instructor. Examines representations in a variety of lit-
erary, media, and critical genres by or of lesbians, gay
men, transgenders, and others marginalized because of
their sexuality or gender expression. Topics may include
the history of sexuality, camp, posthuman
and sexualities, queer theory, and lesbian
gay literature and film. Course is repeatable as
content changes.

ENGL 278. Seminar in Minority Discourse (4) Seminar,
3 hours; outside research, 3 hours. Prerequisite(s):
graduate standing or consent of instructor. Intensive
study and research in cultural traditions formerly
excluded from literary history, such as African
American, Asian American, Chicano, and Native
American. Cross-cultural studies in the representa-
tions of such marginalized groups. Topics may include
the African American novel; border culture; nine-
teenth-century Black bodies; oral history and litera-
ture. Course is repeatable as content changes.

ENGL 279. Seminar in Rhetorical Studies (4) Seminar,
3 hours; outside research, 3 hours. Prerequisite(s):
graduate standing or consent of instructor. Intensive
research and study in rhetoric or composition theory.
Topics may include the rhetorical dimensions of litera-
ture, literary theory, and civic discourse; the ethics or
history of rhetoric; competing conceptions of the writ-
ing process; and the relations between rhetorical, liter-
ary, and cultural criticisms. Course is repeatable as
content changes.

ENGL 280. Colloquium in English and American
Literature (2) Seminar, 2 hours. Prerequisite(s): gradu-
ate standing. Colloquium of both a formal and informal
order on current research topics for students, faculty,
and visiting scholars. Graded Satisfactory (S) or No
Credit (NC). May be repeated for credit.

ENGL 281. Seminar in Comparative Studies (4) Seminar,
3 hours; outside research, 3 hours. Prerequisite(s): grad-
uate standing or consent of instructor. Intensive study of
two or more ostensibly distinct fields, periods, disciplines, or arts. Course is
repeatable as content changes.

ENGL 282. Seminar in Bibliography and Textual
Criticism (4) Seminar, 3 hours; outside research, 3
hours. Prerequisite(s): graduate standing or consent
of instructor. Advanced research in the history of the
book and textual production, including such topics as
written work of a graduate order commensurate in
amount with the number of units elected. ENG 101
and ENG 103 may not be used for this arrangement.
Graded Satisfactory (S) or No Credit (NC). May be
repeated for credit.

ENGL 296. Master's Portfolio (2) Outside research, 6
hours; consultation, 2-3 hours. Prerequisite(s): com-
pletion of five quarters of master's study in English;
consent of the Graduate Advisor. Students revise,
extend, and develop essays written during their mas-
ter's program in preparation for the master's portfolio
examination. Graded Satisfactory (S) or No Credit
(NC).

ENGL 299. Research for Thesis or Dissertation (1-12)
Thesis, 3-36 hours. Prerequisite(s): satisfactory com-
pletion of the Ph.D. qualifying examination; consent of
instructor. Research, under the direction of a faculty
member, for preparation of the thesis or dissertation.
Graded Satisfactory (S) or No Credit (NC). Course is
repeatable; students may enroll in a maximum of 12 units per quarter.

Professional Courses

ENGL 301. Introduction to the Teaching of English (1)
individual and group conferences, 1 hour.
Prerequisite(s): graduate standing. A flexible program
of meetings and workshops specifically devoted to ori-
enting apprentices and transfer TAs to the writing pro-
gram at UC Riverside. Concentrates on the problem of
organizing and teaching ENG 001A, ENG 001B,
and ENG 001C or its equivalent. Required of all
apprentices and transfer TAs. Students must enroll
currently in ENG 302. Graded Satisfactory (S) or
No Credit (NC). May be repeated for credit for a maxi-
mum of 2 units.

ENGL 302. Teaching Practicum (1-4) Seminar, 1-4
hours. Prerequisite(s): graduate standing. A flexible
program of meetings and conferences on the prob-
lems and techniques of teaching instruction most perti-
nent to Basic Writing or to ENG 001. Required of all
TAs for at least five quarters, after which the TA may,
with the permission of the Director of ENG 001, elect
to take ENG 304 instead. Open to all graduate stu-
dents. Graded Satisfactory (S) or No Credit (NC).
May be repeated for credit.

ENGL 303. Advanced Teaching Practicum (1-2)
Discussion, 1 hour; practicum, 1-2 hours.
Prerequisite(s): graduate standing or consent
of instructor. A flexible program of meetings and confer-
ces on the problems and techniques of teaching lit-
erature, cultural studies, film studies, and related
courses. Graded Satisfactory (S) or No Credit (NC).
Course is repeatable as content changes.

ENGL 304. Professional Research Preparations (4)
Seminar, 3 hours; outside research, 3 hours; consulta-
tion, 5 hours per quarter. Prerequisite(s): consent of
instructor. Covers the procedures, preparation, and
presentation of oral and written research materials,
including prospectus, with individual direction from
instructor. Graded Satisfactory (S) or No Credit (NC).

ENGL 380. The Teaching of Written Composition (4)
Summer Seminar, 8 hours. Prerequisite(s): consent
of instructor; participation in the Inland Area Writing
Project Summer Workshop. A study of research and
practice in the teaching of written composition in the
elementary and secondary schools. Offered in sum-
mmer only. Students may receive either a letter grade or
Satisfactory (S) or No Credit (NC) grade. See instruc-
tor for grading basis; no petition is required.

ENGL 381. Preparing to Teach Teachers (1-4) Summer
Seminar, 2-8 hours. Prerequisite(s): consent of
instructor; concurrent enrollment in ENG 380.
Participation in the Inland Area Writing Project
Summer Workshop. Preparation and presentation of
inquiry projects. Emphasis on inquiry into pedagogical
assumptions and the way they contribute to expert
teaching practices. Offered in summer only. Students
may receive either a letter grade or Satisfactory (S) or
No Credit (NC) grade. See instructor for grading basis;
no petition is required.

Entomology

Subject abbreviation: ENTM
College of Natural and Agricultural Sciences

Ring T. Cardé, Ph.D., Chair
Richard A. Redak, Ph.D., Vice Chair
Graduate Department Office, 175 Entomology
insects.ucr.edu

Undergraduate Faculty Advisor
(800) 735-0717 or (951) 827-4116
insects.ucr.edu/programs/graduate.html

Professors
Michael E. Adams, Ph.D. (Entomology/Cell Biology
and Neuroscience)
Peter W. Atkinson, Ph.D.
Nancy E. Beckage, Ph.D. (Entomology/Cell Biology
and Neuroscience)
Thomas S. Bellows, Jr., Ph.D.
Ring T. Cardé, Ph.D. Alfred M. Boyce Chair
in Entomology
Brian A. Federici, Ph.D.
J. Daniel Hare, Ph.D.
John M. Heraty, Ph.D.
Robert F. Luck, Ph.D.
Jocelyn G. Miller, Ph.D.
Thomas A. Miller, Ph.D.
Joseph G. Morse, Ph.D.
Bradley A. Mullens, Ph.D.
Timothy D. Paine, Ph.D.
Thomas M. Perring, Ph.D.
Alexander Raikhel, Ph.D. (Entomology/Cell Biology
and Neuroscience)
Richard A. Redak, Ph.D.
Michael K. Rust, Ph.D.
Richard Stouthamer, Ph.D.
S. Nelson Thompson, Ph.D.
John T. Trumble, Ph.D.
William E. Walton, Ph.D.

Professors Emeriti
Leland R. Brown, Ph.D.
Richard D. Goeden, Ph.D.
E. Fred Legner, Ph.D.
James A. McMurtry, Ph.D.
Mir S. Mulla, Ph.D.
Earl R. Oatman, Ph.D.
John D. Pinto, Ph.D.

Associate Professors
P. Kirk Visscher, Ph.D.
Gregory P. Walker, Ph.D.

Assistant Professors
Anandasankar Ray, Ph.D.
Weirauch, Christiane, Ph.D.

**
B.S. degrees in Entomology areas follows: The B.A. degree. The B.S. degree offers graduate programs leading to either the B.S. or breadth requirements. Consult with a department.

Major

The Department of Entomology offers undergraduate programs leading to either the B.S. or the B.A. degree. The B.S. degree offers students with a strong interest in the natural sciences an opportunity to emphasize this aspect of their education. The B.A. degree is available to students who wish to obtain a broader background in the humanities and social sciences than is required of students in the B.S. program.

Information on the programs and course requirements is available at CNAS Academic Advising Center, 1223 Pierce Hall. Counseling, course recommendations, and information on education and career goals are provided by the Undergraduate Faculty Advisor, Dr. Thomas M. Perrin, 225 Entomology.

University Requirements

See Undergraduate Studies section.

College Requirements

See College of Natural and Agricultural Sciences, Colleges and Programs section.

Some of the following requirements for the major may also fulfill some of the college's breadth requirements. Consult with a department advisor for course planning.

Major Requirements

The major requirements for both the B.A. and the B.S. degrees in Entomology are as follows:

1. Lower-division requirements (50–51 units)
   a) BIOL 005A, BIOL 05LA, BIOL 005B, BIOL 005C
   b) PHYS 002A, PHYS 002B, PHYS 002C, PHYS 02LA, PHYS 02LB, PHYS 02LC
   c) MATH 008B or MATH 009A, MATH 009B
   d) CHEM 001A, CHEM 001B, CHEM 001C, CHEM 011A, CHEM 011B, CHEM 011C

2. Upper-division requirements (67 units)
   a) ENTM 100/BIOL 100, ENTM 107, ENTM 173/BIOL 173, and 4 units in any combination of ENTM 190, ENTM 197, ENTM 199, or ENTM 199H
   b) Twenty-four (24) additional units of entomology electives, which may include up to 2 additional units of ENTM 190, ENTM 197, or ENTM 199H
   c) BCH 100
   d) BIOL 102
   e) BIOL 107A
   f) CHEM 112A, CHEM 112B, CHEM 112C
   g) STAT 100A

BIOL 151 and BIOL 175 are suggested in order to acquire a background in the life sciences appropriate for an Entomology major.

For students intending to specialize at the graduate level in insect toxicology or insect physiology, biochemistry, and molecular biology, it is recommended that the BCH 110A, BCH 110B, and BCH 110C sequence and BCH 102 be substituted in place of an equal number of upper-division course units in life sciences. Due to course content overlap, credit is not awarded for BCH 110A, BCH 110B, or BCH 110C if it has already been awarded for BCH 100.

Sample Program

### Freshman Year

<table>
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<tr>
<th>Major Units</th>
<th>Fall</th>
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<td>BIOL 005A, BIOL 05LA; BIOL 005B</td>
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<td>MATH 008B or MATH 009A, MATH 009B</td>
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<tr>
<td>Humanities/Social Sciences</td>
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### Sophomore Year

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<td>CHEM 112A, CHEM 112B, CHEM 112C</td>
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<td>MATH 008B or MATH 009A, MATH 009B</td>
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<td>CHEM 001A, CHEM 001B, CHEM 001C, CHEM 011A, CHEM 011B, CHEM 011C</td>
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### Senior Year

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<td>Humanities/Social Sciences</td>
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<tr>
<td><strong>Total Units</strong></td>
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### Minor

The Department of Entomology offers a minor in Entomology designed to allow the student the freedom to pursue areas of particular interest.

The minor consists of no less than 20 and no more than 28 units of Entomology courses to be selected as follows:

1. ENTM 100/BIOL 100
2. Select from the following upper-division Entomology courses to complete unit requirement: ENTM 106, ENTM 107, ENTM 109, ENTM 112/BIOL 112, ENTM 114, ENTM 124, ENTM 126, ENTM 126L, ENTM 127, BIOL 127, ENTM 128, ENTM 129, ENTM 129L, ENTM 133, ENTM 162/Biol 162, ENTM 173/Biol 173, ENTM 190, ENTM 197, ENTM 199, ENTM 199H

3. No more than 4 units of ENTM 190, ENTM 197, ENTM 199, or ENTM 199H, either solely or in combination, may be applied toward the unit requirement.

4. Of the specified upper-division units, a minimum of 16 must be unique to the minor and may not be used to satisfy major requirements.

See Minors under the College of Natural and Agricultural Sciences in the Colleges and Programs section of this catalog for additional information on minors.

### Graduate Program

The Department of Entomology offers programs leading to the M.S. (thesis plan) and Ph.D. degrees with specialization in, but not restricted to, the following areas of study:

- Arthropod vectors of plant pathogens
- Behavior
- Biochemistry and physiology
- Biological control
- Chemical ecology
- Ecology and evolution
- Integrated pest management
- Insect–plant interactions
- Medical and veterinary entomology
- Molecular entomology
- Nematology
- Neuroscience
- Pathology
- Pesticide toxicology
- Systematics
- Urban entomology

Information on participating faculty and their research specializations may be found at insects.ucr.edu. University requirements for the M.S. and Ph.D. degrees are given in the Graduate Studies section of this catalog.

### Admission

Students must have a bachelor's degree with a major in Entomology, a biological science, Chemistry, Biochemistry, or a suitable equivalent. Regardless of undergraduate major, students must have had, or complete soon after entering graduate school, the following:

1. One year of course work eah ing general biology, general chemistry, and organic chemistry.
2. The equivalent of a one quarter course each in genetics and biochemistry.
3. The equivalent of 30 quarter units of life sciences other than entomology. Students who wish to specialize in insect biochemistry, insect physiology, molecular entomology, neuroscience, or toxicology may substitute additional courses in physical, organic, and biological chemistry; toxicology; and pharmacology for courses in life sciences.

Credit from these courses does not count toward the unit requirement of the M.S. degree.
The department requires GRE General Test scores (verbal, quantitative, and analytical). All applicants whose first language is not English and do not have an undergraduate or graduate degree from an accredited institution where English is the exclusive language of instruction must submit a recent Test of English as a Foreign Language (TOEFL) and obtain a minimum score on the exam of 550 (paper-based), 213 (computer-based), or 80 (internet-based).

Course Work All students must take ENTM 201, ENTM 202, and ENTM 203.

Normative Time to M.S. 6 quarters
Normative Time to Ph.D. 17 quarters

Opportunities for Interdisciplinary Graduate Study
Faculty from the Department of Entomology also participate in the following additional graduate programs:

- Biochemistry and Molecular Biology
- Cell, Molecular, and Developmental Biology
- Neuroscience
- Chemistry
- Environmental Toxicology
- Evolution, Ecology, and Organismal Biology (EEOB)
- Genetics, Genomics and Bioinformatics

These interdepartmental programs draw on the strengths of distinguished scientists from several units. For further information concerning work in these areas, see the respective program descriptions in the Programs and Courses section of this catalog or contact the Biological Sciences Graduate Student Affairs Center, at (800) 735-0717.

Lower-Division Courses

ENTM 010. Natural History of Insects (4) F, W, S Lecture, 3 hours; demonstrations, 1 hour. A study of the fascinating world of insects and of their impact on man; designed for non-entomology majors. Living and preserved insects and many other visual aids are used.

ENTM 020. Bees and Beekeeping (4) F, Odd Years Lecture, 3 hours; discussion, 1 hour. Fundamentals of keeping honey bees, their fascinating social behavior, and their economic importance as pollinators of agricultural crops and as producers of honey and other products. Demonstrations of bee biology and behavior, with colonies of bees, and of beekeeping techniques, equipment, and extraction of honey.

Upper-Division Courses

ENTM 100. General Entomology (4) F Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): BIOL 005B, BIOL 005C, or equivalents; or consent of instructor. Introductory study of insects, Earth’s most diverse group of animals (75 percent of animal species are insects). Lecture covers the anatomy, physiology, ecology, behavior, and diversity of insects. Laboratory focuses on insect identification. Cross-listed with BIOL 100. Walker

ENTM 106. Insect Evolution (3) S Lecture, 2 hours; laboratory, 3 hours. Prerequisite(s): BIOL 100/ENTM 100 or consent of instructor. Introduces principles of insect morphology, with emphasis on characters of phylogenetnic and adaptive significance and insect evolution. Topics include the comparative anatomy and phylogenetic relationships of extinct and living insect groups. Laboratory emphasizes principles of comparative morphology and evolutionarily important character complexes.

ENTM 107. Insect Biodiversity (3) W Lecture, 2 hours; laboratory, 3 hours. Prerequisite(s): BIOL 100/ENTM 100 or consent of instructor. Lectures introduce the science of insect systematics, stressing diagnostic characters of the major taxa and insect biodiversity. Laboratories focus on developing skills in insect identification to the family level.

ENTM 109. Field Entomology (4) S Laboratory, 4 hours; field, 8 hours. Prerequisite(s): BIOL 100/ENTM 100 or equivalents or consent of instructor. Study and field collection of insects in selected ecological communities from the diversity of life zones comprising Southern California. Students prepare specimens collected to professional standards, identify specimens, and submit their collections for grading and incorporation into the Department of Entomology’s teaching and research collections.

ENTM 112. Systematics (4) W Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 005C or equivalent. Principles and philosophy of classification: phylogenetic and phenetic methods, species concepts, taxonomic characters, evolution, hierarchy of categories, and nomenclature. Cross-listed with BIOL 112 and BPSC 112. Heraty

ENTM 114. Aquatic Insects (4) S, Even Years Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): BIOL 005A, BIOL 005B, BIOL 005C, or consent of instructor. Investigates aquatic insects as nutrient cyclers, pollution indicators, disease vectors, and fish food. Involves identification of major orders and families, morphological and physiological adaptations, and life history strategies. Laboratory emphasizes identification (collection) and includes a group field ecology project and two weekend field trips. Mullens, Walton

ENTM 124. Agricultural Entomology (4) F, Odd Years Laboratory, 4 hours; field, 8 hours. Prerequisite(s): BIOL 100/ENTM 100 or equivalent or consent of instructor. Identification, life history, ecology, distribution, and management of key pest and beneficial species learned through field observation, discussions with industry representatives, and laboratory study. Detailed notes and collections from field trips to all major growing regions of Southern California form the basis for laboratory discussion.

ENTM 126. Medical and Veterinary Entomology (3) W, Odd Years Lecture, 3 hours. Prerequisite(s): BIOL 005A, BIOL 005B, BIOL 005C, or consent of instructor. Biology, ecology, and management of arthropods affecting human and animal health. Arthropods as direct pests and vectors of important diseases (e.g., malaria, plague). Disease epidemiology and prevention and control of pests and associated diseases are discussed. Mullens

ENTM 126L. Laboratory in Medical and Veterinary Entomology (2) W, Odd Years Laboratory, 6 hours. Prerequisite(s): BIOL 005A, BIOL 005B, BIOL 005C, or consent of instructor. Concurrent or previous enrollment in ENTM 126 is recommended. Identification of arthropods affecting humans and animals. Practical epidemiological exercises, including age-grading, blood meal and pathogen identification in vectors, vector capacity assessment, bioassay procedures, and sampling. Field trips(s) to animal production and mosquito abatement and research facilities are scheduled. Mullens

ENTM 127. Insect Ecology (4) W Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 005A, BIOL 05LA, BIOL 05SB, BIOL 005C, CHEM 001C or CHEM 01HC, CHEM 112C, MATH 009B or MATH 09HB, PHYS 002C, PHYS 02LC, BCH 100 or BCH 110A, one course in statistics; or consent of instructor. Introduces principles of insect ecology with examples emphasizing the Arthropoda. Topics include factors governing population growth; ecological and evolutionary interactions with hosts, competitors, and natural enemies; structure of ecological communities; and adaptations to different environments. Cross-listed with BIOL 127. Bellows, Jr., Walton

ENTM 128. Chemistry and Toxicology of Insecticides (3) F, Odd Years Lecture, 3 hours. Prerequisite(s): a course in organic chemistry, BIOL 100/ENTM 100; or consent of instructor. Chemical properties and reactions of insecticides and acaricides and their modes of action and biochemical behavior in animal and plant systems. Miller

ENTM 129. Introduction to Biological Control (2) F Lecture, 2 hours. Prerequisite(s): BIOL 100/ENTM 100 or consent of instructor. Principles and methods of biological control; biology and behavior of entomophagous insects; historical review and critique of important world projects. Bellows

ENTM 129L. Introduction to Biological Control Laboratory (2) F Laboratory, 6 hours. Prerequisite(s): ENTM 129 (it is strongly recommended that ENTM 129L be taken concurrently with ENTM 129). Laboratory identification of entomophagous insects; experiments designed to illustrate various types of parasitism; familiarization with mass rearing and culture techniques for entomophagous insects.

ENTM 133. Urban Entomology (4) S, Even Years Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): BIOL 100/ENTM 100 or consent of instructor. Biology and management of arthropod pests of the urban-industrial community with an emphasis on structural, household, and stored product pests. Exercises on the recognition and identification of these pests, their life histories, and strategies for their control. Rust

ENTM 162. Insect Behavior (4) F Lecture, 4 hours. Prerequisite(s): BIOL 100/ENTM 100, or BIOL 005A, BIOL 005B, and BIOL 005C; or consent of instructor. An analysis of the mechanisms that cause and control behavioral reactions of insects. Emphasis on ethological and physiological knowledge concerning orientation mechanisms, communication systems, learning, and the role of the nervous system in integrating behavior in insects. Cross-listed with BIOL 162. Carde, Visscher

ENTM 173. Insect Physiology (4) S Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): BIOL 005A and BIOL 005B or equivalents; CHEM 112A, CHEM 112B, CHEM 112C or equivalents; or consent of instructor. Introduction to principles of insect physiology. Subjects include growth, development and hormones, cuticle, nervous system, circulation, respiration, digestion, nutrition, excretion, reproduction, water balance, and temperature relations. Prior knowledge of insects is not assumed. Cross-listed with BIOL 173. Miller, Thompson

ENTM 190. Special Studies (1-5) F, W, S Prerequisite(s): consent of instructor. Directed studies
in specialized fields in entomology such as insects affecting subtropical fruits, deciduous fruits and nuts, floricultural crops and turf, vegetable and field crops, forest and ornamental trees and shrubs, stored products, and households. Course is repeatable.

ENTM 197. Research for Undergraduates (1-4) F, W, S
Prerequisite(s): consent of instructor. Directed original research and preparation of written report. Course is repeatable.

ENTM 199H. Senior Honors Research (1-5) F, W, S
Laboratory, 3-15 hours. Prerequisite(s): senior status and consent of instructor; a GPA of 3.5 or better in entomology courses and 3.2 in all University course work. Research in entomology under supervision of a faculty member in entomology. The student will submit a written report. Course is repeatable.

Graduate Courses

ENTM 201. Structure and Function of Insects (5) F
Lecture, 2 hours; laboratory, 3 hours; discussion, 1 hour. Prerequisite(s): BCH 100 or BCH 110A; BIOL 100/ENTM 100 (both may be taken concurrently); or consent of instructor. Introduces principles of insect physiology and morphology. Topics include insect development, reproduction, circulation, metabolism and excretion, respiration, digestion, and fundamentals of the nervous system.

ENTM 202. Molecular Biology, Systematics, and Behavior (5) W
Lecture, 3 hours; laboratory, 3 hours; discussion, 1 hour. Prerequisite(s): BCH 100 or BCH 110A; ENTM 201; or consent of instructor. Introduces principles of molecular biology, systematics, and insect behavior. Topics include the use of molecular tools in Entomology, the application of systematics in understanding insect evolution, and behavior particular to insects and relevant to insect research in a range of subdisciplines.

ENTM 203. Ecology, Population Genetics, and Pest Management (5) S
Lecture, 3 hours; laboratory, 3 hours; discussion, 1 hour. Prerequisite(s): ENTM 202, undergraduate course in ecology; or consent of instructor. Introduces principles of insect ecology, genetics, evolution, and pest management. Topics include insect population dynamics and community interactions, genetics of geographic variation, adaptation of insect populations, and the ecological, behavioral, and genetic basis for management of control of pestiferous species.

ENTM 206. Insect Physiology and Biochemistry (3) S
Lecture, 3 hours. Prerequisite(s): upper-division courses in general entomology and general biochemistry or consent of instructor. Graduate-level introduction to the physiology and biochemistry of insect systems. Topics covered include basics of growth and development, reproduction, digestion, nutrition, metabolism, respiration, circulation, ion and water balance, nervous and muscular systems, circadian rhythms. Adams, Thompson

ENTM 207. Arthropod Vectors in Relation to Plant Disease (4) S, Even Years
Lecture, 2 hours; laboratory, 6 hours. Prerequisite(s): BIOL 100/ENTM 100, BIOL 120/MCBL 120/PLPA 120; or consent of instructor. Detailed analyses of existing mechanisms involved in the transmission of plant pathogens by arthropods. Emphasis on learning through extensive laboratory experimentation. Perrig

ENTM 208. Host-Parasite Relationships (3) F, W, S
Lecture, 3 hours. Prerequisite(s): BIOL 100/ENTM 100 or BIOL 157 or consent of instructor. Explores the fundamental biochemical and developmental requirements for “successful” host-parasite relationships in insects. Emphasizes wasp and nematode parasites of insects and vector-parasite interactions involved in transmission of parasites in malaria, trypanosoma, and Lyme disease. Cross-listed with BIOL 208.

Beckage

ENTM 209. Microtechniques in Insect Morphology (3) W, Even Years
Laboratory, 6 hours; outside research, 3 hours. Prerequisite(s): BIOL 005A, BIOL 005B, BIOL 100/ENTM 100; or equivalents; or consent of instructor. Development of research techniques and skills used in the study of insect morphology. Covers the principles of and provides hands-on experience with the following: optical microscopy, scanning electron microscopy, whole-mount slide preparation techniques, morphometric measurement and analysis, scientific illustration, macrophotography, and histological techniques. Walker

ENTM 210. Molecular Biology of Human Disease Vectors (3) Lecture, 2 hours; seminar, 1 hour. Prerequisite(s): consent of instructor. Covers the molecular aspects of vectors transmitting most dangerous human diseases. Lectures and student presentations on current issues in molecular biology and genomics of vector insects and pathogens they transmit. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor. Cross-listed with OMDB 210 and MCBL 210.

ENTM 212. Ecological Systems in Space and Time (4) F, W, S
Lecture, 3 hours; field, 30 hours per quarter. Prerequisite(s): BIOL 117 or BIOL 152/GEOL 152 or equivalent or consent of instructor. Focuses on how ecological systems are interpreted and reconciled at the community, landscape, and paleontological scales. Addresses the role of extrinsic factors operating at each of these scales. Also examines the historical development of our understanding of ecological systems at various scales. Cross-listed with BIOL 212 and GEO 212.

ENTM 219. Theory of Systematics (4) S, Even Years
Lecture, 2 hours; discussion, 2 hours. Prerequisite(s): BIOL 110/BSPC 110/ENTM 112 or equivalent or consent of instructor. Examines topics developed around a series of classical and recent papers on the principles, philosophy, and methodology of modern systematics and phylogenetic methods. Cross-listed with BIOL 219 and GEO 219. Heraty, Springer

ENTM 227. Insect Population Ecology (3) W, Odd Years
Lecture, 3 hours. Prerequisite(s): BIOL 127/ENTM 127 or consent of instructor. Recommended: ENTM 129, STAT 100A; STAT 100B or equivalent. Theory of animal population regulation. Factors affecting distribution and abundance of animals with emphasis on examples from the Arthropoda. Lick

ENTM 229. Advanced Biological Control (4) F, Alternate Years
Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): BIOL 127/ENTM 127, or equivalents, or consent of instructor. The course explores theory and practices relating to the use of natural enemies in the suppression of insect, weed, pathogen, and vertebrate populations. The laboratory surveys insect and other natural enemies, their attributes, collection, cultivation, quarantine handling, and field use. Normally letter graded, but students may petition the instructor for a Satisfactory (S) or No Credit (NC) grade.

ENTM 230. Entomophagous Insects (4) F, Lecture, 2 hours; laboratory, 6 hours. Prerequisite(s): BIOL 100/ENTM 100 or equivalent, graduate standing; or consent of instructor. Introduces the biology and identification of entomophagous insects. Students collect and rear parasites and prepare specimens according to professional standards. Laboratory identification focuses on the family level for parasitic insects. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor. Heraty

ENTM 231. Insect Pathology (4) S, Even Years
Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): BIOL 100/ENTM 100, at least one course in microbiology; or consent of instructor. Consideration of the principles of general insect pathology and microbiology. Detailed study of noninfectious and infectious diseases of insects, diagnosis, epizootiology, physiopathology, symptomatology, and the use of microbial agents in the control of insect pests. Federici

ENTM 232. Molecular Biology of Insects (4) S, Even Years
Lecture, 3 hours; workshop, 1 hour. Prerequisite(s): BIOL 107A or consent of instructor. Application of molecular biology to entomology and entomological problems. Emphasizes how molecular biological tools are used to understand insect genome organization, pest resistance, transgenic insects, insect behavior, and insect systematics. Atkinson

ENTM 240. Research Methods in Insect Chemical Ecology (4) W, Odd Years
Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 127/ENTM 127 or ENTM 203 or consent of instructor. Survey of the methods used in the isolation, identification, and bioassay of biologically active natural products. Topics include bioassay design and execution, and microscale chemical separation and identification techniques. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Millar

ENTM 241. Insect-Plant Interactions (4) F, Odd Years
Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 127/ENTM 127 or consent of instructor. Concepts of the development and maintenance of ecological associations between plants and arthropod herbivores in ecological and evolutionary time; organization of arthropod communities on plants; phytochemical basis for the mediation of plant-arthropod associations; coevolution of plants and herbivorous insects; manipulation of plant-arthropod associations in arthropod pest management programs. Hare, Trumble

ENTM 242. Development of Hypotheses and Research Design (3) S
Lecture, 1 hour; discussion, 1 hour; written work, 3 hours. Prerequisite(s); graduate standing or consent of instructor. Teaches fundamentals of research topic selection, development of hypotheses, and selection of experimental designs. Students prepare full-length federal grant proposals, then review and rank them in grant panel review format. Millar, Trumble

ENTM 243. Advanced Insect Physiology, Biochemistry, and Molecular Biology (3) W, Even Years
Lecture, 2 hours; seminar, 1 hour. Prerequisite(s): BCH 211 or ENTM 232 or both ENTM 202 and ENTM 203; or consent of instructor. Explores the latest key issues of insect physiology, biochemistry, and molecular biology. Raikhel

ENTM 249. Special Topics in Entomology (1-6)
Lecture, 1-6 hours; laboratory, 0-15 hours. Prerequisite(s): graduate standing or consent of instructor. Explores topics within the area of specialization of each faculty member. Content emphasizes recent advances in the special topic area and varies accordingly. Students who take examinations or submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable as content changes.

ENTM 250. Seminar in Entomology (1) F, W, S
Seminar, 1 hour. A series of lectures by visiting scientists, staff
and advanced graduate students on research topics in entomology and allied fields. Graded Satisfactory (S) or No Credit (NC).

**ENTM 251. Seminar in Insect-Plant Interactions (2) W** Seminar, 2 hours. Prerequisite(s): ENTM 241 or consent of instructor. Rigorous examinations and interpretation of published experimental data dealing with insect behavior, and an attempt to derive general principles underlying behavior. Subject matter varies from year to year. Course may be taken more than once for credit.

**Paine, Trumble, Walker**

**ENTM 252. Seminar in Insect Behavior (2) S** Seminar, 2 hours. Prerequisite(s): BIOL 162/ENTM 162 or consent of instructor. An analysis and interpretation of experimental data relating to insect behavior. Subject matter varies from year to year. Course is repeatable as content changes.

**Carde, Miller, Visscher**

**ENTM 254. Seminar in Biological Control (2) F** Seminar, 2 hours. Prerequisite(s): BIOL 127/ENTM 127, ENTM 129, or consent of instructor. Concepts, questions and hypotheses in biological control. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Bellows, Stoughtam

**ENTM 255. Seminar in Medical and Veterinary Entomology (2) F** Seminar, 2 hours. Prerequisite(s): ENTM 126 or consent of instructor. Rigorous review and analysis of advanced topics in medical and veterinary entomology and related disciplines. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable as content changes.

**Mullens, Walton**

**ENTM 256. Seminar in Systematic Entomology (2) S** Seminar, 2 hours. Prerequisite(s): BIOL 112/BPSC 112/ENTM 112 or consent of instructor. Selected topics in insect systematics. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable as content changes.

**Heraty**

**ENTM 258. Seminar in Insect Pest Management (2) W** Seminar, 2 hours. Prerequisite(s): consent of instructor. Selected topics in insect pest management. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable as content changes.

**Perring**

**ENTM 261. Seminar in Genetics, Genomics, and Bioinformatics (1) W, S** Seminar, 1 hour. Prerequisite(s): graduate standing or consent of instructor. Oral reports by visiting scholars, faculty, and students on current research topics in Genetics, Genomics, and Bioinformatics. Graded Satisfactory (S) or No Credit (NC). Course is repeatable. Cross-listed with BCH 261, BIOL 261, BPSC 261, GEN 261, and PLPA 261.

**ENTM 262. Seminar in Molecular Biology and Genomics of Disease Vectors (1) Seminar, 1 hour.** Prerequisite(s): graduate standing or consent of instructor. Seminar series, sponsored by the Center for Disease-Vector Research at the Institute for Integrative Genome Biology, provides an opportunity for graduate students to discuss current issues of molecular biology and genomics of vector insects and pathogens they transmit with guest speakers. Graded Satisfactory (S) or No Credit (NC). Course is repeatable. Cross-listed with MCBL 262.

**ENTM 271. Research Seminar in Management of Vegetable Crop Pests (1) W** Seminar, 1 hour. Prerequisite(s): consent of instructor. Seminar and critical discussion emphasizing current research and advances in management of vegetable crop pests. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

**Trumble**

**ENTM 272. Research Seminar in Insect Communication and Behavior (1) F, W, S** Seminar, 1 hour. Prerequisite(s): consent of instructor. Seminar and critical discussion emphasizing current research and advances in insect communication and behavior. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

**ENTM 276. Research Seminar in Medical, Urban, and Veterinary Entomology (1) F, S** Seminar, 1 hour. Prerequisite(s): consent of instructor. Seminar and critical discussion emphasizing current research and advances in medical, urban, and veterinary entomology. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

**Carde, Miller, Visscher**

**ENTM 277. Research Seminar in Insect Biochemistry and Toxicology (1) F, W, S** Seminar, 1 hour. Prerequisite(s): consent of instructor. Seminar and critical discussion emphasizing current research and advances in insect biochemistry and toxicology. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

**Gil**

**ENTM 289. Special Topics in Neuroscience (2) F, W, S** Seminar, 2 hours. Prerequisite(s): graduate standing or consent of instructor. An interdisciplinary seminar consisting of student presentations and discussion of selected topics in neuroscience. Content and instructor(s) vary each time course is offered. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. Cross-listed with BCH 289, BIOL 289, CHEM 289, NSRC 289, and PSYC 289. Hatton

**ENTM 290. Directed Studies (1-6) F, W, S** Literature studies on special topics under direction of a member of the staff. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

**ENTM 291. Individual Study in Coordinated Areas (1-6) F, W, S** Prerequisite(s): graduate standing. Faculty assisted programs of individual study for candidates who are preparing for examinations. The following rules apply: 1) Up to 6 units may be taken prior to award of the Master’s degree, such units to be in addition to minimum unit requirements for the degree; 2) Up to 12 additional units may be taken prior to advancement to candidacy for the Ph.D.; 3) The course may be repeated within these limits. Graded Satisfactory (S) or No Credit (NC).

**ENTM 297. Directed Research (1-6) F, W, S** Exploratory research toward the development of the dissertation problem or other research not specifically for thesis or dissertation. Graded Satisfactory (S) or No Credit (NC).

**ENTM 299. Research for Thesis or Dissertation (1-12)** Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

**ENTM 301. Teaching Entomology at the College Level (1) F, W, S** Seminar, 1 hour. Prerequisite(s): graduate standing in Entomology. A program of weekly meetings and individual formative evaluation required of new entomology Teaching Assistants. Covers instructional methods and classroom/section activities most suitable for teaching Entomology. Conducted by departmental faculty or the Teaching Assistant Development Program. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

**Environmental Engineering**

**See Chemical and Environmental Engineering**

**Environmental Sciences**

Subject abbreviation: ENSC

**College of Natural and Agricultural Sciences**

Jianying “Jay” Gan, Chair
Kurt A. Schwabe, Vice-Chair
Program Office, 3428 Pierce
(951) 827-5103; mari.ridgeway@ucr.edu
www.envisci.ucr.edu

**Professors Emeriti**

Andrew C.-S. Chang, Ph.D. Agricultural Engineering
Walter J. Farmer, Ph.D. Soil Chemistry
William A. Jury, Ph.D. Soil Physics
John Letey, Jr., Ph.D. Soil Physics
Lanny J. Lund, Ph.D. Soil Morphology, Genesis, and Classification
Albert L. Page, Ph.D. Soil Chemistry
Henry J. Vaux, Jr., Ph.D. Natural Resource Economics

**Professors**

Christopher Amrhein, Ph.D. Soil Chemistry
Janet T. Arey, Ph.D. Atmospheric Chemistry
Roger Atkinson, Ph.D. Atmospheric Chemistry
David E. Crowley, Ph.D. Soil Microbiology
William T. Frankenberger, Jr., Ph.D. Soil Microbiology
Jianying “Jay” Gan, Ph.D. Environmental Chemistry
Robert C. Graham, Ph.D. Soil Mineralogy and Pedology
Keith C. Knapp, Ph.D. Natural Resource Economics
David R. Parker, Ph.D. Soil Biogeochemistry
Roberto Sánchez-Rodriguez, Ph.D. Environmental Policy
Daniel Schlenk, Ph.D. Aquatic Ecotoxicology
Jiri Simunek, Ph.D. Hydrology
Laosheng Wu, Ph.D. Soil Physics
Marylynn V. Yates, Ph.D. Environmental Microbiology
Paul J. Ziemann, Ph.D. Atmospheric Science

**Environmental Sciences**

Robert C. Graham, Ph.D. Soil Mineralogy and Pedology
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**Associate Professors**

Michael A. Anderson, Ph.D. Environmental Chemistry
Kenneth A. Baerenklau, Ph.D. Resource and Environmental Economics
David M. Crohn, Ph.D. Biosystems Engineering
Linda Fernandez, Ph.D. Resource and Environmental Economics
Kurt A. Schwabe, Ph.D. Resource and Environmental Economics

**Environmental Engineering**

**See Chemical and Environmental Engineering**