# GRADUATE PROGRAMS CHEMISTRY

The graduate programs in the Department of Chemistry at ESF are structured around four areas of research and application:

- Biochemistry
- Environmental Chemistry
- Organic Chemistry of Natural Products
- Polymer Chemistry

Faculty members in the department are internationally recognized experts and are well funded by federal agencies (NSF, DOE, NASA, etc.), industry, government, and NGOs. Graduate students commonly receive national fellowships. The environment for graduate students is challenging but supportive, as faculty are invested in student success.

Master of Science and Doctoral students must complete a minimum of 18 credit hours and 30 credit hours of graduate level coursework, respectively. In addition, doctoral students must pass a doctoral candidacy examination.

Current research projects encompass natural and synthetic polymer chemistry, biochemistry and microbiology; organic chemistry of natural products and chemical ecology; chemistry of air and water; climate change.

## M.P.S. in Environmental and Forest Chemistry

The Masters in Professional Studies is a coursework-based program intended for students who need additional courses in Chemistry, but who are not planning on pursuing a research career in the field. M.P.S. students take courses in anyof the subject areas of the department: Biochemistry, Environmental Chemistry, Inorganic Chemistry, Natural Products/Organic Chemistry and Polymer Chemistry. The curriculum is sufficiently flexible to allow a student interested in specializing in one of these areas to take the core sequence in that area, although this is not required. Students who have taken any of these courses as undergraduates may not repeat them for graduate credit.

In addition to the formal coursework, the M.P.S. program also requires an integrative experience that allows the student to synthesize their knowledge. This can be a detailed analysis of one area of chemistry, an independent study, internship with industry, or work in a research laboratory. The integrative experience should be approved by the student's steering committee prior to starting. The student will be expected to present a written final report on the integrative experience.

### M.P.S. Program Requirements

The Master of Professional Studies (M.P.S.) degree requires a total of 30 credits (minimum) in the following configuration:

| Area | Credits |
|---|---|
| Chemistry | 15 |
| Other sciences, engineering and mathematics | 6 |
| Seminars | 3 |

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|---|---|
| Integrative experience (internship or independent study) | 3 |
| Elective coursework, seminars, internships or research experience | 3 |
| **Total (minimum)** | 30 |

- **15 credits of graduate chemistry courses**, including chemistry courses are available at ESF and Syracuse University.
- **6 credits of graduate coursework in Science, Mathematics or Engineering**. These may include graduate courses offered at ESF or Syracuse University in physical or biological sciences, mathematics (including statistical analysis), or any area of engineering. Courses must be approved by the student's steering committee.
- **3 credits of seminar**: Either FCH 797 Graduate Seminar may be repeated, or students may choose seminars offered in other departments with approval of the advisor.
- **3 credits for an integrative experience** as FCH 898, Professional Experience/Synthesis in Chemistry.
- **3 credits of additional graduate coursework**: These remaining three credits may be drawn from additional graduate level coursework, seminars, internships and research experience as approved by the student's steering committee.

## M.S. & Ph.D. in Environmental and Forest Chemistry

The Biochemistry, Environmental Chemistry, and Polymer Chemistry research areas each have a required core sequence of courses. All graduate students must present a public department seminar through FCH 797 plus a capstone seminar.

**General Requirements**

Steering committee and program of study: By the end of their first year of study, all graduate students must have two faculty, in addition to their major professor, appointed as members of their steering committee. The steering committee provides guidance throughout the student's graduate school career, including approval of must the list of courses the student will take as part of their degree.

**M.S. Program Requirements**

M.S. students are required to take at least 30 credits, with at least 18 credits of coursework (with some options require additional credits) and at least 12 credits of research. While a minimum number of research credits are required, successful completion of an M.S. thesis project is determined by effort and effectiveness, not by credit numbers alone.

**Ph.D. Program Requirements**

Ph.D. students are required to take at least 60 credits, with at least 30 credits of coursework (some options require additional credits) and at least 20 credits of research. While a minimum number of research credits are required, successful completion of a Ph.D. dissertation project is determined by effort and effectiveness, not by credit numbers alone.

The candidacy exam at ESF has three formats, but Chemistry uses format 3 (the thesis proposal) exclusively. After authoring the document, students defend it orally in front of their steering committee and one or two examiners.

## Research Areas

There are four graduate areas of study in Chemistry:

### Biochemistry

Graduate studies in biochemistry reflect the College's interests in microbial, insect, bio-based fuel, and plant biochemistry.

After completing a one-year sequence in general biochemistry, students select advanced courses from a range of offerings in chemistry, organismal biology and molecular biology. In some cases, additional courses may be taken from Syracuse University.

### Environmental Chemistry

ESF is one of the few institutions offering graduate degrees with an emphasis in environmental chemistry in the United States. The 13participating faculty make it one of the largest such programs in the world.

Students take advanced courses in environmental chemistry and biochemistry as well as specialized courses including oceanography, biogeochemistry, analytical methods, sustainability and pollution control.

Research in environmental chemistry spans a wide range, from fieldwork to laboratory work to computer modeling. Areas of research include global climate change, coral reef ecosystems, biogeochemistry, atmospheric chemistry, regional and global air quality, and transient and

persistent organic pollutants.  The program emphasizes a framework wherein students can incorporate new knowledge as it becomes available and deal with new problems as they are

### Organic Chemistry of Natural Products

Graduate students in organic chemistry of natural products take coursework in mechanistic organic chemistry, synthetic organic chemistry and the organic chemistry of natural products.

Courses in biochemistry, inorganic chemistry, statistics and specialized courses in chemistry or biology may be arranged and selected by the student in consultation with faculty.

Research in the field of organic chemistry of natural products includes the isolation and characterization of new natural substances; the synthesis of new or improved natural substances; and the study of the relation of molecular structure to biological response. Chemical research in each of these areas is coupled with biological testing. Research involving isolation and synthetic chemistry requires the student to develop expertise in separation techniques, such as the several methods of chromatography and spectrometric identification of molecules.

### Polymer Chemistry

Graduate students in polymer chemistry take courses in the physical and organic chemistry of polymers and such additional courses as the student and advisor consider necessary, including from chemistry, chemical engineering, mathematics, physics, and other areas.

Special topics in a spectrum of polymer fields are offered or can be arranged in consultation with the faculty.

**Joint Research Program- Chemical Ecology**

In addition to the four research areas described above, in collaboration with the Department of Environmental Biology and the Department of Chemistry, students may also pursue research in Chemical Ecology. Students in this program have a home department in either Chemistry or Biology. Faculty from both areas contribute to the plan of study, enabling each student to acquire advanced skills in the area most salient to their own research. This joint program recognizes the necessity of understanding multiple scientific fields when grappling with complex environmental challenges in the natural world.

Chemical ecologists study organismal interactions, both intra- and interspecific, mediated by chemical substances. These interactions occur among microbes, plants, and animals. Study of such interactions typically involves joint efforts of biologists and chemists in basic and applied research in the laboratory and field. The application of chemical ecology has contributed significantly to reduced pesticide use and improved yields in forestry and agriculture while protecting the environment from harmful contaminants.