as well. Thus students are likely to encounter new developments in nanoscience and nanotechnology, consider experimental conditions that will reduce the environmental impact of laboratory wastes, reflect on new approaches to disease control, or explore instrumental techniques applicable in drug synthesis or forensic laboratories. Our goal is to engage students from diverse backgrounds and interests in the excitement of chemistry; foster in them the habit of informed and critical thinking; involve them in independent learning and research; and prepare them for the successful pursuit of a wide variety of professional opportunities.

The chemistry **CURRICULUM**—approved by the Committee on Professional Training of the American Chemical Society (ACS)—is designed to help students develop a broad and solid understanding of chemical principles, facts and theory. All of the principal areas of chemistry are represented in the department's courses, at both introductory and advanced levels. In addition, courses or tutorials are available in several interdisciplinary or special interest areas, including nanoscience and forensic chemistry.

The department offers several major or minor programs:

- The **chemistry major** (including an ACS-certified major option) requires introductory sequences in chemistry, physics, and calculus, at least eight intermediate and advanced courses, and a seminar/capstone sequence.
- The **Interdisciplinary major in the Natural Sciences** with emphasis in chemistry requires introductory sequences in chemistry, physics and either biology or geology, ten additional courses chosen appropriately from the offerings of those four departments, and the seminar/ capstone sequence.
- The **chemistry minor** requires an introductory sequence in chemistry, at least five appropriately chosen intermediate or advanced courses, and parts of the seminar/ capstone sequence.
- A new **Biochemistry** major has been designed and should be put in place during the 2005-2006 academic year. It will require introductory courses in chemistry, biology, math and physics, some specific intermediate courses (*e.g.*, organic, biochemistry, molecular biology) plus electives chosen from a list of other courses in those four departments.
- Chemistry courses can be applied toward a major or minor in **Environmental Studies**, and some chemistry courses also count toward the interdisciplinary area in neuroscience.

Most students begin the study of chemistry at Lawrence through the two-term Principles of Chemistry sequence. Others, who are particularly well-prepared, begin with the one-term Accelerated General Chemistry course. It is also possible for students to begin in sophomore courses like Organic or Analytical Chemistry on the basis of Advanced Placement exam scores or a local placement examination. Because the chemistry department considers participation in **RESEARCH**

to be an essential part of learning chemistry, there is a program-wide emphasis on research and research skills, beginning with short projects in the introductory courses, building through longer and more complex projects in the intermediate courses, and culminating in one or more summer or academic year research projects carried out in collaboration with a faculty member. Students need not be seniors to do research. Students have been engaged in research as early as the summer after their freshman year, and some have spent three summers plus some academic terms doing research (either here or at other institutions) by the time they graduate. All students doing research projects present their results as talks or posters on campus. Many also present results at regional or national meetings of scientific societies, and some have coauthored papers appearing in scientific journals. Student research can also be the basis for an undergraduate "honors thesis" leading to Honors in Independent Study at graduation.

Each of the faculty members has ongoing research projects, and students are involved in essentially all of those. Some recent or current student projects are highlighted here.

Nicole Urbick '04 worked for several years with Professors Blackwell and Nordell and biology faculty, exploring the formation of chloroplasts in plant cells under different light exposure conditions. She earned Honors at Graduation *Magna cum Laude*.

Katie Maerzke '05 and **Denise Nelson '05** have also worked with Professor Blackwell on investigations of nonlinear dynamical models as applied to chemical systems.

Students working with Professor Hall have made several contributions to published work. **Katharine Chapman '04** was first author on a paper in *Biochemistry and Molecular Biology Education*, and **Mark Cronan '03** was a co-author on a paper in the *Journal of Immunology*.

Shashima Nakahara '05 and **Melanie Ufkin '06** both presented at the PEW Undergraduate Research Symposium in Chicago in fall, 2004. Shashima

described research on signal transduction pathways activated by rhinovirus, which result in the release of inflammatory mediators. She also defended her poster on the same subject at a Biochemistry conference in San Diego. Melanie examined the effects of nanoparticle exposure on immune cells, and used electron microscopy to visualize nanoparticles that are part of a biological sensor. She defended a poster at the AAAS/Merck undergraduate poster competition in Washington, D.C. **Elizabeth Freeman '05** carried on a study of the effects of parthenolide (isolated from the herb feverfew) on immune cells, while **Dana Raugi '06** analyzed patient samples collected in a collaborative study with University of Wisconsin-Madison scientists; that study's aim was to discover the effect of common cold infection on asthmatics and how those effects might be attenuated.

During the summer of 2005, **Megan Wilson '06** and **Laurel Benson '08** pursued the hypothesis that common cold virus attaching to immune cells elicits signal transduction pathways that result in the release of inflammatory mediators that cause asthma exacerbations.

Several students, including **Shi-Hsia Hwa '05**, **Yong Seok Choi '06**, and **Steven Vander Naalt '06** have worked with Professor Lokensgard in recent years in an on-going effort to determine the chemical identity of an aquatic kairomone (a compound generated by one species that affects the development of another). In this case the larvae of *Chaoborus*, a small midge fly, and the water flea *Daphnia* are the organisms involved. **James Stark '05**, **Stephen Henry '04**, and **Asa Wesenberg '05** have been engaged in a similar on-going effort to identify the chemical compound(s) and behaviors by which crickets identify one another's gender.

Alison Williams '04 and **Chorthip Peeraphatdit '05** worked with Professors Nordell and Hall, exploring the synthesis of CdSe semiconductor quantum dots and the development of a colorimetric detection system for Pb (II) ions using DNA-modified gold nanoparticles. The experiments they developed have since been used in several courses here.

Also under Professor Nordell's direction, **Cherisse Hall '07**, **Richard Amankwah '06** and **Benjamin Glover '08** conducted a series of water analyses

during the summer of 2005. They did multiple analyses on samples collected in several locations on the Fox River (which runs past the campus) and several area creeks. Historically a heavily industrialized river, the Fox is now a much cleaner and more recreation-friendly river with significantly improved water quality; this project seeks to better understand the water quality challenges that continue to face the river. These students are also collecting data on the presence of various pollutants, including PCBs, in river sediment and in the tissue of zebra mussels living in the river.

During the summer of 2004 **Aaron Jubb '06** studied arsenic removal and mesoporous materials in collaboration with Professor Thompson. In summer 2005, Aaron conducted experiments to understand whether a mesoporous material can be identified by the patterns of molecules emitted when that material is calcined at high temperatures. **Tahmida Nazreen '06** joined the Thompson research team in summer 2005, working to implement in-house studies of reaction kinetics in mesoporous synthesis. Both Aaron and Tahmida seek to grow monolithic mesoporous materials whose optical properties can be studied. Their hope is to use their results to creatively modify the syntheses in ways that will yield new and interesting materials.

To promote **PROFESSIONAL DEVELOPMENT** of our students, the department strongly encourages those planning careers or further study in chemistry and related fields to pursue off-campus chemistry internships or research experiences during their tenure at Lawrence. Lawrence students have traveled across the country to work at various universities, national laboratories and companies, complementing the experiences they have gained while carrying out research here.

The seminar/capstone sequence of courses is another way in which the department strives to promote its majors' professional development. The seminar series features research presentations by visiting scientists, career information from Lawrence faculty or staff or returning alumni, discussions of professional responsibilities and ethics, and the like. An introduction to finding and using information in the chemical literature and a "capstone" seminar course for senior majors are also part of this program. There is also a multi-disciplinary research seminar series featuring students working on campus each summer.

Lawrence students share their interest in, and enthusiasm for, chemistry in a number of **EXTRACURRICULAR AND OUTREACH ACTIVITIES**. One of the best known on campus is a student group that produces and presents "The Chem Show." This program of skits and demonstrations has been enjoyed by thousands of visiting elementary students over the past few years.

Other students go out into K-12 classrooms in the community, or host groups of students who come to the campus. Women chemistry students are encouraged to participate in PRYSM (Partners Reaching Youth in Science and Math), a program of one-on-one partnerships between 8th grade girls and Lawrence undergraduate women, and in GEMS (Girls Exploring Math & Science), a program that brings groups of middle-school girls to campus for hands-on science activities.

In addition, the department sponsors a number of special events throughout the year, including an annual weekend retreat at Björklunden, Lawrence's beautiful "northern campus." Other such "community-building" events include an annual PumpkinFest, bowling or miniature golf outings with graduating seniors at the end of the year, a pizza lunch featuring information on summer research opportunities, and an annual spring picnic. Pictures and information concerning these events and other aspects of the program can be found on the department's web site: www.lawrence.edu/dept/chemistry

In the fall of 2000 the chemistry department moved into a spectacular new building, the \$18 million **SCIENCE HALL**. This facility includes classrooms, state-of-the-art teaching and research laboratories, computer facilities, faculty offices, and lots of student study areas. Many chemistry majors have their own desk space in student offices in the building. Science Hall also houses a broad selection of major scientific instruments, all of them available for hands-on student use. These include spectroscopic instruments (Nuclear Magnetic Resonance, Infrared, UV-Visible, fluorescence, Atomic Absorbance); instruments useful for separation of mixtures and identification of their components (liquid and gas chromatography, including a GC coupled to a mass spectrometer); equipment for electrochemical investigations; and a number of specialized instruments for biochemistry. In addition, an X-ray diffractometer, a transmission electron microscope, and a scanning electron microscope are shared with other departments. We continue working to increase and update our instrumental and analytical capabilities.

AFTER GRADUATION, Lawrence chemists build careers in a wide variety of fields. About 60% of the department's graduates begin work on Ph.D. degrees in chemistry or on M.D. degrees, either right after graduation or within a year or two. The others go in a wide range of directions. Students from the past few classes have entered medical

school at Emory (Atlanta) and Washington U. (St. Louis); graduate programs in chemistry or biochemistry at Cornell, Illinois, Michigan, Stanford, UC-San Diego, North Carolina, Wisconsin, and elsewhere; graduate study in neuroscience at Emory and in food chemistry at Penn State; chemical engineering *via* a 3-2 program at Washington U; high school teaching; and employment in various chemical or pharmaceutical companies.

This year's alumni spotlight features Gary Van Berkel '82, Group Leader of the Organic and Biological Mass Spectrometry Group at Oak Ridge National Laboratory. In June, 2005, Gary was honored with the Biemann Medal of the American Society for Mass Spectroscopy, a highly distinguished international award recognizing exceptional achievement and contributions to understanding of this important analytical technique.

FACULTY

Mary F. Blackwell, associate professor; University of Illinois-Urbana, B.A.; University of California-Berkeley, Ph.D. Interests: biophysical chemistry, secondary electron transport in photosynthesis, applications of non-linear dynamics to chemical systems.

James S. Evans, professor of computer science and chemistry; Bates College, B.A.; Princeton University, M.A., Ph.D. Interests: structure and interactions of proteins, computer architecture and organization.

David J. Hall, assistant professor; Butler University, B.S.; University of Wisconsin-Madison, Ph.D. Interests: biochemical pathways that regulate the replication of picornaviruses; biochemical signals that lead to the exacerbation of asthma.

Jerrold P. Lokensgard, Robert McMillen Professor of Chemistry; Luther College, B.A.; University of Wisconsin-Madison, M.A., Ph.D. Interests: organic chemistry, especially reaction mechanisms; synthesis and properties of dendrimers; naturally occurring compounds, especially pheromones or kairomones.

Karen J. Nordell, associate professor; Northwestern University, B.A.; Iowa State University, Ph.D.

Interests: inorganic and materials chemistry, nanoscience and nanotechnology, synthesis and applications of new metal-organic coordination polymers and nanoscale materials.

David E. Thompson, assistant professor; Carleton College, B.A.; University of Wisconsin-Madison, Ph.D. Interests: analytical and physical chemistry of (1) surfactant templated mesoporous materials and (2) surfactants in the membranes of erythrocytic malaria; also standard analytical methods in cryogenic sorptometry, gas chromatography/mass spectrometry, high performance liquid chromatography, scanning electron microscopy, transmission electron microscopy, and novel laser based spectroscopic methods involving ultrafast vibrational spectroscopy.