

# **Graduate Studies in BIOLOGY**

## **University of Missouri-St. Louis**

### **INTRODUCTION**

The University of Missouri-St. Louis, the second largest campus of the University of Missouri system, is located in North St. Louis County. As the St. Louis area's only public research-oriented university, UM-St. Louis enrolls more than 12,000 undergraduate, graduate, and professional students.

The Department of Biology, which offers the B.A., B.S., M.S., and Ph.D. degrees, has 24 regular full-time and 10 adjunct faculty with interests in a wide range of disciplines in the biological sciences. Graduate students may work toward an M.S. degree in the three broad areas of biology: (a) Cellular, Molecular, and Developmental Biology, (b) Ecology, Evolution, and Systematics, and (c) Physiology and Behavior. Graduate students in the Ph.D. program may receive training in several areas of biology. Students in the M.S. and Ph.D. programs also have the opportunity to do graduate work in collaboration with scientists at the Missouri Botanical Garden through our cooperative graduate program. The Department also has close ties with the research community of metropolitan St. Louis. Because of a large number of biologically-related industries in St. Louis, there is a strong market for students trained in cellular and molecular biology.

The department is part of a consortium of institutions which includes the Missouri Botanical Garden, Washington University, Southern Illinois University-Edwardsville, and St. Louis University. Through this program, students from any of the participating institutions may enroll in courses at another institution as part of their regular curriculum.

### **Institutional Strengths**

#### **Research Facilities**

The research facilities at UM-St. Louis include a recently constructed research building, renovated laboratories in another building, and a modern research greenhouse. Other facilities include growth chambers, animal rooms, mainframe computer (VAX and IBM), microcomputer laboratories, aquarium room with both fresh and saltwater facilities, stockroom, shop, and darkrooms. Faculty labs contain HPLC systems, infrared gas analyzers, gas chromatogram, spectrophotometers, ultra centrifuges, equipment for protein, nucleic and high voltage electrophoresis, PCR machines, fluorescent microscopes, and image processing system. Available for ecological research are protected preserves at Weldon Spring Experimental Farm and Tyson Research Center administered by Washington University. Both sites are within 30 to 45 minutes of the UM-St. Louis campus.

#### **The International Center for Tropical Ecology**

The department offers a strong multidisciplinary program of study integrating theoretical and applied topics associated with tropical biology and conservation. Building on existing strengths within UM-St. Louis, and the Missouri Botanical Garden, the Center provides a unique form of interaction among graduate students, researchers, and visiting scholars. The faculty have expertise in both tropical and temperate ecosystems, including such topics as tropical plant-insect dynamics, ecology and behavior of tropical vertebrates, ecological genetics of tropical shrubs, and physiological ecology of tropical tree species. Faculty from the Departments of Anthropology, Economics, History, and Political Science, and the Center for International Studies, also enhance the multidisciplinary element of many Center events.

#### **Biotechnology Program**

The department offers a strong program in biotechnology for students who are interested in the principles and application of biochemistry, cell and molecular biology, developmental biology, and immunology. This program allows students to become educated in the principles required for biotechnology applications, thus providing them with the training that is essential for employment in biotechnology industries, or for more advanced academic training. This program is particularly appropriate for students who may be employed in biotechnology industries and require up-to-date education in that field, or for students who hope to enter this area of biology as a career in the future. Many graduates of this department are employed by local biotechnology industries such as Sigma Chemical Company,

Monsanto Corporation, Mallinckrodt, and Chiron.

### **Missouri Botanical Garden**

The Missouri Botanical Garden, which interacts closely with our graduate program, maintains one of the strongest programs in tropical plant study and exploration in the world. Its staff of more than 40 Ph.D.-level botanists, together with its world-renowned herbarium and excellent computer laboratory and greenhouse facilities, offer researchers and students an extraordinary venue for studying systematic botany. Education on all levels has been a major focus of the Garden for more than 100 years, and staff and student researchers pursue ecological and conservation projects in Latin America, Africa, Madagascar, North America, and Asia.

### **St. Louis and Surrounding Area**

The University of Missouri-St. Louis is situated on an attractive campus in the suburban northwest quadrant of the metropolitan area. With more than 2 million residents, the St. Louis metropolitan area offers every amenity of life in a major city. The downtown area, a national model for renewal and vigorous growth, is a major center of commerce and tourism. At the same time, local neighborhoods and suburban communities vary widely in atmosphere, and many have a small town "feel." The local economy is diverse, with strengths in business, finance, industry, education, health and life sciences, and technology. A great variety of opportunities exists for choices in housing, education, employment, and entertainment. In addition, St. Louis is located just 90 minutes from the beautiful Ozarks, where hiking, camping, and canoeing can be enjoyed.

### **Graduate Assistantships**

Stipends for teaching and research assistantships are awarded on a competitive basis to qualified graduate students in Master's or Ph.D. programs. Out-of-state educational fees are waived for graduate assistants. Assistantships are funded at \$4,700 per semester. Summer funding of \$4,700 is awarded to Ph.D. students so that their annual support is \$14,100 a year. Master's students who are awarded teaching assistantships typically receive a minimum of \$9,400 support per year for 2 years and are eligible for summer funding as teaching or research assistants through individual faculty members. Applications for assistantships must be sent separately from graduate school applications to the Director of Graduate Studies in the Department of Biology and be received by December 1.

## **Master of Science in BIOLOGY**

The Department of Biology offers two ways of achieving the Master of Science degree. The first is a non-thesis option suitable for those who may already have extensive research experience or for educators who seek to upgrade their academic skills but do not require research experience. The second is a traditional apprenticeship in research leading to a written thesis. All students admitted to the Masters' graduate program are considered to be in the non-thesis program unless they have been accepted into an individual faculty lab. Starting with a common core, either option may be developed into a final degree program in one of the following areas: animal behavior, biochemistry, biotechnology, conservation biology, development biology, ecology, evolution, genetics, microbiology, molecular and cellular biology, microbiology, plant and animal physiology, plant systematics, population biology, and tropical biology.

### **M.S. Admission Requirements**

Applicants to the M.S. program must submit completed application and personal data forms, three letters of recommendation from undergraduate faculty, and transcripts of all previous work. Submission of GRE scores, although not required, is highly recommended and will be helpful in a positive consideration of admittance. Admission as a regular graduate student normally requires graduation from an accredited college with an overall minimum GPA of 3.00 and a minimum GPA of 3.00 in the applicant's undergraduate major.

All foreign applicants, except those from countries where English is the primary language, must take the TOEFL Examination (Test of English as a Foreign Language). Ordinarily, a score of 550 or better is required. In addition, upon arrival, all international students are required to take an English placement exam. Depending on the results, students may be required to take 1-3 English courses their first semester. Finally, all international Ph.D. students and M.S. students with a TA are required by Missouri state law to take a course to enhance their teaching skills.

In addition to Graduate School admission requirements, applicants should have completed advanced undergraduate biology courses including introduction to biology, biochemistry, basic calculus, cell structure and function, structural and organic chemistry, ecology, evolution, and genetics. Courses in college physics and a course in statistics is highly recommended. Students admitted to the degree program who have not met some of the prerequisites may be asked to pass appropriate courses before graduating. These courses will be agreed upon by the student's advisor, the student, and the Director of Graduate Studies during the first semester of enrollment. In particular, undergraduate deficiencies in genetics and either biochemistry or evolution shall be made up by taking the appropriate course(s). A maximum of three credits of B392 Topics in Biology can be given to graduate students for B224, B246, or B371 if they receive a B or better grade for all undergraduate course work and complete a graduate-level paper assigned by the instructor. Instructor consent is required.

### **M.S. Degree Requirements**

**General Requirements:** All students are required to take at least four but not more than eight hours of Biology 489, Graduate Seminar.

**Advisors:** All incoming thesis and non-thesis students will be assigned an academic advisor by the Director of Graduate Studies upon admission to the graduate program. In the event that a student's interests change or the faculty advisor feels the student's direction no longer falls within his/her area of expertise, the student and advisor should discuss whether a change of advisor is warranted. The graduate director must be notified in writing of any changes in advisors. If a student or advisor is uncomfortable discussing the issue directly with his/her advisor (or vice versa), he/she is encouraged to meet with the director or associate director of the graduate program. Written guidelines are available upon request.

**Non-thesis Option:** Including the general requirements, students must take at least 36 credit hours of which at least half must be at the 400 level. Students are encouraged to take a laboratory course (300 or 400 level) or two credit hours of Biology 490, Graduate Research. A maximum of 5 credit hours of Biology 490 will be counted toward the 36 credit hour total. This research may be conducted in the field, laboratory, or library. A member of the Graduate Committee of the Department of Biology will advise new master's students until a permanent advisor in the student's area of specialization is identified. Before the student has completed 18 hours in the master's program, the student and advisor together plan a suitable program of course work. This program for the Master's Degree must be filed with the Director of Graduate Studies before the student completes 18 credit hours in the master's program. An "Application for Graduate Degree" form must be filed 6 weeks before graduation. The form should be prepared by the student's advisor and submitted to the Director of Graduate Studies. It is the student's responsibility, however, to be sure the form has been filed.

**Thesis Option:** Including the general requirements, students must take at least 30 graduate credit hours of which at least half must be at the 400 level. No more than 13 hours Biology 490, Graduate Research, may be counted toward the degree. Students, with their advisor, recommend an appropriate advisory committee of two or more faculty members for approval by the graduate director. The chair of the thesis committee would be a member of the graduate faculty other than the student's advisor. The student's committee must be approved before the student completes 12 hours in the master's program. The student, advisor, and advisory committee together plan a suitable program of research and course work. This Program for the Master's Degree must be filed with the Director of Graduate Studies before the student completes 15 credit hours in the master's program. The Thesis/Project Proposal, a 2-10 page outline or paper, must be approved by the advisory committee and submitted to and approved by the Director of Graduate Studies before the student enrolls in more than 4 credit hours of Biology 490, Graduate Research, and before the student has completed 15 credit hours in the master's program. A thesis embodying results of original research shall be submitted to and approved by the Department of Biology and the Graduate School. This approval requires both a written and an oral presentation and defense. General regulations concerning preparation of thesis must be met.

## **Ph.D. in BIOLOGY**

The doctoral program emphasizes empirical and theoretical approaches to biological research. Students are required to integrate basic skills in biology with focal studies in an emphasis area. The program is designed to provide research experience and training appropriate for advanced positions in academic research and teaching, government and public agencies and in industry.

### Ph.D. Admission Requirements

Applicants to the Ph.D. program must submit formal application to the Graduate Admissions Office. In addition, the applicant should arrange to have sent: three letters of recommendation from faculty members at previously attended colleges or universities, transcripts of all post-secondary academic work, and Graduate Record Examination (GRE) scores (Verbal, Quantitative, and Analytical). Admission to the Ph.D. program normally requires a minimum grade point average overall and in biology courses of 3.0 (where A= 4.0).

Applicants from countries where English is not a primary language are required to take the TOEFL Examination (Test of English as a Foreign Language). Scores must be submitted before admission can be decided. Ordinarily, a score of 550 or better is required.

Applicants should have a bachelor's degree from an accredited United States college or university or evidence of equivalent training at an accredited institution outside the United States. Applicants should have the appropriate background for graduate work in biology including courses in genetics, biochemistry, and evolution. Courses in calculus, organic chemistry, and college physics are also expected. A course in statistics is highly recommended. Students admitted to the Ph.D. program who have not met some of the prerequisites will be required to make up deficiencies before admission to candidacy. The deficiencies will be decided during orientation meetings prior to the start of the second semester. Three credits of B392 Topics in Biology can be given to graduate students for B224, B246, or B371 if they receive a B or better grade for all undergraduate course work plus completing a graduate level paper assigned by the instructor. Instructor consent is required.

### Ph.D. Degree Requirements

In addition to the general requirements of the Graduate School, the basic requirements for the Ph.D. degree in Biology include sixty (60) credit hours of course work which must be taken beyond the bachelor's degree. At least 30 of the 60 hours must be taken at the 400 level. With the explicit consent of the advisory committee, students may take for graduate credit up to three credit hours of 200 level courses in allied departments. Courses in Biology at the 200 level and below are not available for graduate credit. At least 31 of the 60 hours must be taken while in residence at the University of Missouri-St. Louis. Graduate credit for course work transferred from another program is subject to approval by the graduate committee and by the Graduate School. Graduate courses taken elsewhere will be considered for transfer credit during orientation meetings conducted prior to the start of the second semester of enrollment.

Required course work shall be completed as follows (24 total credit hours):

- a) Biology 388 (3 hours), *Biometry*, or equivalent course in statistics
- b) Biology 489 (2 hours), *Graduate Seminar*. Three semesters required (6 credits total).
- c) 12 hours of formal course work required by the student's emphasis area at the time a student is admitted to the Ph.D. program.

The maximum number of credit hours that may be applied toward the 60 hour requirement is limited as stated below.

- a) A combination of 6 total credit hours of the following:  
Biology 405, *Topics in Ecology, Evolution, and Systematics*  
Biology 406, *Topics in Molecular, Cellular, & Developmental Biology*  
Biology 407, *Topics in Floristic Taxonomy*
- b) Biology 489, *Graduate Seminar*, 10 hours
- c) Biology 490, *Graduate Research*, 30 hours

**Student/Advisor Relationship:** Doctoral students will be assigned an advisor upon admission to the graduate program. The progress of a doctoral student will rely heavily on the relationship between that student and his/her advisor. It is expected that the student and advisor will have at least one annual discussion of the progress of the student in the doctoral program. This meeting provides a good opportunity to discuss strengths and weaknesses of the student's performance. This meeting also provides the student an opportunity to discuss the role of the advisor. In the event that a student's interests change or the faculty adviser feels the student's direction no longer falls within his/her area of expertise, the student and advisor should discuss whether a change of advisor is warranted. The graduate director must be notified in writing of any change in advisors. If a student is uncomfortable discussing the

issue directly with his/her advisor (or vice versa), he/she is encouraged to meet with the director or associate director of the graduate program. Written guidelines are available upon request.

Biology graduate studies, p. 5

**First Year Research Experience:** Graduate students are expected to become involved in a research experience during their first year program, usually winter or summer semester. In consultation with the advisor, a student can meet this expectation in a variety of ways including: (1) laboratory experience with a faculty member; (2) independent research; (3) participation in a course offered by the Organization for Tropical Studies; or (4) options to be agreed upon by the advisor and the Graduate Director. Students participating in research experience not related to their dissertation should enroll in Biology 491, *Graduate Research Practicum*.

**Qualifying Examination:** Students must pass a qualifying examination (which consists of a written and oral component) based on fundamental principles presented in formal courses and in papers of special importance in the field. The written component of the exam will be distributed to students by a faculty committee in the appropriate emphasis area in December of each year, and the oral component of the exam will be conducted in January. Students beginning studies in the fall semester would normally take the qualifying examination prior to their fourth semester of full-time study. Doctoral students who have earned a M.S. degree previously are encouraged to take the examination in their first year. A reading list, upon which the exam is based, will be given during the spring semester prior to the exam. Students who receive a conditional pass will be tested again. Students who fail may be allowed to retake the qualifying examination the following year. Students who fail twice will be recommended to terminate the program.

**Admission to Candidacy:** In order to be admitted to candidacy students must satisfy the requirements of the graduate school, which includes passing all qualifying examinations and completing all required course work (which is a minimum of 24 credit hours as specified above).

**Dissertation Proposal:** All students must defend orally a written dissertation proposal to their dissertation committee. The chair of the dissertation committee would be a member of the graduate faculty other than the student's advisor. (A draft of this proposal must be given to the members of the committee no later than two weeks prior to the date of the defense). The approved proposal must be submitted to the Director of Graduate Studies in Biology. Doctoral students may not enroll in more than four credits of graduate research (Biology 490) before they have received approval for their dissertation proposal. All students are expected to submit their research proposals to outside agencies for financial support of their research.

**Dissertation:** A dissertation embodying the results of original research shall be submitted to and approved by the Department of Biology and the Graduate School. The general regulations of the Graduate School concerning the preparation of the dissertation must be met. These rules include a public oral defense of the written dissertation. (The dissertation should be distributed to committee members no less than four weeks prior to the anticipated date of defense). Dissertations are to be presented in a style appropriate for one or more publications in scientific journals.

**Teaching:** At least one semester of supervised teaching is required of all doctoral students.

### **Program Structure**

**Year 1:** During the week of registration prior to the beginning of classes, students newly admitted to the doctoral program shall meet with at least three members of the faculty representing the area of emphasis of the student. A second meeting will be held toward the end of the first semester. These meetings are designed to introduce each student to the faculty in his/her area of study and to provide early orientation into the department and degree program. In addition, this informal process will help to identify particular strengths and/or possible deficiencies in the background of the student and therefore to assist in the organization of a program of studies. After the orientation committee has met with the student, they will consult with the student's advisor to decide upon course requirements. Each student will receive a written statement from this committee about any course deficiencies or requirements that he/she will need to address and any courses which are acceptable for graduate transfer credit by the start of the second semester. It is expected that students will complete the majority of their course work during the first two years. Students with M.S. degrees may also complete their qualifying examinations during their first year.

**Year 2:** Students are expected to continue course work, to complete their qualifying examinations, and to initiate work toward their dissertation proposal during the second year. Sometime during the second year, the student should try to collect preliminary data for their dissertation proposal. In addition, the student might initiate communications with prospective members of the dissertation advisory committee. It is expected that doctoral students will be ready for admission to candidacy by the end of their second year.

*Year 3:* The major focus of this year is preparation, completion, and oral defense of the dissertation proposal. It is expected that doctoral students will complete their proposal by the fifth semester. Students should devote a majority of their effort to doctoral research during their third year.

*Year 4 and 5:* The focus of these years are the dissertation research with the addition of any necessary relevant specialized courses or seminars. Students should have a committee meeting each year past the third year proposal defense. It is expected that a student will write their dissertation no later than their fifth year.

### **Ph.D. Emphasis Area in Ecology, Evolution and Systematics**

Students who are admitted into the Ph.D. program in the emphasis area of ecology, evolution, and systematics (EES) will be required to complete the curriculum described below. Individuals interested in tropical biology and/or conservation biology can choose courses from specialized curriculum in those areas (see below).

**Required Courses:** In addition to the courses required for the Ph.D. in Biology, students in the EES emphasis area are required to successfully complete two of the three courses listed below during their first two years in the graduate program.

Biol 341 *Population Biology* (3 credits)

Biol 442 *Population and Community Ecology* (3 credits)

*A course in systematics, either*

Biol 351 *Flowering Plant Families: Phylogeny and Diversification* (5 credits)

or

Biol 365 *Plant Systematics*

**Elective Courses:** The remaining credits in this area must be acquired through at least 3 of the courses listed below or in the list of required courses. Courses at Washington University, St. Louis University, and Southern Illinois University-Edwardsville may be used with permission of the student's advisor and the Director of Graduate Studies in Biology.

Biol 423 *Tropical Resource Ecology* (3 credits)

Biol 425 *Advanced Tropical Vertebrate Ecology* (3 credits)

Biol 429 *Advanced Molecular Evolution* (3 credits)

Biol 440 *Ecological Research in Temperate Zones* (3 credits)

Biol 445 *Public Policy of Conservation and Sustainable Development* (3 credits)

Biol 446 *Theory and Applications of Conservation Biology* (3 credits)

Biol 448 *Advanced Evolution of Animal Sociality* (3 credits)

Biol 458 *Advanced Evolutionary Ecology of Plants* (3 credits)

Biol 459 *Advanced Evolutionary Ecology of Animals* (3 credits)

Biol 465 *Methods in Plant Systematics* (4 credits)

Biol 480 *Advanced Behavioral Ecology* (3 credits)

Biol 483 *Applications of Geographic Information Systems* (3 credits)

Biol 487 *Advanced Tropical Ecology and Conservation* (3 credits)

*Organization for Tropical Studies (OTS) Field Course* (3 credits)

### **Ph.D. Emphasis Area in Cellular and Molecular Biology**

Students who are admitted into the Ph.D. program in the emphasis area of Molecular and Cellular Biology will fulfill the degree requirements for a Ph.D. in Biology and will take the courses described below.

**Required Courses:** In addition to the courses required for the Ph.D. in Biology, students in this emphasis area must complete three of the five courses listed below during their first two years in the graduate program.

Biol 376 *Topics in Biological Chemistry* (3 credits)

(or Chem 372, *Advanced Biochemistry*)

Biol 428 *Advanced Techniques in Molecular Biology* (4 credits)

Biol 435 *Advanced Molecular Cell Biology* (3 credits)

Biol 426 *Advanced Gene Expression in Eukaryotes* (3 credits)  
Biol 438 *Advanced Gene Expression in Prokaryotes* (3 credits)

Biology graduate studies, p. 7

**Elective Courses:** The remaining credits in this area must be acquired through at least 3 of the courses listed below or in the list of required courses. Courses at Washington University, St. Louis University, and Southern Illinois University-Edwardsville may be used with permission of the student's advisor and the Director of Graduate Studies in Biology.

Biol 320 *Introduction to Neuroscience* (3 credits)  
Biol 360 *Techniques in Electron Microscopy* (5 credits)  
Biol 417 *Advanced Immunology* (3 credits)  
Biol 429 *Advanced Molecular Evolution* (3 credits)  
Biol 434 *Advanced Virology* (3 credits)  
Biol 444 *Advanced Gene Activity During Development* (3 credits)

## **Graduate Certificate in Tropical Biology and Conservation**

A Graduate Certificate in Tropical Biology and Conservation is a multidisciplinary program of study integrating theoretical and applied topics associated with tropical biology and conservation. The Graduate Certificate is intended for the following: those who wish to pursue a career in conservation biology from either a research or practical standpoint; those who already have careers in conservation or environmental biology who wish to enhance their background; those who are pursuing careers in related fields who could benefit from additional formal training in conservation biology. Cooperating groups include the Missouri Botanical Garden, the Center for International Studies at UM-St. Louis, and the departments of Anthropology, Economics, History, Political Science, Social Work, and Sociology.

### **Core Courses:**

Biol 445 *Public Policy of Conservation and Sustainable Development* (3 credits)  
Biol 447 *Internship in Conservation Biology* (1-4 credits)  
(may be replaced with a biology elective for individuals with applied conservation or environmental agency experience upon consent of the Graduate Committee)  
Choice of: Biology 446, *Theory and Application of Conservation Biology* (3 credits)  
Biology 487, *Advanced Tropical Ecology and Conservation* (3 credits)

### **Electives:**

Biol 341 *Population Biology* (3 credits)  
Biol 351 *Flowering Plant Families: Phylogeny and Diversification* (5 credits)  
Biol 364 *Ornithology* (3 credits)  
Biol 367 *Entomology* (3 credits)  
Biol 385 *Wildlife Ecology and Conservation* (3 credits)  
Biol 396 *Introduction to Marine Science* (3 credits)  
Biol 423 *Advanced Tropical Resource Ecology* (3 credits)  
Biol 424 *Advanced Tropical Resource Ecology Field Studies* (2 credits)  
Biol 425 *Advanced Tropical Vertebrate Ecology* (3 credits)  
Biol 441 *Advanced Population Biology* (3 credits)  
Biol 442 *Advanced Population and Community Ecology* (3 credits)  
Biol 446 *Theory and Application of Conservation Biology* (3 credits)  
Biol 458 *Evolutionary Ecology of Plants* (3 credits)  
Biol 459 *Advanced Evolutionary Ecology of Animals* (3 credits)  
Biol 465 *Methods in Plant Systematics* (4 credits)  
Biol 480 *Advanced Behavioral Ecology* (3 credits)  
Biol 483 *Applications of Geographic Information Systems* (3 credits)  
Biol 487 *Advanced Tropical Ecology and Conservation* (3 credits)  
Biol 489 *Graduate Seminar* (2 credits), when relevant

**Graduate Certificate in Tropical Biology and Conservation** (Continued)

Chemistry 419	<i>Advanced Readings in Chemistry</i> (1 credit)
Economics 230	<i>International Economic Analysis</i>
Economics 251	<i>Intermediate Economic Theory: Microeconomics</i>
Economics 360	<i>Natural Resource Economics</i> (3 credits)
History 300	<i>Selected Topics in History</i> (3 credits), when relevant
History 371	<i>History of Latin America: To 1808</i> (3 credits)
History 372	<i>History of Latin America: Since 1808</i> (3 credits)
History 381	<i>West Africa Since 1800</i> (3 credits)
History 425	<i>Readings in Latin American History</i> (3 credits), when relevant
History 430	<i>Readings in African History</i> (3 credits), when relevant
Political Science 248	<i>Environmental Politics</i> (3 credits)
Political Science 253	<i>Political Systems of South America</i> (3 credits)
Political Science 254	<i>Political Systems of Mexico, Central America, and the Caribbean</i> (3 credits)
Political Science 258	<i>African Politics</i> (3 credits)
Political Science 283	<i>International Political Economy</i> (3 credits)
Political Science 285	<i>International Organizations and Global Problem Solving</i> (3 credits)
Political Science 347	<i>Introduction to Environmental Law and Policy</i> (3 credits)
Political Science 359	<i>Studies in Comparative Politics</i> (3 credits), when relevant
Political Science 385	<i>International Law</i> (3 credits)
Political Science 388	<i>Studies in International Relations</i> (3 credits)
Political Science 394	<i>Leadership and Management in Nonprofit Organizations</i> (3 credits)
Political Science 414	<i>Topics in Public Policy Analysis</i> (3 credits), when relevant
Political Science 448	<i>Political Economy of Public Policy</i> (3 credits)
Political Science 459	<i>Seminar in Latin American Politics</i> (3 credits), when relevant
Political Science 462	<i>Political Theory and Public Policy</i> (3 credits)
Political Science 481	<i>Seminar in International Relations</i> (3 credits)
Social Work 390	<i>Seminar in Social Work Issues</i> (1-3 credits), when relevant
Sociology 342	<i>World Population and Ecology</i> (3 credits)
Sociology 346	<i>Demographic Techniques</i> (3 credits)
Sociology 426	<i>Community and Regional Conflict Intervention</i> (3 credits)

## **Graduate Certificate in Biotechnology**

The Graduate Certificate in Biotechnology is offered for students with a Bachelor's degree who wish to obtain advanced level training in those fields of biology that pertain to biotechnology without necessarily earning a Master's degree. Students who enter this program may have a variety of interests including biochemistry, microbiology, molecular biology, cell biology, developmental biology, or molecular evolution.

### **Core Courses:**

Biol 426 *Advanced Gene Expression in Eukaryotes* (3 credits)  
Biol 428 *Advanced Techniques in Molecular Biology* (4 credits)  
or  
Biol 438 *Advanced Gene Expression in Prokaryotes* (3 credits)  
Biol 489 *Graduate Seminar* (2 credits)

### **Electives:**

Biol 317 *Immunobiology* (3 credits)  
Biol 319 *Immunobiology Laboratory* (3 credits)  
Biol 371 *Biochemistry* (3 credits)  
Biol 376 *Topics in Biological Chemistry* (3 credits)  
Biol 406 *Topics in Molecular, Cellular, Developmental Biology* (1 credit)  
Biol 417 *Advanced Immunology* (3 credits)  
Biol 429 *Molecular Evolution* (3 credits)  
Biol 431 *Internship in Biotechnology* (Arr.)  
Biol 434 *Advanced Virology* (3 credits)  
Biol 435 *Advanced Molecular Cell Biology* (3 credits)  
Biol 444 *Gene Activity During Development* (3 credits)

Chem 372      *Advanced Biochemistry* (3 credits)  
Chem 373      *Biochemical Techniques* (2 credits)