

**Science and The Liberal Arts:
The Future of Science Education at Skidmore College**

The 21st century poses problems for the world unlike any faced by humans in their history. Global climate change, AIDS and the spread of infectious diseases, industrial pollution, environmental resource depletion, and species preservation pose enormous problems that will require new modes of thinking and new technologies to resolve. At the same time, new developments in the sciences hold great promise for addressing these problems, but doing so successfully will require new and imaginative modes of thinking and research.

Liberal arts colleges as a group, and Skidmore in particular, must help to respond to these challenges by providing all of our students with both a broad and deep understanding of science and its accomplishments. Even more particularly, we must provide our science students with a firm understanding of the foundations of contemporary science, the interdisciplinary possibilities of the discrete science disciplines, and substantive, meaningful research experiences focusing on real life issues that prepare them to become scientists in the 21st century.

With strong, established majors in the natural sciences, and with newly emerging interdisciplinary programs in environmental science, neuroscience, and biological chemistry, the College is poised to contribute in a distinctive way to educating the next generation of scientists. In addition, Skidmore has a responsibility to the larger academic community and to the public to promote a wider understanding of the implications of science and technology and the choices they create. Such an understanding is critical to a democracy and the choices its citizens must make.

Over the past three years, Skidmore has made several key investments and completed a number of structural changes in the sciences. We have added to our faculty in computer science, biology, chemistry, and psychology. We have established a new GIS laboratory and expanded our microscopy facilities. We have created new interdisciplinary majors in neuroscience and environmental studies and we have reorganized physics and chemistry, which had operated as a single entity, into separate departments. These initiatives have laid the groundwork for a broader and more coherent science program, one that will not only serve a much larger number of students but will also establish the sciences as a much more integral part of the College's institutional identity.

A New Era in Science Education at Skidmore: Building upon these investments and taking up the charge of the College's Strategic Plan for our science programs to play a more central role in the College's curriculum, we are launching a \$15 million initiative that will

- Strengthen our interdisciplinary science programs in biological chemistry, neuroscience, and environmental science
- Expand our student-faculty collaborative research effort
- Add to our science teaching and research facilities, and
- Launch the Science Literacy Project to promote wider understanding of the most pressing scientific and technological issues of the day.

We expect these investments to yield a 50% increase in the number of students majoring in the sciences, to provide a significant enhancement of the academic experience for those students, and to produce a substantial increase in the awareness of key science-related issues and scientific literacy across the campus and beyond.

Interdisciplinary Science at Skidmore College

Solutions to many contemporary scientific problems reside at the intersections of traditional disciplines – at the confluence of biology and chemistry, of computer science and biology, of biology and psychology, of physics and chemistry, of exercise science, chemistry and biology – intersections that afford multiple perspectives in the search for solutions. This drives the need for interdisciplinary science education, and the national conversation on science education makes this need evident. If our science students are to prosper in 21st-century science, they must learn to cooperate and communicate at these intersections.

Interdisciplinary (ID) science programs are an emerging feature of science education at many leading liberal arts colleges. Skidmore is determined not merely to join this enterprise but rather to lead it; to develop levels of collaboration among faculty and students in differing disciplines so as to model the work of discovery within the contemporary scientific community. Specifically, our ID science programs will build on a strong foundation of two or more disciplines, enabling our students to master the complementary knowledge and experimental techniques of these disciplines within upper-level courses, and provide instructional contexts and opportunities for interdisciplinary collaborative research that make good on the promise of interdisciplinarity. These ID science programs will guide students to cutting edges in science, engaging them in the type of inquiry-based, rigorous study that fosters the depth and breadth of scientific understanding vital for students planning to enter top-tier graduate programs, professional programs in healthcare, or scientific research.

Such undergraduate preparation is distinctively labor-intensive, since each participating student is, in effect, experiencing an honors program within the sciences. Achieving true interdisciplinarity also means we must dedicate the time and resources necessary to support cooperative curriculum design among scientists in complementary disciplines, provide more opportunities for jointly designed and jointly taught interdisciplinary science courses, and increase the resources required for shared collaborative research with students. Finally, we recognize that such ID ventures cannot come at the expense of the resources and strengths of the traditional science disciplines, especially since these disciplines provide the essential foundation for interdisciplinary work. To be successful, therefore, they must be conceived and implemented in the context of a strong disciplinary framework.

To achieve these goals, we have identified the following four areas for investment: biological chemistry, neuroscience, environmental science, and, more broadly, student research. These represent the areas of greatest opportunity to build upon our existing strengths and student interest. Investments in these areas will also benefit and strengthen our core disciplinary offerings in such departments as biology, chemistry, and psychology.

Biological Chemistry

In the past few decades, powerful discoveries and exciting innovations have occurred at the intersection of biology and chemistry: proteomics, genomics, recombinant DNA, nanotechnology, bioinformatics, computational modeling, live-cell imaging, and combinatorial chemistry. These advancements have emerged through collaboration between these two disciplines, which historically, had operated independently. Most biologists and chemists now recognize their disciplinary interdependence and their need to cooperate as they seek discovery in the life sciences. This realization drives the need for enhanced undergraduate interdisciplinary science education, as we prepare our students for 21st-century research. Biological chemistry responds to this need by equipping our students with knowledge and skills absolutely essential as they prepare for professional degrees in science and in medicine. It will also build upon the independent strengths of our chemistry and biology departments through interdisciplinary team teaching, through shared research projects involving our chemists and biologists, and through collaborative research that engages our students in the converging knowledge and experimental techniques of these disciplines.

Neuroscience

Neuroscience seeks to understand the mechanisms that give rise to thought and behavior. Since the primary mechanism of these functions is the brain and central nervous system and their study can be pursued from biological, biochemical and psychological perspectives, neuroscience has become, by necessity, an interdisciplinary endeavor. Neuroscientists investigate the connections between events that occur at the subcellular level (molecular genetics and molecular biology), the cellular level (electrophysiology, cell histology), the systems level (developmental biology, neurophysiology, functional anatomy), and the behavioral level of the whole organism (animal behavior, cognitive psychology). Addressing the fundamental questions of neuroscience thus requires the collaboration of specialists in diverse fields. Neuroscience as a research discipline stands at the very center of current cultural and social issues (e.g., stem cell research), public health issues (e.g., anti-depressant, anti-psychotic and ADHD medications) and ethical issues (e.g., use of brain imaging for product marketing).

Environmental Science

Environmental problems are among the most knotty and complex issues we face as we enter the 21st century. Water and air quality, natural resource consumption, waste disposal, food production, and global climate change are all challenges that now surface as top priorities on local, regional, national and international agendas. A solid, interdisciplinary understanding of natural science in addition to social, cultural, historical and ethical insights must inform the development of public policy and shape decision-making in regard to such problems. Our environmental science track (which operates within the larger environmental studies program) affords an integrated study of the physical, chemical, and biological aspects of environmental issues and encourages exploration of how these aspects influence and are influenced by people and institutions.

Expanding Student Research in the Sciences

In keeping with our strategic emphasis on student engagement and academic achievement, we are particularly interested in expanding students' participation in independent and collaborative research. Our experience with the new programs in environmental science (ES) and neuroscience (NS) over the past three years suggests that as these programs expand, and as the biological chemistry program comes to life, we will see a sharp increase in student requests for collaborative research programs with faculty. In 2002-3 alone, 13 NS students participated in collaborative research at the sophomore-Junior level and 14 NS majors conducted research during their senior year. In addition, 4 NS students have participated in summer collaborative research programs at Skidmore. This strong research has resulted in a number of students presenting their findings at regional and national science meetings. Suzanne Murphy '04, Nora Siegal '05, Ibarido Zambrano '06, for example, presented their work at the last two International Society for Neuroscience conferences, annual events that attract over 28,000 neuroscientists.

To address the anticipated increased demand for student-faculty collaborative research projects, both during the academic year and in the summer, and to complement our increased teaching strength, the College will establish a new collaborative research fund. This fund will support a range of academic-year and summer research experiences. These would include semester long independent studies, travel to make presentations at academic conferences, and summer research internships in faculty labs on campus. Our goal is to establish an endowed fund of \$2 million that will allow us to increase these experiences by 50% over the next ten years—from 112 to 175-80.

Enhancements to the Science Faculty and Staff

Four new endowed faculty lines will be required to staff new ID courses, mentor increased numbers of students, direct independent studies and collaborative research, and provide expertise for managing the scientific equipment necessary to move these programs forward. They will also, of course, supplement offerings within our existing departments. In addition, two lab technician/assistants will be hired to assist with the equipment and lab preparation across the entire science curriculum as well as the new programs. As outlined below, these investments will enable us both to expand our curriculum and accommodate

more students majoring in the sciences, as well as increase our offerings for non-majors, particularly through our newly designed First-Year Experience seminar program.

Professor of Biological Chemistry: We seek a new faculty member with the education and training in bioanalytical, biophysical, or bioorganic chemistry. The new faculty member will be responsible for developing innovative upper-level chemistry electives that enrich biological chemistry and collaborate with the two existing biochemists in the department in contributing to development of the new ID program. She/he will assist in the delivery of the first-year foundational chemistry sequence and upper level chemistry courses, enhance the department's contribution to the new first year seminars, and develop a strong undergraduate ID research program in the area of his/her research interest.

Professor of Neuroscience (Molecular Development): Knowledgeable in molecular biology and in developmental neuroscience, this faculty member will study the timing of factors involved in brain development, investigating questions that are of profound clinical, biomedical, and social importance. Under his/her guidance, students will explore issues of cause and effect at the molecular and cellular levels, of abnormalities in brain development such as autism and mental retardation, schizophrenia, depression, anxiety and addiction. She/he will also introduce students to questions about how male and female brains develop and become different in adulthood. Development of the brain entails an exquisitely precise series of events regulated by factors at the genetic, molecular, and cellular levels of organization. To understand these events, the new faculty member and students will employ the tools of modern molecular biology and genetics to reveal pattern and process and gain experimental skills. While dedicated to neuroscience, this position will also allow other faculty members in biology to redirect their efforts to support biological chemistry

Professor of Neuroscience (Learning and Memory): This faculty member will introduce students to teaching and research at the leading edge of Neuroscience. Through instruction and support of collaborative research involving advanced technology and instrumentation, this instructor will help students explore – and extend – the contemporary understanding of how nerve cells in the brain (neurons) and the synapses between neurons change in response to novel events and maintain those changes in the form of memories.

Professor of Environmental Science: This faculty member will have a focus in environmental risk assessment, environmental impact assessment, and brownfield restoration, with a particular research interest in water resources and expertise in Geographic Information Systems. She/he will be able to teach our ES foundation course, *Environmental Concerns in Perspective*, parallel teach an upper level environmental science methods course with a social scientist, and teach 300-level dedicated environmental science courses that will bring interdisciplinary depth to the ES major. She/he will contribute a First-Year Seminar that supports our Water Resources Initiative and guide undergraduates in water-related research. Finally, she/he will engage students in ES-related co-curricular activities and contribute to the Science Literacy Project.

Technical Staff: Skidmore will also endow new technical staff positions to support operations both within the traditional discipline-based natural science departments and the new ID programs. These staff members will perform vital logistical, technical, and safety-related tasks to assure that laboratory resources are prepared and maintained for effective support of laboratory instruction. We will hire one full-time person to deploy, maintain, calibrate, and upgrade laboratory instrumentation in biology, chemistry, and physics. We will also hire one full-time animal care technician for support of animals in biology, psychology, neuroscience, and environmental studies; this person also will support of the federally mandated Institutional Animal Care and Use Committee. These new hires will free up faculty time, enabling our professors to focus more of their efforts on working directly with students in teaching and research.

The Science Literacy Project

Skidmore recognizes that a strong liberal arts college must engage in the study of science as a cornerstone of liberal learning for all its students; in doing so, we must embrace the study and articulation of science and its larger social implications as a public responsibility. Given the pace of scientific change, evaluating and explaining the consequences of scientific discovery and technological achievement for the non-specialist is an ongoing challenge. This challenge will be met at Skidmore College by launching the Science Literacy Project (SLP), a broad initiative of College lectures, forums, and educational outreach to the campus at large and to local public schools to explain and interpret science issues for both students and citizens in the surrounding Saratoga Springs and Capital regions.

Like the Interdisciplinary Science programs, the SLP will foster a comprehensive, interdisciplinary approach to the exploration of contemporary science issues. Such a program will summon scientists, social scientists, artists, and humanists alike to the table, fostering critical exchanges about compelling questions in science, technology, and related issues in public policy. An important part of these conversations will link Skidmore's faculty and students to teachers and students in the local public schools. The SLP will enrich and diversify campus conversations, broaden the understanding of science on our campus, and heighten our institutional profile within the community.

The SLP will be overseen by a director drawn from the College's science faculty. The Director will organize outreach efforts to local schools, coordinate a mentoring program for upper-level science majors and students in science-related First-Year Seminars, and develop a schedule of SLP lectures. A particular focus will be to manage a new Distinguished Visiting Scientist Residency that will be a cornerstone of this effort. The Residency will bring to Skidmore scientists and scholars of national renown for two, week long campus visits each year. During their residencies the visiting scientists will offer public lectures and participate in College forums that will be widely publicized and open to the public. In addition, they will conduct seminars for Skidmore students and faculty members, workshops for local public school teachers, and direct visits to science classes in local schools.

We are seeking to establish an endowment of \$1 million to support the SLP. This endowment will cover a portion of the salary for the director, stipends and travel for the Residencies, and administrative support and programmatic costs for the mentoring and outreach programs.

Anticipated Outcomes: The Sciences at Skidmore in 2015

Through the initiatives identified above, we seek nothing less than a radical realignment of the position of science education at Skidmore College. Throughout our history, the natural sciences have often operated in the shadow of other fields of inquiry. More recently, as we have strengthened our offerings in science and have attracted a number of highly accomplished science majors (e.g., Porter Scholars programs), our success has sometimes gone unnoticed. As a leading liberal arts college, however, we accept the responsibility to acquaint all our graduates with the broad sweep of human knowledge and to prepare informed, responsible citizens who can participate effectively in civic discourse that frequently deals with developments in science and technology. If we are fulfill that mandate, we must provide a more balanced curriculum College-wide, a curriculum that includes greater representation of the natural sciences; we must prepare greater numbers of our graduates for science-related careers; and we must enhance the awareness of our entire academic community in regard to issues of science and public policy. The initiatives described above represent significant steps toward achieving these outcomes.

Repositioning the Sciences

The result will be a fundamental shift in the curricular center of gravity within Skidmore, placing the sciences more squarely in the mainstream of our academic community. At the same time, our focus on interdisciplinary programs plays to our historic strength in this approach, which is a hallmark throughout the curriculum. In so doing, it will move the College into the vanguard of contemporary undergraduate

science teaching at leading liberal arts colleges across the country. Skidmore will also, we believe, attract significantly heightened attention, especially in the Capital Region and the Northeast, for the Science Literacy Project. This will help attract greater numbers of students with an interest in the sciences to the College. Based on our experiences of the past several years, we are confident that we will see a steady increase in the number of students attracted to the natural sciences as majors.

Increased Opportunities for Science Majors *and* Non-Majors

Adding the new faculty and technical support staff positions we have identified will make possible a significant expansion of our science offerings to serve both majors and non-majors. For non-majors, for example, the increase in teaching strength will enable us to play a central role in our new First-Year Seminar program. In the past, because of the demands of their disciplines and their lab courses, members of the science faculty have found it difficult to participate in such extra-departmental ventures. The format of these new First-Year Seminars creates new opportunities for meeting the objectives of the strengthened science program for beginning students – giving them access to the scientific information, methodologies, and concepts they will need to engage as responsible citizens able to participate meaningfully in civic debates relating to the scientific and technical challenges we face in the 21st century.

In addition to providing a broader educational experience for non-majors, these additions will enable us to attract a significantly greater number of students to the sciences as majors and deepen the educational experience of each of our more advanced science students. Specifically, we expect the number of science majors to grow by more than 50% from the current level of 90 to 140. We also anticipate that these investments will help address the larger, national issue of attracting more women to the natural sciences and mathematics. Given our historic enrollment patterns, which show women outnumbering men in several of our science majors such as biology, biochemistry, and neuroscience, and given that much of our planned expansion is in areas typically of great interest to women, we expect that the majority of these new majors will, in fact, be women. This projected growth would increase the percentage of students majoring in the sciences on our campus overall from 14 to 22%, a level that is much more comparable with our peer institutions. In addition to strengthening the science programs themselves and enhancing the science literacy of our general student population, this shift in patterns of majors will strengthen the balance of our liberal arts curriculum and enhance the overall intellectual climate of the campus.

For science students at Skidmore, these investments will increase significantly the range of choices in course offerings and individual faculty advising and mentoring. It will also provide students with additional support for independent study supervision and collaborative research with faculty. In addition, the interdisciplinary course development possible with the addition of these new faculty will no doubt lead to new synergy within the entire science area of the College, leading to the creation of still further interdisciplinary ventures and programmatic collaborations. Over the coming decade, any prospective student interested in studying the sciences at Skidmore will be able to observe a program marked by creativity, energy, and the kind of collegiality among students and faculty that signifies an inviting, undergraduate program of exceptional quality and flexibility.

CREATIVE THOUGHT. BOLD PROMISE.
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**Science and The Liberal Arts
Funding Priorities (Endowment)**

<p>➤ Support for four New Interdisciplinary Faculty lines (Includes costs for laboratory renovation and equipment*)</p> <ul style="list-style-type: none"> • Professor of Biological Chemistry: <i>\$2.25 million</i> • Professor of Neuroscience (Molecular Development): <i>\$2.25 million</i> • Professor of Neuroscience (Learning and Memory): <i>\$2.25 million</i> • Professor of Environmental Science: <i>\$2.25 million</i> 	\$9 million
➤ Support for Laboratory and Technical Personnel	\$2 million
➤ Support for Student/Faculty Collaborative Research	\$2 million
➤ Support for the Acquisition and Maintenance of New Laboratory Equipment	\$1 million
➤ Support for the Science Literacy Project	\$1 million
<u>TOTAL</u>	<u>\$15 million</u>

*NB: Pending completion of the College's comprehensive facilities review, which will result in a new master plan for the campus, we anticipate the need for additional laboratory and teaching spaces in the sciences. This plan will be developed in greater detail over the next 6-9 months.

APPENDIX I

Since the new ID faculty members have yet to be appointed and since their precise research interests and teaching assignments have yet to be determined, what follows is a provisional draft of new courses that build interdisciplinary substance into existing and proposed ID science programs.

a) Biological Chemistry

200-Level: Introductory Biological Chemistry.

This course has two critical functions in the Biological Chemistry ID curriculum. First, it serves as an entry-level integration of the core knowledge acquired in the introductory biology, chemistry and mathematics courses by examining how these disciplines relate to each other in the context of contemporary biomedical research. Secondly, this course serves to launch the core of the Biological Chemistry ID program through the introduction of elemental aspects pertaining to the study of biological chemistry through inquiry based and problem-based learning.

300-Level: Advanced Biological Chemistry

This is an in-depth investigation into issues within contemporary biochemistry that may include energy acquisition and utilization, enzyme kinetics, cell signaling cascades, and the regulation of gene expression. This course will explore how emerging fields such as genomics, proteomics, bioinformatics, and computational modeling have contributed to our understanding of these processes. It will emphasize the relevance of this knowledge to human metabolism and disease. Finally, we will explore how advances in pharmacogenomics, combinatorial chemistry and high throughput screening have changed the face of drug design and discovery.

300-Level: Senior Seminar in Biological Chemistry

A seminar designed to explore contemporary issues in molecular biology and biochemistry and to teach communication skills relating to scientific research. The courses include presentations by guest speakers, faculty and students, as well as discussion of contemporary literature.

300-Level: Capstone Laboratory Research in Biological Chemistry

This course provides students the opportunity to work collaboratively with faculty on research initiatives. In light of the interdisciplinary nature of this program, students will be encouraged to pursue research with faculty from diverse fields to further stimulate the strength of their interdisciplinary experience. Students will give oral presentations of their research in a year-end symposium and submit their work in manuscript form.

- b) Neuroscience: A strong and innovative neuroscience program explores the nervous system at multiple levels of analyses. Furthermore, the true interdisciplinary nature of the field can best be modeled through team-taught courses, where the expertise of participating faculty represent these different levels of analyses, and through innovative courses that even reach beyond traditional neuroscience borders themselves and connect with non-science disciplines. The addition of two NS faculty will transform the existing program. The new hires will allow NS to create two innovative, team-taught, lab-based neuroscience courses that will provide the students' major foundational experience in the field (NS 201 Molecular and Cellular Neuroscience and NS 202 Behavioral and Cognitive Neuroscience). The hires will also allow the NS program to add an interdisciplinary senior capstone course for all majors that foregrounds student-faculty collaborative research and team-taught upper level interdisciplinary seminars.

The Molecular Developmental Neuroscientist will teach:

200-Level (Neuroscience):	<i>Cellular and Molecular Neuroscience</i> (new gateway course)
300-Level (Neuroscience):	<i>Capstone Course</i>
300-Level (Biology):	<i>Developmental Biology</i>
300-Level (Biology):	<i>Neural Development and Disorders</i>

The Learning and Memory Neuroscientist will teach:

200-Level (Neuroscience):	<i>Behavioral and Cognitive Neuroscience</i> (new gateway course)
200-Level (Neuroscience):	<i>Learning and Memory</i>
300-Level (Neuroscience):	<i>Capstone Course</i>
100-Level (Neuroscience):	<i>Mind and Behavior</i> (existing gateway course recast as exploration course for non-majors)

The new hires create sufficient degrees of freedom so that existing faculty will participate in the development of team-taught NS courses at the 300-level. Examples include courses in Neurodegenerative Disease, NeuroMarketing and NeuroEthics.

300-Level (Neuroscience):	<i>Special Topics in Neuroscience</i>
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c) Environmental Science

100-Level: Environmental Concerns in Perspective

An interdisciplinary, multiple-perspective approach to the study of environmental concerns. In this course, students study the interaction of human beings and their social, political, and economic institutions with the natural environment. Issues such as air pollution, water pollution, and land management are discussed from the perspectives of both the natural sciences and the social sciences. Local, regional, national, international and historical perspectives on these issues are also discussed. As a foundation course for both the ES major and minor and an elective foundation course for the International Affairs major, this course is typically oversubscribed despite having expanded our offering to three sections per year.

300-Level: Case Studies in Environmental Sustainability

A research oriented capstone course required for all environmental studies majors during their senior year. This course is designed to enhance students' research, writing and oral communication skills generally and as they relate to environmental studies, and to strengthen their awareness of environmentally related issues by engaging students in a semester-long, community-based research project. Case studies and contemporary readings will serve as a foundation for discussion related to the community-based research project in the course, while primary literature will be used to guide students through the appropriate methodologies for the project. The course culminates in the presentation of the research project to environmental studies, faculty, students, and community members.

Our one faculty member in ES currently covers ES 375, but to fulfill our interdisciplinary vision for this capstone experience, the course should be team-taught by at least one natural scientist and one social scientist. In addition to the environmental scientist described above, the ES program has submitted a foundation proposal to hire a social scientist with expertise in policy and regional planning with a research focus on water resources. An environmental scientist paired with such a social scientist will provide the complementary expertise to foster rich, interdisciplinary discussion and exploration of an environmental research question.

The 300-level courses that currently count for the Environmental Science major are courses offered within disciplinary departments. While we will continue to rely heavily on such course offerings, we have the opportunity, with the environmental science hire, to offer a truly innovative science curriculum by building interdisciplinary depth through dedicated 300-level environmental science course offerings such as *Environmental Science Research Methods*, *Risk*

and Environmental Impact Assessment and Brownfield Restoration. Such dedicated course offerings are nearly nonexistent in environmental science undergraduate curricula at other college and universities, and adding such courses would further enhance our institutional niche as a leader in interdisciplinary science.

300-level: Environmental Science Research Methods

A course offered by the proposed environmental scientist, taught in parallel with a 300-level social sciences research methods course offered by the proposed social scientist, will better prepare students for the research component of ES 375, graduate school, and science-oriented careers. We envision this course culminating in a full research proposal for a project that will be carried out in ES 375. The parallel teaching approach will allow students in both methods courses to come together at critical points in their research proposal development and will hence foster a richer understanding of the different approaches and perspectives that come to bear on environmental research.

300-level: Risk and Environmental Impact Assessment

A course that focuses on the process of identifying the environmental and human health impacts of various development projects, linking to concepts of sustainable development, techniques to shape projects to suite the local environment, and means to reduce adverse impacts. The course will synthesize chemical, biological, and geological knowledge by examining potential influences on water and air quality, biodiversity, natural resource consumption and waste generation. Building on approaches covered in *Environmental Statistics*, students will also learn to calculate various risk factors, deal with uncertainty and select between development alternatives.

300-level: Brownfield Restoration

A course that explores the complex process of refurbishing contaminated land. Reusing contaminated properties can play a significant role in rebuilding old cities, creating jobs, increasing the tax base, and preventing the destruction of open space, but such projects require an interdisciplinary examination of the chemical composition of contaminants, and how such contaminants have entered and influenced surface and ground waters, soils and ecological communities. The course will also explore techniques for the removal of contaminants, including hazardous waste disposal, mechanical remediation and bioremediation.