
Biology

In the College of Sciences

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<http://www.bio.sdsu.edu>

Faculty

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Chair of Department

Leroy R. McClenaghan, Jr., Ph.D., Professor of Biology, Associate
Chair of Department

J. David Archibald, Ph.D., Professor of Biology,
(Graduate Coordinator, Biology)

Sanford I. Bernstein, Ph.D., Professor of Biology

Annalisa Berta, Ph.D., Professor of Biology

Richard L. Bizzoco, Ph.D., Professor of Biology

Michael J. Buono, Ph.D., Professor of Biology

Douglas H. Deutschman, Ph.D., Professor of Biology

Christopher C. Glembofski, Ph.D., Professor of Biology and
Associate Dean of the Division of Graduate Affairs

Roberta A. Gottlieb, M.D., Professor of Biology

Greg L. Harris, Ph.D., Professor of Biology
(Graduate Adviser, Biology Ph.D. program)

Stanley R. Maloy, Ph.D., Professor of Biology and
Dean of the College of Sciences

Kathleen L. McGuire, Ph.D., Professor of Biology

Walter C. Oechel Ph.D., Professor of Biology
(Graduate Adviser, Ecology Ph.D. program)

Jacques Perrault, Ph.D., Professor of Biology

Robert S. Pozos, Ph.D., Professor of Biology

Tod W. Reeder, Ph.D., Professor of Biology

Anca Mara Segall, Ph.D., Professor of Biology
(Graduate Adviser, Microbiology)

Michael G. Simpson, Ph.D., Professor of Biology

Mark A. Sussman, Ph.D., Professor of Biology

Constantine Tsoukas, Ph.D., Professor of Biology
(Graduate Adviser, Molecular Biology)

Todd W. Anderson, Ph.D., Associate Professor of Biology
(Graduate Adviser, Ecology)

Andrew J. Bohonak, Ph.D., Associate Professor of Biology

Kevin Burns, Ph.D., Associate Professor of Biology
(Graduate Adviser, Evolutionary Biology)

Matthew S. Edwards, Ph.D., Associate Professor of Biology

Marshal C. Hedin, Ph.D., Associate Professor of Biology

Brian T. Hentschel, Ph.D., Associate Professor of Biology

Kevin A. Hovel, Ph.D., Associate Professor of Biology

Scott Kelley, Ph.D., Associate Professor of Biology

David Lipson, Ph.D., Associate Professor of Biology

Forest Rohwer, Ph.D., Associate Professor of Biology

Elizabeth R. Waters, Ph.D., Associate Professor of Biology

Kathy S. Williams, Ph.D., Associate Professor of Biology

Robert W. Zeller, Ph.D., Associate Professor of Biology

Rulon W. Clark, Ph.D., Assistant Professor of Biology

Kelly Doran, Ph.D., Assistant Professor of Biology

Ralph Feuer, Ph.D., Assistant Professor of Biology

Chun-Ta Lai, Ph.D., Assistant Professor of Biology

Rebecca Lewison, Ph.D., Assistant Professor of Biology

Roland Wolkowicz, Ph.D., Assistant Professor of Biology

Ricardo Zayas, Ph.D., Assistant Professor of Biology

Associateships and Assistantships

Graduate teaching associateships and graduate assistantships in biology are available to a limited number of qualified students. Application and additional information may be secured from the graduate coordinator in biology.

General Information

The Department of Biology offers graduate study leading to the degrees of Master of Arts and Master of Science in biology and the Master of Science degree in microbiology. In addition, the Department of Biology offers a joint program leading to the Ph.D. with the University of California, San Diego, and the ecology group offers a joint program leading to the Ph.D. with the graduate group in ecology at the University of California, Davis. These academic programs can prepare students for teaching careers.

Modern life science buildings provide facilities for graduate study in the biological sciences. Additional facilities available in the community include the San Diego Zoo hospital, the United States Department of Agriculture, Fish and Game Commission, the Hubbs-Sea World Research Institute, the San Diego Natural History Museum, and the Naval Underseas Center. San Diego State University also operates a marine laboratory on Mission Bay and has access to research sites in the Chihuahu Valley, Fortuna Mountain, and Temecula (Riverside County).

Admission to Master's or Doctoral Study

Students applying for admission should electronically submit the university application available at <http://www.csumentor.edu> along with the \$55 application fee.

All applicants must submit admissions materials separately to SDSU Graduate Admissions and to the Department of Biology.

Graduate Admissions

The following materials should be submitted as a complete package directly to:

Graduate Admissions
Enrollment Services
San Diego State University
San Diego, CA 92182-7416

- (1) Official transcripts (in sealed envelopes) from all postsecondary institutions attended;

Note:

- Students who attended SDSU need only submit transcripts for work completed since last attendance.
- Students with international coursework must submit both the official transcript and proof of degree. If documents are in a language other than English, they must be accompanied by a certified English translation.

- (2) GRE scores (<http://www.ets.org>, SDSU institution code 4682);
- (3) TOEFL score, if medium of instruction was in a language other than English (<http://www.ets.org>, SDSU institution code 4682).

Master of Arts Degree in Biology

Master of Science Degree in Biology

Master of Science Degree in Microbiology

The following materials should be mailed or delivered to:

Department of Biology
Graduate Coordinator
San Diego State University
5500 Campanile Drive
San Diego, CA 92182-4614

- (1) Biology department application;
- (2) Application for teaching associateship position or graduate assistantship (optional);
- (3) At least two letters of recommendation in sealed and signed envelopes (optional form available online or may be obtained from department). Forms are available at

<http://www.bio.sdsu.edu/gradprog.html>.

Ph.D. Degree in Biology (Cell and Molecular)

The following materials should be mailed or delivered to:

Biology Joint Doctoral Program Coordinator
Department of Biology
San Diego State University
5500 Campanile Drive
San Diego, CA 92182-4614

- (1) Statement of professional goals;
- (2) Resume or curriculum vitae;
- (3) Department application and residence form (http://www.bio.sdsu.edu/cmb/phd_app_proced.html, or may be obtained from the department);
- (4) Three letters of recommendation in sealed and signed envelopes (form available online or may be obtained from the department).

Ph.D. Degree in Ecology

The following materials should be mailed or delivered to:

Ecology Joint Doctoral Program Coordinator
Department of Biology
San Diego State University
5500 Campanile Drive
San Diego, CA 92182-4614

- (1) Statement of professional goals;
- (2) Resume or curriculum vitae;
- (3) Three letters of recommendation in sealed and signed envelopes (form available online or may be obtained from the department).

Application for admission must be made simultaneously to San Diego State University and the University of California, Davis.

Section I. Master's Degree Programs

The Master of Science degrees in biology and microbiology are acceptable as preparation for more advanced degree programs. Studies for degrees in biology must be completed in one of the research programs listed below. The Master of Arts degree in biology has a foreign language requirement.

Admission to the Degree Curriculum

In addition to the general requirements for admission to the university with classified graduate standing, as described in Part Two of this bulletin, a student must satisfy the following requirements before he/she will be considered for recommendation to enter the masters program.

1. Meet the requirements deemed equivalent to a baccalaureate degree in biology or microbiology at San Diego State University.
2. Have a grade point average of 2.85 or better on work taken for the baccalaureate degree.
3. Have a grade point average of 3.0 or better in upper division courses (at least 24 units) acceptable for the major.
4. Meet biology departmental expectations on the GRE General Test.
5. Be considered as capable of graduate work in the biological sciences by at least two letters of reference submitted to the biology graduate coordinator.
6. Be accepted by a research program and be sponsored by a faculty member of the area (required only for programs in ecology and evolutionary biology).

NOTE: Admission to a research program within the biology graduate program will be limited to the number of students for which adequate facilities and faculty sponsorship are available. Students should therefore be as specific as possible in their indication of research interests and career goals. Individual research programs will admit students solely on the basis of merit in relation to space and faculty availability.

Students who do not meet all of the above requirements for admission with classified graduate standing may be admitted with conditionally classified graduate standing upon the recommendation of the research program. Students so admitted will be advised as to the nature of their deficiency and the time to be allowed to achieve full classified graduate standing.

Biology

Advancement to Candidacy

All students must satisfy the general requirements for advancement to candidacy, including the foreign language requirement for the Master of Arts degree, as stated in Part Two of this bulletin. Presenting a successful thesis proposal (as indicated by submission of a completed thesis proposal form) is required to be advanced to candidacy.

Specific Requirements for the Master of Arts Degree in Biology

In addition to meeting the requirements for classified graduate standing and the basic requirements for the master's degree as described in Part Two of this bulletin, the student must complete a graduate program of 30 units of upper division and graduate courses selected, with the approval of the graduate coordinator, from the biological sciences as listed below, or from closely related fields. At least 15 of the units selected must be in 600- and 700-numbered courses, including Biology 799A, Thesis. A maximum of six units of the required 30 units may be selected from acceptable courses offered in the College of Education. A reading knowledge of scientific French, German, Russian, or Spanish, and a final oral examination in the field of the thesis and its implications in the broad fields of biology are also required.

Specific Requirements for the Master of Science Degree in Biology

In addition to meeting the requirements for classified graduate standing and the basic requirements for the master's degree as described in Part Two of this bulletin, the student must complete a graduate program of 30 units of upper division and graduate courses selected, with the approval of the graduate coordinator, from the biological sciences as listed below, or from closely related fields. At least 15 of the units selected must be in 600- and 700-numbered courses, including Biology 799A, Thesis. A maximum of six units of the required 30 units may be selected from acceptable courses offered in the College of Education. A final oral examination in the field of the thesis and its implication in the broad fields of biology is also required.

Master's Degree Research Programs

Ecology (Major Code: 04201): The overall program emphasizes quantitative approaches to ecological research and the framing of problems within the general context of ecological theory. Faculty and student research currently falls into the areas of limnology, marine ecology, plant community ecology and primary productivity, physiological plant ecology, marine aquaculture and fisheries ecology, animal population ecology and energetics, ecological genetics, ecosystems management, and systems ecology. Program adviser, Anderson.

Evolutionary Biology (Major Code: 04071): This research program is broadly concerned with the biology and evolution of whole organisms. The student has a wide variety of research areas from which to choose, including morphology, systematics, paleontology, natural history, behavior, comparative physiology, developmental biology, population genetics, coevolution, and evolutionary theory. Many groups of organisms are studied, including marine and terrestrial invertebrates, vertebrates, and plants. Program adviser, Burns.

In addition to the emphases described above, a number of faculty have active research programs in marine biology and accept graduate students in this area.

Microbiology (Major Code: 04111): A separate graduate degree is offered in microbiology. Program adviser, Segall.

Molecular Biology (Major Code: 04161): The program area is concerned with biology at the molecular level, with particular emphases on the correlation of structure and function of macromolecules, catalysis and control, molecular genetics, regulation of gene expression, and the molecular basis of cellular architecture, cell movement, bioenergetics and membrane function (administered through Molecular Biology Institute). Program adviser, Tsoukas.

Physiology (Major Code: 04101): Research opportunities are offered by faculty in the cell and molecular biology, ecology, and evolutionary biology program areas. Subareas of interest include cardiovascular, cellular, molecular, physiological plant ecology, and comparative physiology. Requirements for this program vary depending on the program area of the faculty adviser and prospective applicants are encouraged to contact potential faculty advisers or the program adviser before applying. Program adviser, Harris.

Microbiology

Advancement to Candidacy

All students must satisfy the general requirements for advancement to candidacy, as stated in Part Two of this bulletin. Satisfactory progress on the thesis research will be prerequisite to obtaining departmental approval for advancement.

Specific Requirements for the Master of Science Degree in Microbiology

(Major Code: 04111)

In addition to meeting the requirements for classified graduate standing and the basic requirements for the master's degree as described in Part Two of this bulletin, the student must complete a graduate program of 30 units of upper division and graduate courses selected, with the approval of the graduate adviser, from the biological sciences and closely related fields. All students entering the Master of Science program in microbiology will be required to take an advanced course in the molecular biology of microbes.

Not less than 18 units must be selected from courses in the area of microbiology. Among the 600- and 700-numbered courses selected, the student's program must include Biology 799A, Thesis. A maximum of six units of the required 30 units may be selected from acceptable courses offered in other related areas, including the College of Education and the Graduate School of Public Health.

A final oral examination on the field of the thesis and its implication in the broad fields of microbiology is required.

Section II. Doctoral Programs

Biology (Cell and Molecular)

(Major Code: 04111)

<http://www.bio.sdsu.edu/cmb/JointDoc.html>

The cooperating faculties of the Departments of Biology at the University of California, San Diego and at San Diego State University offer a joint doctoral program in biology (cell and molecular). The research interests of the participating faculty members cover a wide range of biological problems.

At SDSU, the major areas of research at the graduate level and the participating faculty members include:

Biological structures: T. Huxford, J. Love, T. Frey.

Cardiovascular molecular biology: R. Davis, C. Glembotski, R. Gottlieb, R. Sabbadini, M. Sussman.

Cell and molecular immunology: K. McGuire, C. Tsoukas, P. van der Geer.

Gene expression: G. Harris, W. Stumph, R. Zeller.

DNA recombination and chromosome structure: A. Segall.

Molecular biology of viruses and bacteriophage: R. Feuer, J. Perrault, F. Rohwer, R. Wolkowicz.

Molecular evolution: C. Arenas-Mena, S. Kelley, E. Waters.

Molecular microbiology: K. Doran, D. Lipson, S. Maloy.

Neurobiology: R. Zayas.

Substructure and function in motile cells: S. Bernstein, R. Bizzoco, P. Paolini.

Program

Undergraduate Preparation for Admission

Applicants for admission to the doctoral program offered jointly by UCSD and SDSU must present evidence of adequate preparation and capacity for advanced work in biology. There are no inflexible requirements for entrance to graduate study in this program, but a strong background in biology, mathematics, chemistry, and physics is recommended. The applicant must have a bachelor's degree or the equivalent from an accredited institution of higher learning with training comparable to that provided by the University of California's and San Diego State University's undergraduate programs. Admission to the program requires acceptance by each institution on recommendation of the participating departments at UCSD and SDSU. It is understood that acceptance of a student into the joint program by each of the departments will be conditioned by their respective standards for graduate admissions and also by available facilities.

Residency Requirements

After formal admission to the joint doctoral program, the student must spend at least one academic year in full-time residence at each of the two campuses. The definition of residence must be in accord with the regulations of the University of California, San Diego, and San Diego State University.

Advising Committee

Upon admission to the program the joint doctoral graduate adviser will establish an advising committee for the student. This committee will consist of three faculty members. In consultation with the student, the committee will develop the student's course of study and will establish the student's joint qualifying committee.

Course Requirements

There is no specific number of courses required for the doctoral program in biology, except a one-year graduate course including genetics, cellular and molecular biology. Prior to taking the qualifying examination, every student is expected to have a firm understanding of modern biological principles. Usually students will be expected to complete a set of at least four laboratory rotations, and such rotations may be fulfilled on either campus.

Coursework may be selected from offerings at either UCSD or SDSU.

Qualifying Examinations

Qualifying Committee

The qualifying committee consists of five faculty members, at least two from UCSD (one of whom must be a full-time faculty member in the Biology Department). The dissertation adviser may be a member of the qualifying committee. The members of the qualifying committee will be selected by the advising committee in consultation with the student. In order to provide continuity between examinations, at least one member of the qualifying committee shall be a member of the SDSU Executive Committee. Final appointment of qualifying committee members will be made jointly by the Graduate Deans of SDSU and UCSD.

The qualifying committee will be responsible for carrying out the qualifying examination, and the chair of this committee will report the outcome of the examination and any related academic recommendations to the Executive Committee. The chair will also provide a written evaluation of the student's performance. The chair of the qualifying committee is responsible for notifying the members of the time and place of the examination, and the student is responsible for obtaining all required documents necessary for the examination four weeks before the scheduled examination time.

Qualifying Examination

The examination will be administered in one session and consists of two parts.

First Part: Oral presentation of dissertation research results and proposed dissertation plan (duration is 40-50 minutes, similar to a formal seminar presentation, slides, etc.). The student should come prepared to defend the overall experimental design, including possible outcomes and interpretations, and be thoroughly familiar with the literature in his or her chosen field. A major portion of this examination will be devoted to background information so that a student can demonstrate the context in which the proposed research project lies. A succinctly written version of the proposed dissertation plan (maximum 14 double spaced pages) should be provided to committee members at least two weeks before the presentation. Prior written approval by all SDSU Qualifying Committee members stating that the written dissertation proposal is sufficiently developed must be obtained before the oral presentation takes place.

Second Part: In consultation with the members of the Qualifying Committee, the student will select two subject areas broadly related to the dissertation research. Two members of the Qualifying Committee with expertise in these areas will serve as primary mentors. The student will carry out literature research in each of the topics and select three to four research papers in each area to be discussed during the examination. Each of the papers to be discussed must meet the approval of the two primary mentors. The student will be expected to answer questions on the selected papers, relevant background, and potentially related topics. A major goal of this portion of the examination is to test the student's ability to extract information from the literature, to critically and objectively analyze this information, and to formulate a thorough knowledge base of the subject area.

The qualifying committee may specify a course of study to strengthen any weaknesses identified during the qualifying examination. Upon successful completion of the qualifying examination the student must make application to the office of Graduate Studies at UCSD for advancement to candidacy. Upon payment of the candidacy fee to UCSD, and after approval by the graduate deans on both campuses, the office of Graduate Studies at UCSD will notify the student of advancement to candidacy.

Joint Dissertation Committee

After a student is admitted to candidacy, a dissertation committee consisting of at least five faculty members is nominated by the graduate advisers and appointed jointly by the Graduate Deans at SDSU and UCSD. The student's dissertation research adviser will be the chair of this committee. At least one member of this committee must be from SDSU and one member must be a full-time faculty member from UCSD.

Dissertation

Following successful completion of the qualifying examination, the major remaining requirement for the Ph.D. degree will be satisfactory completion of a dissertation consisting of original and significant research carried out under the guidance of a faculty member. Requirements currently in force at UCSD and SDSU must be met for completing and filing the dissertation.

Award of the Degree

The Doctor of Philosophy degree in biology will be awarded jointly by the Regents of the University of California and the Trustees of The California State University in the names of both institutions.

Financial Support

The Department of Biology at SDSU endeavors to provide adequate support for all students so that full time can be devoted to research, training, and study. During 2008-09, support package included tuition, a stipend (approximately \$22,000-\$24,000), health coverage, and funds for research supplies. All students are required to obtain teaching experience, which is normally accomplished by appointment as a graduate teaching associate.

Faculty

The following faculty members of the cooperating institutions participate in the joint doctoral program being available for direction of research and as members of joint doctoral committees.

San Diego State University:

Graduate Adviser: S. Bernstein

Faculty: Arenas-Mena, Bernstein, Bizzoco, Davis, Feuer, Edwards, Frey, Glembotski, Gottlieb, Harris, Huxford (Chemistry and Biochemistry), Kelley, Krisans, Lipson, Love (Chemistry and Biochemistry), Maloy, McGuire, Paolini, Perrault, Rohwer, Sabbadini, Scott (Psychology), Segall, Stumph (Chemistry and Biochemistry), Sussman, Tsoukas, van der Geer (Chemistry and Biochemistry), Waters, Wolkowicz, Zeller, Zyskind.

University of California, San Diego:

Graduate Adviser: S. Brody

Faculty: All UCSD Biology Faculty

Ecology

(Major Code: 04201)

http://www.bio.sdsu.edu/ecology/prog_phd.php

The cooperating faculties of the Department of Biology, San Diego State University and the Graduate Group in Ecology, University of California, Davis offer a joint program in ecology leading to the Ph.D. The research interests of the participating faculty members cover a wide range of problems and represent the interdisciplinary nature of modern biology.

At SDSU, the research projects are underway concerning:

Coastal and marine ecology: Study of estuarine wetland functions, food webs, effects of natural and human disturbance, and interaction of native and exotic species. Population dynamics of invertebrates (esp. echinoderms). Community ecology of coral reefs, eelgrass beds, rocky shores, sandy beaches, the Salton Sea and other saline lakes.

Physiological ecology: Effects of global change (elevated CO₂ and climate change) on the structure and functioning of terrestrial ecosystems, including local chaparral, deserts, Alaska's North Slope, and vegetation near CO₂-emitting springs. Comparative and ecological physiology of vertebrates.

Population ecology: Reproductive biology of marine plants (algae and seagrasses). Analysis of life history strategies in animal and plant populations. Responses of chaparral vegetation to fire. Study of insect population dynamics and insect-plant interactions in natural and disturbed habitats. Aquaculture of marine fish. Genetic variation in small mammals. Food choice and adequacy of diets of animals in captivity.

Restoration and conservation ecology: Application of ecological principles to conserve species, manage fire, restore disturbed habitats, and retain genetic diversity (esp. in marine plants). Development of methods for assessing, restoring and creating coastal wetland ecosystems. Evaluation of efforts to restore or create deserts, coastal sage scrub, vernal pool, and riparian ecosystems. Role of mycorrhizae and soil biology in restoring vegetation.

A complete list of SDSU faculty and their research interests can be obtained from the graduate adviser of the program.

Program

Undergraduate Preparation for Admission

Applicants for admission to the doctoral program must present evidence of adequate preparation and capacity for advanced work in ecology. Preparation should include a strong background in biology, physics, chemistry, and mathematics. Applicants must have a bachelor's degree from an accredited college or university. Acceptance of a student into the joint program by each institution depends on meeting the standards of admission of the respective institutions and by available facilities for research and instruction.

Residency Requirements

After formal admission to the joint doctoral program, the student must spend at least one academic year in full-time residence on each of the two campuses. The definition of residence must be in accord with the regulations of the University of California, Davis, and San Diego State University.

Advising Committee

Upon admission to the program, the doctoral graduate advisers of the two institutions will establish an advising committee for the student. This committee will consist of three faculty members chosen jointly from the two cooperating institutions. In consultation with the student, the committee will develop the student's course of study and will establish the student's joint qualifying committee. At least one member of the advising committee must be from SDSU and one from UCD.

Course Requirements

Upon arrival at SDSU the advising committee works with the student to develop a course of study, which involves coursework at both SDSU and UCD and core requirements at UCD (three quarters of Ecology 296, three Ecology 290 seminars, and Principles and Application of Ecological Theory [Ecology 200A, 200B]). Prior to taking the qualifying examination, students complete the course of study, including the three quarters at UCD, and develop a firm understanding of ecological principles and research methods.

There is a five-year limit for completion of the Ph.D. in Ecology following advancement to candidacy.

Qualifying Examinations

Qualifying Committee

A five-member committee, composed of appropriate numbers of faculty members from each of the cooperating institutions, will be recommended by the advising committee for each student and approved by the Graduate Deans from each institution. The student's dissertation adviser cannot be a member of the qualifying committee.

The qualifying committee will conduct an oral comprehensive qualifying examination, which will evaluate the student's understanding of modern biological principles. The examination will focus on principles of ecology, research methods, and three areas related to the major research interest of the student. The purpose of this examination is to permit the student to demonstrate competence not only in the major research field but also in related areas of ecology.

The joint qualifying committee may specify a course of study to strengthen any weaknesses identified during the qualifying examination. Upon successful completion of the qualifying examination, the student must make application to the Graduate Division at UCD for advancement to candidacy. Upon payment of the candidacy fee to UCD, and after approval by the graduate deans on both campuses, the Graduate Division at UCD will notify the student of advancement to candidacy.

Joint Dissertation Committee

After a student is admitted to candidacy, a dissertation committee consisting of at least three faculty members is nominated by the graduate advisers and appointed jointly by the graduate deans at SDSU and UCD. The student's dissertation research adviser will be the chair of this committee. At least one member of this committee must be from SDSU and one member from UCD.

Dissertation

Following successful completion of the qualifying examination, the major remaining requirement for the Ph.D. degree will be satisfactory completion of a dissertation consisting of original and significant research carried out under the guidance of a faculty member. Requirements currently in force at UCD and SDSU must be met for completing and filing the dissertation.

Award of the Degree

The Doctor of Philosophy degree in ecology will be awarded jointly by the Regents of the University of California and the Trustees of The California State University in the names of both institutions.

Financial Support

The Department of Biology at SDSU endeavors to provide adequate support for all students so that full time can be devoted to research, training, and study. Support includes tuition, a stipend, and funds for research supplies. All students are required to obtain teaching experience, which is normally accomplished by appointment as a graduate teaching associate.

Faculty

Graduate Advisers:

San Diego State University: W. Oechel

University of California, Davis: Mark W. Schwartz

SDSU Faculty: Anderson, Bohonak, Clark, Deutschman, Edwards, Franklin, Hentschel, Hovel, Hurlbert, Lai, Lewison, Lipson, McClenaghan, Oechel, Reeder, Regan, K. Williams

Evolutionary Biology

(Major Code: 04071)

San Diego State University is in the process of securing approval for the joint Ph.D. program in Evolutionary Biology with the University of California, Riverside. For further information, contact the Department of Biology.

The cooperating faculties of the Department of Biology, San Diego State University (SDSU) and the Graduate program in Evolution, Ecology, and Organismal Biology (EEOG) at the University of California, Riverside (UCR) offer a joint program in evolutionary biology leading to the Ph.D. The research interests of the participating faculty cover a wide range of topics in evolutionary biology.

Program

Undergraduate Preparation for Admission

Applicants for admission to the doctoral program must present evidence of adequate preparation and capacity for advanced work in evolutionary biology. Preparation should include a strong background in biology. Applicants must have a bachelor's degree from an accredited college or university. Acceptance of a student into the joint program by each institution depends on meeting the standards of admission of the respective institutions and by available facilities for research and instruction.

Residency Requirements

After formal admission to the joint doctoral program, the student must spend at least one academic year in full time residence on each of the two campuses. The definition of residence must be in accord with the regulations of the University of California, Riverside, and San Diego State University.

Advising Committee

At the start of the student's first year in the program, the student will form a Guidance Committee. This committee will consist of four faculty members, two chosen from each institution. From SDSU, the committee must include the student's prospective dissertation advisor and an additional, programmatically appropriate, member. From UCR, the committee members will be drawn from faculty within the EEOB graduate program. In consultation with the student, the Guidance Committee plans the student's program through Advancement to Candidacy.

Course Requirements

The Guidance Committee works with the student to develop an individualized course of study and identify potential deficiencies. Students in the joint doctoral program will have similar requirements as students in UCR's EEOB graduate program. Specifically, the joint doctoral students will take the Theory of Evolution (UCR Biol 216) and at least two disciplinary courses (see below; the two required disciplinary courses must cover different disciplines; at least one disciplinary course must be taken at UCR). In addition, the students will enroll in a current research topics seminar course during each

UCR quarter or SDSU semester of residence. The majority of required course work should be completed prior to the Written Qualifying Examination, which is taken at the end of the second year. All required disciplinary courses (see below) must be completed before taking the Oral Qualifying Examination. An example of the required coursework and anticipated schedule for completion is presented below:

Year One at SDSU

Each semester:
 BIOL 795 Seminar in Ecology and Evolutionary Biology (3)
 Cr/NC

At least one of the following courses:
 BIOL 624 Population Genetics (3)
 BIOL 740 Phylogenetic Systematics (3)

Year Two at UCR

UCR BIOL 216 The Theory of Evolution
 Each quarter of residence:
 UCR BIOL 252 General Colloquium in Biology (or another
 disciplinary colloquium)

UCR BIOL 265 Advances in Population and Evolutionary
 Biology

At least one of the following courses:
 UCR BIOL 211 Ecology: Genes to Ecosystems
 UCR BIOL 212 Ecological Systems in Space and Time
 UCR BIOL 213 Behavioral Ecology
 UCR BIOL 214 Evolutionary Genetics
 UCR BIOL 217 Population and Community Ecology
 UCR BIOL 219 Theory of Systematics
 UCR BIOL 220 Evolutionary Physiology

Qualifying Examinations

Qualifying Committee

By the end of the second year, students are expected to have taken a written qualifying examination. The written examination is evaluated by an ad hoc committee of faculty participating in the JDPEB program. The committee will have a minimum of four faculty, at least two from SDSU EB and two from UCR EEOB. Upon passing the written examination, the student (in consultation with their SDSU and UCR co-advisers) selects an Oral Examination Committee. This committee normally consists of five faculty members: a minimum of two SDSU EB faculty and a minimum of two UCR EEOB faculty, and a UCR outside committee member. The student writes a detailed research proposal and schedules an oral examination. During the examination, the candidate must defend the research proposal and may be questioned on other topics by the Oral Examination Committee.

Joint Dissertation Committee

After passing the Written and Oral Examinations, students file for Advancement to Candidacy with the Graduate Divisions at SDSU and UCR. On the petition, students state the dissertation topic and selects the members of the Dissertation Committee, to be approved by the Graduate Division. This committee will consist of at least four faculty members, including the major adviser. At least two members must be from at least two members must be from the evolutionary biology faculty of SDSU and the EEOB faculty of UCR (with approval from the Graduate Division at UCR).

Dissertation

Following successful completion of the qualifying examination, the final requirement of the Ph. D. degree will be satisfactory completion of a dissertation consisting of original and significant research carried out under the guidance of the joint dissertation committee. Requirements currently in force at SDSU and UCR must be met for completing and filing the dissertation.

Award of the Degree

The Doctor of Philosophy degree in Evolutionary Biology will be awarded jointly by the Regents of the University of California and the Trustees of the California State University in the names of both institutions.

Financial Support

The Department of Biology at SDSU endeavors to provide adequate support for all students so that full time can be devoted to research training and study. Support includes tuition, a stipend, and funds for research supplies. All students are required to obtain teaching experience, which is normally accomplished by appointment as graduate teaching associate.

Faculty

Graduate Advisers:

San Diego State University: A. Berta

University of California, Riverside: C. Hayashi

SDSU Faculty: Archibald, Berta, Bohonak, Burns, Clark, Hedin, Kelley, Rohwer, Reeder, Simpson, Waters, Zeller.

Courses Acceptable on Master's and Doctoral Degree Programs in Biology (BIOL)

Refer to Courses and Curricula and Regulations of the Division of Graduate Affairs sections of this bulletin for explanation of the course numbering system, unit or credit hour, prerequisites, and related information.

UPPER DIVISION COURSES

Writing Requirement: Completion of the Graduation Writing Assessment Requirement or the eligibility to enroll in an upper division writing course is a prerequisite for all upper division biology courses numbered 450 and above.

BIOL 508. Coevolution (3)

Prerequisites: Biology 352 and 354.

Coevolution in interspecific interactions, like herbivory, predation, parasitism, competition, pollination, and mimicry.

BIOL 509. Evolutionary Biology (3)

Two lectures and two hours of activity.

Prerequisite: Biology 352.

Evolutionary biology including genetics of populations, speciation, systematic biology, adaptation, role of development in evolution, evolution of behavior, and comparative biology. Evolutionary biology as the central organizing principle of biology.

BIOL 510. Molecular Evolution (3)

Prerequisites: Biology 352 and 366 or graduate standing.

Molecular evolution including concepts of homology and convergence, the nearly neutral theory of evolution, evolution of new protein function, detecting selection, multi-gene family evolution and evolutionary genomics.

BIOL 511. Evolution of Development (3)

Prerequisites: Biology 352 and 366.

Dynamic relationship between regulatory functions that control development and the evolutionary process, and vice versa, illustrated with evidence derived from developmental, phylogenetic, paleontological, computational, and ecological research. Emphasis on genomic regulatory networks of transcriptional regulatory elements and cell-signaling pathways.

BIOL 512. Evolution and Ecology of Marine Mammals (3)

Two lectures and three hours of laboratory.

Prerequisites: Biology 352 and 354.

Biology of marine mammals including pinniped, cetacean and sirenian evolution, diet and foraging strategies, social organization, reproductive strategies, echolocation, diving physiology, and conservation.

BIOL 514. Biology of the Algae (4)

Three lectures and three hours of laboratory.

Prerequisites: Biology 203, 203L, 204, 204L and six units of upper division coursework in the major.

Evolution, life histories, morphology, physiology, and ecology of micro and macro algae, with attention to both marine and freshwater taxa, and of sea-grasses.

BIOL 515. Marine Invertebrate Biology (4)

Two lectures and six hours of laboratory.

Prerequisites: Biology 203, 203L, 204, 204L. Strongly recommended: Completion of three to six upper division units in the major.

Structure and function, ecology, behavior, physiology and phyletic relationships of marine invertebrate animals.

BIOL 516A. Marine Larval Ecology Research Part 1 (4)

Three lectures and three hours of laboratory.

Prerequisites: Biology 203, 203L, 204, 204L, 215.

Biology of marine invertebrate larvae. Biodiversity, evolution of complex life cycles, larval culture techniques, physiological and ecological consequences of environmental variability during larval development. Designing and peer reviewing original research proposals related to larval ecology.

BIOL 516B. Marine Larval Ecology Research Part 2 (4)

Three lectures and three hours of laboratory.

Prerequisites: Biology 516A and consent of instructor.

Research experience investigating marine invertebrate larval ecology.

BIOL 517. Marine Ecology (4)

Two lectures and six hours of laboratory.

Prerequisite: Biology 354.

Ecological concepts as applied to pelagic and benthic marine organisms and their environment. Field and laboratory experience in oceanographic techniques, particularly the coastal environment.

BIOL 523. Herpetology (4)

Two lectures and six hours of laboratory.

Prerequisites: Biology 203, 203L, 204, 204L. Recommended: Biology 352.

Evolution, systematics, distribution, and ecology of amphibians and reptiles of the world.

BIOL 524. Ornithology (4)

Two lectures, six hours of laboratory or field excursions, and a field project.

Prerequisites: Biology 203, 203L, 204, 204L. Strongly recommended: Completion of three to six upper division units in the major.

Study and identification of birds, especially those of the Pacific Coast and the San Diego region.

BIOL 525. Mammalogy (4)

Two lectures and six hours of laboratory.

Prerequisites: Biology 203, 203L, 204, 204L. Strongly recommended: Completion of three to six upper division units in the major.

Evolution, systematics, distribution and ecology of mammals of the world.

BIOL 526. Terrestrial Arthropod Biology (4)

Two lectures and six hours of laboratory.

Prerequisites: Biology 203, 203L, 204, 204L. Strongly recommended: Biology 352 and completion of three to six upper division units in the major.

Structure, function, behavior, ecology, evolution, and relationships of major groups of terrestrial arthropods, including insects, arachnids, and myriapods. Identification and natural history of southern California diversity.

BIOL 527. Animal Behavior (3)

Prerequisites: Biology 215; Biology 203, 203L, 204, 204L, or Psychology 211 and 260 for psychology majors.

Biological bases of animal behavior with emphasis on ethological approach, including evolution and adaptive significance of behavior.

BIOL 528. Microbial Ecology (3)

Two lectures and three hours of laboratory.

Prerequisites: Biology 203, 203L, 204, 204L. Recommended: Biology 350 and 354.

Roles of microorganisms in soil, aquatic and marine ecosystems, microbial adaptations to the environment, and interactions within microbial communities and between microbes and multicellular organisms. Laboratory techniques to isolate and study microbes.

BIOL 530. Plant Systematics (4)

Two lectures and six hours of laboratory, field trips.

Prerequisites: Biology 203, 203L, 204, 204L. Strongly recommended: Completion of three to six upper division units in the major.

Plant description, identification, classification, and nomenclature with emphasis on evolutionary patterns, interdisciplinary data acquisition, and phylogenetic analysis.

BIOL 531. Taxonomy of California Plants (4)

Two lectures and six hours of laboratory.

Prerequisites: Biology 203, 203L, 204, 204L.

Fundamentals of plant taxonomy with emphasis on identification of plants native and naturalized to California. Plant collecting techniques. Field trips are required.

BIOL 535. Plant Ecology (4)

Three lectures and three hours of laboratory.

Prerequisites: Biology 203, 203L, 204, 204L. Strongly recommended: Biology 354.

Plant adaptation and response to living and non-living environment including aspects of plant evolution, demography, ecophysiology community and ecosystem dynamics and soil-plant relationships. Terrestrial systems emphasized.

BIOL 537. Population Modeling for Conservation (3)

Two lectures and three hours of laboratory.

Prerequisite: Biology 354.

Applied population modeling in context of conservation. How mathematical models can be used to simulate population dynamics of single and multiple species and rank conservation management options.

BIOL 538. Environmental Policy and Regulations (3)

Prerequisite: Biology 354.

History of biological conservation and environmental laws; regulations governing biological resources; role of biologists; environmental impact analysis, operation of regulatory and resource agencies; biologists as expert witnesses; wetland protection and mitigation, state heritage programs, role of nongovernmental agencies.

BIOL 540. Conservation Ecology (3)

Two lectures and three hours of laboratory.

Prerequisite: Biology 354.

Human impacts on ecosystems, the resultant endangerment and extinction of plant and animal species, and strategies for the protection and recovery of threatened forms.

BIOL 541. Ecology of Fishes and Fisheries Biology (3)

Two lectures and three hours of laboratory.

Prerequisite: Biology 354.

Ecology of fishes, including environmental constraints, habitats, feeding, behavior, growth, reproduction, biotic interactions, population dynamics and assemblage structure. Fisheries biology concepts, including stock recruitment models, climates and fisheries, density dependence and population regulation, and populations dynamics theory.

BIOL 544. Terrestrial Ecosystems and Climate Change (3)

Prerequisite: Biology 354.

Controls on fluxes and stocks of nutrients within terrestrial ecosystems, ecosystem responses, feedbacks to climate change. Climate systems, water transport, production and decomposition, nutrient cycling, stable isotopes, spatial and temporal integration.

BIOL 546. Systematics and Biodiversity (3)

Two lectures and two hours of activity.

Prerequisite: Biology 352.

History, philosophy, and practical aspects of systematic biology, emphasizing pervasive role of phylogenetic data in evolutionary biology and other fields, phylogenetic structure of all lifeforms, and geographic patterns of diversity, endemism and imperilment.

BIOL 549. Microbial Genetics and Physiology (3)

Prerequisite: Biology 350 or 366.

Physiology of microbial growth, bacterial structure and function, genetics of bacteriophages and bacteria.

BIOL 551. Recombinant DNA (3)

Prerequisites: Biology 350, 366, 366L, Chemistry 365, and credit or concurrent registration in Biology 549 or 567.

Theory and practice of recombinant DNA techniques.

BIOL 554. Molecular Virology (3)

Prerequisites: Biology 366 and Chemistry 365.

Molecular aspects of structure, genetics, and replication of viruses, virus-host interactions, pathogenesis of virus infections, diagnostic virology, and antiviral vaccines and drugs; emphasis on human pathogens.

BIOL 555. Principles of Electron Microscopy (2)

Prerequisites: Biology 204, 204L and Physics 180B.

Principles of scanning and transmission electron microscopy including theoretical basis of sample preparation.

BIOL 556. Scanning Electron Microscopy Laboratory (2)

Six hours of laboratory.

Prerequisite: Credit or concurrent registration in Biology 555.

Biological specimen preparation and operation of scanning electron microscope.

BIOL 557. Transmission Electron Microscopy Laboratory (3)

One lecture and six hours of laboratory.

Prerequisite: Credit or concurrent registration in Biology 555.

Biological sample preparation and operation of transmission electron microscope.

BIOL 560. Animal Physiology (3)

Prerequisites: Biology 203, 203L, 204, 204L; Chemistry 365; Physics 180B, 182A, and 182B.

Physiology of vertebrate and invertebrate animals with emphasis on diversity of solutions to physiological problems and on functional integration of organ systems.

BIOL 561. Radiation Biology (3)

Prerequisites: Biology 203, 203L, 204, 204L; Physics 180B, 182A, and 182B. Recommended: Biology 366.

Principles underlying radiobiological reactions of ionizing radiations. Effects of ionizing radiations at the biochemical, cell, organ, and organism levels.

BIOL 567. Advanced Biochemistry, Cellular, and Molecular Biology (4)

Prerequisites: Biology 366 and Chemistry 365.

Advanced concepts of cellular biology, molecular biology, and biochemistry. (Formerly numbered Biology 467.)

BIOL 567L. Biochemistry, Cellular, and Molecular Biology Laboratory II (2)

Six hours of laboratory.

Prerequisites: Biology 366, 366L, credit or concurrent registration in Biology 567. Recommended: Biology 350.

Intermediate laboratory approaches to biochemistry, cellular biology, and molecular biology at a level appropriate for both advanced undergraduate and graduate students. (Formerly numbered Chemistry 467L.)

BIOL 568. Bioinformatics (3)

Two lectures and three hours of laboratory.

Prerequisite: Biology 366.

Bioinformatics analysis methods and programming skills. Practical bioinformatic software for sequence analysis, bioinformatic algorithms and programming fundamentals.

BIOL 570. Neurobiology (3)

Prerequisite: Biology 366 or 590 or Psychology 360 for psychology majors.

Structure and function of the nervous system to include cellular and molecular mechanisms underlying neuronal excitability and synaptic function, nervous system development, cellular and systems analysis of sensory, motor and higher brain functions. Emphasis on experimental approaches.

BIOL 575. Molecular Basis of Heart Disease (3)

Prerequisite: Biology 366 or 590.

Current literature on the molecular basis of disordered physiology leading to heart disease.

BIOL 576. Developmental Biology (3)

Prerequisite: Biology 366. Strongly recommended: Biology 567.

Fundamental processes of development from fertilized egg to organism. Emphasis on cellular and molecular mechanisms common to development of metazoan organisms.

BIOL 584. Medical Microbiology (3)

Prerequisites: Biology 350 and 366.

Major bacterial and viral pathogens; molecular mechanisms of pathogenesis, microbial toxins and antimicrobial agents; immune response to microbial infections; biochemical and molecular diagnostics.

BIOL 585. Cellular and Molecular Immunology (3)

Prerequisite: Biology 366. Recommended: Credit or concurrent registration in Biology 567 and 567L.

Cellular and molecular aspects of the immune response. Genetics of immunoglobulins, major histocompatibility complex, lymphocyte development and their manifestations on immune responsiveness, lymphokines immunopathologies including AIDS, and contemporary immunological techniques. Not open to students with credit in Biology 485.

BIOL 588. General Parasitology (3)

Two lectures and three hours of laboratory.

Prerequisites: Biology 203, 203L, 204, 204L. Strongly recommended: Completion of six upper division units in the major.

Parasites of medical and veterinary importance with special reference to those of humans. Practical training in identification of common human and animal parasites. Parasitological examination of local wildlife, collection and preservation of parasites.

BIOL 590. Physiology of Human Systems (4)

Three lectures and one hour of discussion.

Prerequisites: Chemistry 365, Physics 180B, 182B; or for the bioengineering emphasis: Physics 195, 196, 197. Recommended: Biology 366.

Human physiology presented at both cellular and organ system levels; neurophysiology, muscle physiology, cardiovascular physiology and respiration, kidney function, hormone function and reproduction. For students majoring in a natural science or pre-professional studies.

BIOL 594. Biotechnology Research Rounds (2) Cr/NC

Prerequisites: Biology 366 and credit or concurrent registration in Biology 567.

Research methods in biotechnology community. Speakers from local biotechnology companies and research institutes discuss power and limitations of current research methods being applied to develop new therapeutics. Evaluation of approaches, results, and utility of these technologies. Not applicable to biology or microbiology majors.

BIOL 596. Special Topics in Biology (1-4)

Prerequisite: Consent of instructor.

Advanced selected topics in modern biology. May be repeated with new content. See *Class Schedule* for specific content. Limit of nine units of any combination of 296, 496, 596 courses applicable to a bachelor's degree. Credit for 596 and 696 applicable to a master's degree with approval of the graduate adviser.

BIOL 597A. Univariate Statistical Methods in Biology (3)

Two lectures and three hours of laboratory.

Prerequisite: Biology 352 or 354 or 366.

Application of univariate statistical techniques in biological sciences.

GRADUATE COURSES

BIOL 600. Seminar (2-3)

Prerequisite: Consent of instructor.

An intensive study in advanced biology. May be repeated with new content. See *Class Schedule* for specific content. Maximum credit six units applicable to a master's degree.

BIOL 604. Seminar in Aquatic Ecology (2)

Prerequisite: Biology 354.

Ecological concepts as applied to the fresh water and marine environment. May be repeated with new content. See *Class Schedule* for specific content. Maximum credit four units applicable to a master's degree.

BIOL 606. Biological Data (3)

Two lectures and three hours of laboratory.

Prerequisite: Biology 597A or equivalent graduate course in biostatistics.

Concepts and applications of advanced statistical techniques in the biological sciences to include multivariate statistics, analysis of discrete data, spatial statistics, time series analysis, and Monte Carlo methods (e.g. bootstrapping and randomization tests).

BIOL 624. Population Genetics (3)

Two lectures and two hours of activity.

Prerequisite: Biology 352.

Theoretical and applied population genetics to include genetic diversity in natural populations, random drift, mutation, gene flow, natural selection, nucleotide variation, and quantitative genetics. Emphasis on data analysis and interpretation.

BIOL 645. Theory and Principles of Ecology (3)

Prerequisites: Admission to graduate program in biology and approval of ecology graduate adviser.

Major theoretical concepts in ecology, topics of current interest, and historical context of central ideas in ecology, with emphasis on use of primary literature.

BIOL 677. Seminar in Marine Conservation Biology (3)

Prerequisite: Graduate standing.

Threats to marine biodiversity and marine populations.

BIOL 688. Seminar in Terrestrial Ecology (2)

Prerequisite: Biology 354.

Ecological concepts as applied to the terrestrial environment. May be repeated with new content. See *Class Schedule* for specific content. Maximum credit four units applicable to a master's degree.

BIOL 696. Advanced Topics in Biology (1-3)

Prerequisite: Consent of instructor.

Intensive study in specific areas of biology. May be repeated with new content. See *Class Schedule* for specific content. Credit for 596 and 696 applicable to a master's degree with approval of the graduate adviser.

BIOL 735. Seminar in Biogeography (2)

Prerequisite: Biology 354.

Concepts and principles of distributional history of plant and animal groups, and origins and dispersal of modern faunas and floras.

BIOL 740. Phylogenetic Systematics (3)

Two lectures and three hours of laboratory.

Prerequisite: Biology 354.

Theory and methodology of phylogenetic systematics. Includes use of computer algorithms, survey of literature and preparation of a project in phylogenetic systematics. Not open to students with credit in Biology 740 (Seminar in Phylogenetic Systematics).

BIOL 766. Advanced Topics in Population and Community Ecology (2-4)

Prerequisites: Biology 354 and consent of instructor.

Selected topics in population and community ecology. May be repeated with new content and consent of the graduate adviser in ecology. Maximum credit six units applicable to a master's degree.

BIOL 770. Seminar in Systematics and Evolution (2-3)

Prerequisite: Consent of instructor.

Selected topics in systematics and evolution. May be repeated with new content. See *Class Schedule* for specific content. Maximum credit four units applicable to a master's degree.

BIOL 795. Seminar in Ecology and Evolutionary Biology (1) Cr/NC

Prerequisite: Graduate standing.

Recent research advances in ecology and evolutionary biology. May be repeated with new content. Maximum credit six units applicable to a graduate degree.

BIOL 797. Research (1-3) Cr/NC/RP

Research in one of the fields of biology. Maximum credit six units of 797 and 798 applicable to a master's degree.

BIOL 798. Special Study (1-3) Cr/NC/RP

Prerequisite: Consent of staff; to be arranged with department chair and instructor.

Individual study. Maximum credit six units of 797 and 798 applicable to a master's degree.

BIOL 799A. Thesis or Project (3) Cr/NC/RP

Prerequisites: An officially appointed thesis committee and advancement to candidacy.

Preparation of a project or thesis for the master's degree.

BIOL 799B. Thesis or Project Extension (0) Cr/NC

Prerequisite: Prior registration in Thesis or Project 799A with an assigned grade symbol of RP.

Registration required in any semester or term following assignment of RP in Course 799A in which the student expects to use the facilities and resources of the university; also student must be registered in the course when the completed thesis or project is granted final approval.

DOCTORAL COURSES

BIOL 897. Doctoral Research (1-15) Cr/NC/RP

Prerequisite: Admission to the doctoral program.

Independent investigation in the general field of the dissertation.

BIOL 899. Doctoral Dissertation (1-15) Cr/NC/RP

Prerequisites: An officially constituted dissertation committee and advancement to candidacy.

Preparation of the dissertation for the doctoral degree. Enrollment is required during the term in which the student plans to graduate.
