

completion of five quarters of master's study in English; consent of the Graduate Advisor. Students revise, extend, and develop essays written during their master's program in preparation for the master's portfolio examination. Graded Satisfactory (S) or No Credit (NC).

**ENGL 297 Directed Research 1 to 6** Research, 3 to 18 hours. Prerequisite(s): graduate standing or consent of instructor. Individual research by graduate students directed by a particular faculty member. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

**ENGL 299 Research For Thesis Or Dissertation 1 to 12** Thesis, 3 to 36 hours. Prerequisite(s): graduate standing or 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 orienting apprentices and transfer TAs to the writing program at UC Riverside. Concentrates on the problem of organizing and teaching ENGL 001A, ENGL 001B, and ENGL 001C or its equivalent. Required of all apprentices and transfer TAs. Students must enroll concurrently in ENGL 302. Graded Satisfactory (S) or No Credit (NC). May be repeated for credit for a maximum of 2 units.

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

**ENGL 303 Advanced Teaching Practicum 1 to 2** Discussion, 1 hour; practicum, 1 to 3 hours. Prerequisite(s): graduate standing or consent of instructor. A flexible program of meetings and conferences on the problems and techniques of teaching literature, cultural studies, film studies, and related courses. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

**ENGL 304 Professional Research Preparations 4** Seminar, 3 hours; research, 3 hours; consultation, 5 hours. 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** 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 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.

**ENGL 381 Preparing to Teach Teachers 1 to 4** Seminar, 2 to 8 hours. Prerequisite(s): consent of instructor; concurrent enrollment in ENGL 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.

**ENGL 410 Seminar in Professional Development 2** Workshop, 2 hours. Prerequisite(s): graduate standing or consent of instructor. Provides a flexible program of meetings and workshops on the development of skills and practices of the professional literary scholar. Includes conference presentations, academic publishing, pedagogy, grant writing, and other career-building practices. Graded Satisfactory (S) or No Credit (NC). course is repeatable to a maximum of 6 units.

## ENTOMOLOGY

**Subject abbreviation: ENTM**  
**College of Natural and Agricultural Sciences**

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William E. Walton, Ph.D., Vice Chair  
Department Office, 175 Entomology  
[insects.ucr.edu](http://insects.ucr.edu)

Graduate Student Affairs  
(800) 735-0717 or (951) 827-5621  
[insects.ucr.edu/graduate-studies-program](http://insects.ucr.edu/graduate-studies-program)

Undergraduate Faculty Advisor  
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### Professors

Michael E. Adams, Ph.D.,  
*Entomology/Molecular, Cell and Systems Biology*  
Peter W. Atkinson, Ph.D.  
Boris Baer, Ph.D.  
Ring T. Cardé, Ph.D.,  
*Distinguished Professor, Alfred M. Boyce Chair in Entomology*  
Brian A. Federici, Ph.D.,  
*Distinguished Professor of Graduate Division*  
Alec Gerry, Ph.D.  
John M. Heraty, Ph.D.  
Chow-Yang Lee, Ph.D.  
Jocelyn G. Millar, Ph.D.,  
*Distinguished Professor*  
Timothy D. Paine, Ph.D.,  
*Distinguished Professor, Tokuji and Bettie L. Furuta Endowed Chair*  
Thomas M. Perring, Ph.D.  
Alexander Raikhel, Ph.D.,  
*Distinguished Professor, Mir Mulla Endowed Chair in Medical Entomology*  
Richard A. Redak, Ph.D.  
Michael K. Rust, Ph.D.,

*Distinguished Professor of Graduate Division*  
Richard Stouthamer, Ph.D.  
John T. Trumble, Ph.D.,  
*Distinguished Professor of Graduate Division*  
William E. Walton, Ph.D.  
Christiane Weirauch, Ph.D.

### Professors Emeriti

Thomas S. Bellows, Jr., Ph.D.  
Leland R. Brown, Ph.D.  
Elizabeth Grafton-Cardwell, Ph.D.  
Richard D. Goeden, Ph.D.  
J. Daniel Hare, Ph.D.  
Marshall W. Johnson, Ph.D.  
E. Fred Legner, Ph.D.  
Robert F. Luck, Ph.D.  
Thomas A. Miller, Ph.D.  
Joseph G. Morse, Ph.D.  
Mir S. Mulla, Ph.D.  
Bradley Mullens, Ph.D.  
John D. Pinto, Ph.D.  
S. Nelson Thompson, Ph.D.  
P. Kirk Visscher, Ph.D.  
Gregory P. Walker, Ph.D.

### Associate Professors

Allison Hansen, Ph.D.  
Dong-Hwan Choe, Ph.D.  
Quinn McFrederick, Ph.D.  
Erin W. Rankin, Ph.D.  
Naoki Yamanaka, Ph.D.

### Assistant Professors

Kerry Mauck, Ph.D.  
Jessica Purcell, Ph.D.  
Hollis Woodard, Ph.D. \*\*

### Lecturers

Matthew Daugherty, Ph.D.,  
*Integrative Biology*  
Mark Hoddle, Ph.D., *Biological Control*  
S. Houston Wilson, Ph.D., *Pest Management*  
Monique Rivera, Ph.D. *Pest Management*

### Cooperating Faculty

Alan Brelsford, Ph.D., *Evolution, Ecology, and Organismal Biology*  
Richard Cardullo, Ph.D., *Evolution, Ecology, and Organismal Biology*  
Paul De Ley, Ph.D., *Nematology*  
Paul Nabity, Ph.D., *Botany and Plant Sciences*  
Nicole Rafferty, Ph.D., *Evolution, Ecology, and Organismal Biology*

## 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 Advisors, Dr. Dong-Hwan Choe, 382 Entomology and Dr. John Heraty, 138 Entomology.

## Transfer Selection Criteria

Applicants to majors in the College of Natural and Agricultural Sciences are selected on the basis of academic preparation, as assessed by their GPA and the strength of preparation for the intended major. A GPA of at least 2.70 is required. (This is a baseline GPA for consideration and not a guarantee of admission.) The GPA cutoff for Transfer admissions will be set each year by the appropriate Divisional Dean in consultation with the Executive Committee and the Chairs, and may differ by program depending on Transfer enrollment capacity.

In addition, applicants will need to complete college courses comparable to at least two of the following UCR year-long sequences in order to meet selection criteria for this major. Courses must be completed with "C" grades or better:

MATH 007A or MATH 009A and MATH 007B or MATH 009B (mandatory)

And at least one sequence from:

1. BIOL 005A, BIOL 05LA or BIOL 020 and BIOL 005B (and BIOL 005C, if articulated)
2. CHEM 001A, CHEM 01LA, CHEM 001B, CHEM 01LB, CHEM 001C, and CHEM 01LC
3. Organic chemistry (one-year lower-division), each course completed with a grade of "B" or better
4. PHYS 002A, PHYS 02LA, PHYS 002B, PHYS 02LB, PHYS 002C, and PHYS 02LC
5. PHYS 040A, PHYS 040B, and PHYS 040C
6. MATH 009C, MATH 010A, MATH 010B, and MATH 046

Courses must be completed with a letter grade, with no grade lower than a "C."

Students should visit [assist.org](http://assist.org) for updated and comprehensive major preparation requirements.

## 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 (59 units)
  - a) BIOL 005A, BIOL 05LA or BIOL 020, BIOL 005B, BIOL 005C
  - b) PHYS 002A, PHYS 002B, PHYS 002C, PHYS 02LA, PHYS 02LB, PHYS 02LC
  - c) MATH 007A or MATH 009A, MATH 007B or MATH 009B
  - d) CHEM 001A, CHEM 001B, CHEM 001C, CHEM 01LA, CHEM 01LB, CHEM 01LC, CHEM 008A or CHEM 08HA, CHEM 008B or CHEM 08HB, CHEM 008C or CHEM 08HC, CHEM 08LA or CHEM 8HLA, CHEM 08LB or CHEM

8HLB, CHEM 08LC or CHEM 8HLC.

2. Upper-division requirements (51 units)
  - a) ENTM 100/BIOL 100, ENTM 107, ENTM 173/BIOL 173, ENTM 180, and 4 units in any combination of ENTM 190, ENTM 197, ENTM 199, or ENTM 199H
  - b) Sixteen (16) additional units of entomology electives, which may include up to 2 additional units of ENTM 190, ENTM 197, ENTM 199 or ENTM 199H
  - c) BCH 100
  - d) BIOL 102
  - e) BIOL 107A
  - f) STAT 100A

Upper division courses in BIOL, BPSC, and related programs including but not limited to BIOL 151 and BPSC 133 are suggested 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	Fall	Winter	Spring
BIOL 005A, BIOL 05LA or BIOL 020; BIOL 005B		4	4
CHEM 001A, CHEM 001B, CHEM 001C, CHEM 01LA, CHEM 01LB, CHEM 01LC	4,1	4,1	4,1
ENGL 001A, ENGL 001B,	4	4	
MATH 007A or MATH 009A, MATH 007B or MATH 009B	4	4	
Humanities/Social Sciences	4		4
<b>Total Units</b>	<b>17</b>	<b>17</b>	<b>13</b>
Sophomore Year	Fall	Winter	Spring
BIOL 005C	4		
Biology/Entomology Electives		4	
CHEM 008A and 008LA, CHEM 008B and 008LB, CHEM 008C and 008LC	4	4	4
PHYS 02A, PHYS 02LA, PHYS 02B, PHYS 02LB, PHYS 02C, PHYS 02LC	4,1	4,1	4,1
Humanities/Social Sciences, STAT 100A	4	4	5
<b>Total Units</b>	<b>17</b>	<b>17</b>	<b>14</b>
Junior Year	Fall	Winter	Spring
BIOL 102	4		
BIOL 107A, ENTM 173/BIOL 173	4		4
ENTM 100/BIOL 100	4		
ENTM 107		4	
Biology/Entomology Electives		7	8
BCH 100, ENTM 19X	4	2	
Humanities/Social Sciences			4
<b>Total Units</b>	<b>16</b>	<b>13</b>	<b>16</b>
Senior Year	Fall	Winter	Spring
ENTM 180, ENTM 19X	2		2
Biology/Entomology Electives	8	8	8
Humanities/Social Sciences, ENGL 001C	4	4	4
<b>Total Units</b>	<b>14</b>	<b>12</b>	<b>14</b>

## 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 require-

ment: ENTM 106, ENTM 107, ENTM 109, ENTM 112/BIOL 112/BPSC 112, ENTM 114, ENTM 124, ENTM 125, ENTM 126, ENTM 127/BIOL 127, ENTM 129, ENTM 129L, ENTM 133, ENTM 154, ENTM 162/BIOL 162, ENTM 173/BIOL 173, ENTM 180, 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

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 human, animal, and plant pathogens
- Behavior
- Biochemistry and Physiology
- Chemical Ecology
- Conservation Biology and Global Change
- Endocrinology and Development
- Ecology and Evolution
- Genetics, Genomics, and Molecular Biology
- Insect Pathology
- Integrated Pest Management
- Invasive Species and Biological Control
- Medical and Veterinary Entomology
- Nematology
- Neuroscience
- Plant-Herbivore Interactions
- Social Insects and Pollination Biology
- Systematics
- Urban Entomology

Information on participating faculty and their research specializations may be found at [insects.ucr.edu](http://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 each in 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 (14 units).

### Seminar Requirements

1. All full-time students must enroll in the ENTM 250 seminar during each quarter in which it is offered. (units vary)
2. Students in the second year and beyond must present a seminar or a poster presentation of their research at the Annual Graduate Student Seminar Day.

### Professional Development

Entomology students must complete an annual Individual Development Plan along with their annual progress report and present an annual seminar or poster presentation covering their research investigations at the Annual Graduate Student Seminar Day, and complete ENTM 201.

## Doctoral Degree

Each student, with the advice of their Ph.D. Guidance Committee, will select courses that complement their research program and help the student prepare for the qualifying examination (units vary).

Students must take at least four Entomology 2-unit seminar courses for a letter grade from the following list: ENTM 249, ENTM 251, ENTM 252, ENTM 254, ENTM 255, ENTM 256, ENTM 258, ENTM 262, ENTM 289 (8 units).

### Written and Oral Qualifying Examinations

Advancement to candidacy depends on the student passing written and oral qualifying examinations.

### Dissertation and Final Oral Examinations

Following completion of their research, students submit a written dissertation and conclude their studies with an oral public defense of the dissertation.

### Teaching Requirement

Ph.D. students must fulfill a three quarter teaching requirement.

### Normative Time to Ph.D.

17 quarters

## Master's Degree

Students should refer to the Graduate Studies section of the catalog for the minimum master's degree requirements.

Each student, with the advice of their M.S. Guidance Committee, will select courses that complement their research program (units vary).

Students must take at least two Entomology 2-unit seminar courses for a letter grade from the following list: ENTM 249, ENTM 251, ENTM 252, ENTM 254, ENTM 255, ENTM 256, ENTM 258, ENTM 262, ENTM 289 (4 Units).

### Thesis and Final Oral Examination

Following completion of their research, students submit a written thesis and conclude their studies with an oral public defense of the thesis.

### Normative Time to M.S.

6 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 (CMDB)
- 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 CNAS Graduate Student Affairs Center, at (800) 735-0717.

## Lower-Division Courses

**ENTM 010 Natural History of Insects 4** Lecture, 3 hours; discussion, 1 hour. A study of the world of insects and their impact on humankind. Designed for non-entomology majors. Utilizes living and preserved insects and other visual aids.

**ENTM 020 Bees and Beekeeping 4** Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): none. 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.

**ENTM 050 The Evidence For Evolution 4** Lecture, 3 hours; extra reading, 3 hours. Prerequisite(s): none. Introduces and explores the extensive evidence supporting evolution as the driver of biological diversity. Designed for non-science majors and/or those with limited prior knowledge about biology. Includes the scientific method, paleontology, natural selection,

genetics, speciation, and the importance of sex. Addresses the broader need for scientific literacy in society. Cross-listed with BPSC 050.

### **ENTM 060W Scicomm: Exploring Effective Communication Methods in the Life Sciences 4**

Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 005A with a grade of C- or better, ENGL 001B with a grade of C or better. Teaches the process of analyzing and translating scientific research into popular science stories. Introduces the art of science communication through written narratives. Provides resources and guidance on interpretation of scientific literature, interviewing scientists, and pursuing careers in entomology, the broader life sciences, and science writing. Fulfills the third-quarter writing requirement for students who earn a grade of "C" or better for courses that the Academic Senate designates, and that the student's college permits, as alternatives to English 001C.

## **Upper-Division Courses**

**ENTM 100 General Entomology 4** Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): BIOL 005B, BIOL 005C, or equivalent(s); 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.

**ENTM 106 Insect Evolution 3** 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 phylogenetic 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 4** Lecture, 3 hours; discussion, 1 hour; laboratory, 3 hours. Prerequisite(s): BIOL 100/ENTM 100 or consent of instructor. Introduces the science of insect systematics. Emphasizes the diagnostic characters of the major taxa and insect biodiversity. Laboratories focus on developing skills in insect identification to the family level.

**ENTM 108 Biology of Social Insects 4** Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 005C with a grade of C- or better. Introduces the diversity of social lifestyles found in insects and the ecological and evolutionary mechanisms that generated this diversity. Emphasizes an integration between classic theoretical studies and modern molecular research on the social insects.

**ENTM 109 Field Entomology 4** Laboratory, 4 hours; field, 8 hours. Prerequisite(s): BIOL 100/ENTM 100 or equivalent(s) 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 111 Molecular Biology and Genomics of Human Disease Vectors 3** Lecture, 2 hours; discussion, 1 hour. Prerequisite(s): BIOL 005A with a grade of C or better, BIOL 05LA with a grade of C or better. Introduces human diseases transmitted by insects/arthropods (insect vectors) that claim about a million deaths annually and cause enormous suffering globally. Highlights adaptations that have contributed to the evolutionary success of disease vectors as well as biotechnological advances in vector control.

**ENTM 112 Systematics 4** 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.

**ENTM 114 Aquatic Insects 4** 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.

**ENTM 124 Agricultural Entomology 4** 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 125 Pesticides, Biological Organisms, and the Environment 3** Lecture, 3 hours. Prerequisite(s): two of the following courses; BIOL 005A; BIOL 005B; BIOL 005C; CHEM 008A and CHEM 08LA or CHEM 08HA and CHEM 08HLA; CHEM 008B and CHEM 08LB or CHEM 08HB and CHEM 08HLB; CHEM 008C and CHEM 08LC or CHEM 08HC and CHEM 08HLC. An introduction to the chemistry, mode of action, and use of insecticides, acaricides, herbicides, and biopesticides from discovery to environmental interactions. Includes genetics of pesticide resistance development and government regulation. Cross-listed with ENTX 125, and PLPA 125.

**ENTM 126 Medical and Veterinary Entomology 4** Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): BIOL 005B, BIOL 005C; or consent of instructor. Covers biology, ecology, and management of arthropods that affect human and animal health. Considers arthropods as direct pests and vectors of notorious diseases (e.g., malaria, plague). Also addresses disease epidemiology and prevention, as well as control of pests and associated diseases.

**ENTM 127 Insect Ecology 4** Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 005A,

BIOL 05LA or BIOL 020, BIOL 005B, BIOL 005C, CHEM 001C or CHEM 01HC, CHEM 008C or CHEM 08HC, MATH 007B or MATH 009B or MATH 09HB, PHYS 002C or PHYS 02HC, PHYS 02LC or PHYS 02HLC, BCH 100 or BCH 110A or BCH 110HA, 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.

**ENTM 129 Introduction to Biological Control 2** 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.

**ENTM 129L Introduction to Biological Control Laboratory 2** 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 130 Invasion Ecology 4** Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 005C with a grade of C- or better, BIOL 102 with a grade of C- or better; or consent of instructor. Explores the introduction, establishment, and impact of non-native, invasive species. Considers how invasions differ across taxonomic groups from pathogens to plants to insects.

**ENTM 133 Urban Entomology 4** 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.

**ENTM 139 The Evolution of Conflict and Cooperation: Cheaters and Altruists 4** Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 005C; or consent of instructor. Explores the evolution of selfish and selfless behavior. An analysis of the evolutionary forces that create either conflict or cooperation among genes, microorganisms and their hosts, and kin. Cross-listed with MCBL 139.

**ENTM 149 Special Topics in Undergraduate Entomology 1 to 4** Lecture, 1 to 4 hours; laboratory, 0 to 12 hours. Prerequisite(s): BIOL 005C with a grade of C- or better; or consent of instructor. Explores topics in entomology within the area of specialization of the instructor(s). Content emphasizes recent advances in the special topic area and varies accordingly. Course is repeatable as content or topic changes to a maximum of 12 units.

**ENTM 154 Forensic Entomology 4** Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): BIOL

005C with a grade of C- or better. Introduces the application of entomological principles and collection of entomological data to be used as evidence in courts of law. Explores the basis of using insects to determine time and place of death in criminal cases, including the collection, handling, and identification of insects of forensic importance. Cross-listed with BIOL 154.

**ENTM 162 Insect Behavior 4** Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 005A, BIOL 005B, BIOL 005C; or BIOL 100 /ENTM 100; or consent of instructor. An analysis of the mechanisms that cause and control behavioral reactions of insects. Emphasizes 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.

**ENTM 173 Insect Physiology 4** Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): BIOL 005A and BIOL 005B or equivalents; CHEM 008A and 08LA or CHEM 08HA and 08HLA; CHEM 008B and 08LB or CHEM 08HB and 08HLB; CHEM 008C and 08LC or CHEM 08HC and CHEM 08HLC; 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.

**ENTM 180 Capstone Research Seminar in Entomology 2** Seminar, 1 hour; discussion, 1 hour; Prerequisite(s): ENTM 100, ENTM 107, upper-division standing in Entomology; or consent of instructor; ENTM 173 is recommended. Capstone course that provides undergraduate students majoring in Entomology with the experience of synthesizing and integrating knowledge and skills gained throughout the Entomology program. Satisfactory (S) or No Credit (NC) grading is not available.

**ENTM 190 Special Studies 1 to 4** Individual Study, 3 to 12 hours. Prerequisite(s): upper-division standing and consent of instructor. Directed studies by a faculty member to address specific curricular needs. A written proposal signed by the supervising faculty member and the undergraduate advisor is required. Course is repeatable as content changes to a maximum of 4 units.

**ENTM 197 Research For Undergraduates 1 to 4** Research, 3 to 12 hours. Prerequisite(s): upper-division standing and consent of instructor. Original research conducted under faculty supervision. A written proposal signed by the supervising faculty member and the undergraduate advisor is required. Requires a formal oral presentation, poster project, or a written report. Course is repeatable to a maximum of 6 units.

**ENTM 198I Individual Internship in Entomology 1 to 12** Written work, 1 to 12 hours; internship, 2 to 24 hours. Prerequisite(s): restricted to class level standing of sophomore, junior, or senior; and consent of instructor. Provides an off-campus internship related to entomology. Internship conducted in the public or private sector but is jointly supervised by an

off-campus sponsor and a faculty member in Entomology. Requires an initial written proposal, journal or lab notebook and a final written report. Course is repeatable to a maximum of 16 units.

**ENTM 199 Senior Research 1 to 4** Research, 3 to 12 hours. Prerequisite(s): senior standing and consent of instructor. Research in entomology performed under supervision of a faculty member. A written proposal signed by the supervising faculty member and the undergraduate advisor is required. Requires a formal written report in the format of a research publication. Course is repeatable to a maximum of 6 units. Credit is awarded for only one of ENTM 199 or ENTM 199H..

**ENTM 199H Senior Honors Research 1 to 5** Laboratory, 3 to 15 hours. Prerequisite(s): senior status; consent of instructor; a GPA of 3.5 or better in Entomology courses and 3.2 in all University course work. Honors course corresponding to ENTM 199. Research in entomology under supervision of a faculty member in entomology. A written proposal signed by the supervising faculty member and the undergraduate advisor is required. The student will submit a written report. Satisfactory (S) or No Credit (NC) grading is not available. Course is repeatable to a maximum of 6 units. Credit is awarded for only one of ENTM 199 or ENTM 199H.

## Graduate Courses

**ENTM 201 Core Areas of Entomology I: Subcellular-Cellular Disciplines 5** Lecture, 3 hours; discussion, 1 hour; laboratory, 3 hours. Prerequisite(s): BCH 100, may be taken concurrently or BCH 100H, may be taken concurrently or BCH 110A, may be taken concurrently or BCH 110HA, may be taken concurrently; graduate standing. Introduces principles of molecular biology and insect physiology. Topics include genetic material and mechanisms, genomics, bioinformatics, gene control, genetic manipulations, endocrine and hormonal signaling, ecdysis, reproduction, and the muscle, nervous, and sensory systems.

**ENTM 202 Core Areas of Entomology II: Suborganismal-Organismal Disciplines 5** Lecture, 3 hours; discussion, 1 hour; laboratory, 3 hours. Prerequisite(s): ENTM 201; graduate standing; or consent of instructor. Introduces principles of insect morphology, insect evolution, and insect behavior. Topics include morphology, systematic theory, evolution, insect identification, and behavior.

**ENTM 203 Core Areas of Entomology III: Supraorganismal Disciplines 5** Lecture, 4 hours; laboratory, 3 hours. Prerequisite(s): ENTM 202; undergraduate course in ecology; graduate standing; or consent of instructor. Introduces principles of insect ecology, genetics, evolution, and pest management. Addresses insect population dynamics and community interactions, genetics of geographic variation, insect behavior, and the management and control of pestiferous species. Includes computer simulations and use of molecular tools applied to supraorganismal phenomena.

**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. Involves lectures and student presentations about 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 CMDB 210, and MCBL 210.

**ENTM 211 Genetic Technologies in Pest Insects 4** Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): graduate standing; or consent of instructor. Introduces the concepts, history, theory, application, and regulatory and societal issues of insect genetic control. Includes laboratory instruction in contemporary insect genetic techniques of CRISPR-mediated gene editing, transposon-mediated insect transgenesis, and site-specific recombination as applied to insect control.

**ENTM 212 Ecological Systems in Space and Time 4** Lecture, 3 hours; field, 30 hours per quarter. Prerequisite(s): one upper-division undergraduate course in population or community ecology or paleoecology; 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 EEOB 212, and GEO 212.

**ENTM 219 Theory of Systematics 4** Lecture, 4 hours. Prerequisite(s): BIOL 112/BPSC 112/ 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 EEOB 219, and GEO 219.

**ENTM 230 Entomophagous Insects 4** 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.

**ENTM 240 Research Methods in Insect Chemical Ecology 4** Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): 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.

**ENTM 241 Insect-Plant Interactions 4** 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.

**ENTM 242 Development of Hypotheses and Research Design 3** 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.

**ENTM 249 Special Topics in Entomology 1 to 6** Lecture, 1 to 6 hours; laboratory, 0 to 15 hours; Prerequisite(s): graduate standing or consent of instructor. Explores topics in entomology within the area of specialization of each faculty member. Content emphasizes recent advances in the special topic area and varies accordingly. Course is repeatable as content changes.

**ENTM 250 Seminar in Entomology 1** Seminar, 1 hour. Prerequisite(s): graduating standing. 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** Seminar, 2 hours. Prerequisite(s): graduate standing; or consent of instructor. Provides rigorous examinations and interpretation of recent publications in the area of insect-plant interactions. Subject matter varies from year to year. Course is repeatable as content or topic changes.

**ENTM 252 Seminar in Insect Behavior 2** Seminar, 2 hours. Prerequisite(s): BIOL 162/ENTM 162 or consent of instructor. An analysis 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 is repeatable as content changes.

**ENTM 254 Seminar in Biological Control 2** Seminar, 2 hours. Prerequisite(s): BIOL 127/ENTM 127, ENTM 129; or consent of instructor. Addresses 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. Course is repeatable.

**ENTM 255 Seminar in Medical and Veterinary Entomology 2** Seminar, 2 hours. Prerequisite(s): graduate standing 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.

**ENTM 256 Seminar in Systematic Entomology 2** 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.

**ENTM 257 CIBER SEMINAR 2** Seminar, 2 hours. Prerequisite(s): graduate standing; or consent of instructor. Selected topics in pollinator health and pollination. Students who present a seminar receive a letter grade; other students receive a Satisfactory(S) No Credit grade. Course is repeatable as content or topic changes.

**ENTM 258 Seminar in Insect Pest Management 2** 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.

**ENTM 261 Seminar in Genetics, Genomics, and Bioinformatics 1** 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, PLPA 261, and GEN 261.

**ENTM 262 Molecular Biology of Arthropod Disease Vectors 2** Seminar, 1 hour; discussion, 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. Course is repeatable to a maximum of 4 units. Cross-listed with MCBL 262.

**ENTM 271 Research Seminar in Management of Vegetable Crop Pests 1** 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.

**ENTM 272 Research Seminar in Insect Communication and Behavior 1** 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** 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.

**ENTM 277 Research Seminar in Insect Biochemistry and Toxicology 1** 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.

**ENTM 289 Special Topics in Neuroscience 2** 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, NRSC 289, and PSYC 289.

**ENTM 290 Directed Studies 1 to 6** Prerequisite(s): graduate standing. 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 to 6** 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 to 6** Prerequisite(s): graduating standing. 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). Course is repeatable.

**ENTM 299 Research For Thesis Or Dissertation 1 to 12** Research, 3 to 36 hours. Prerequisite(s): graduate standing. Original research in an area selected for the advanced degree. Course is repeatable.

## Professional Courses

**ENTM 301 Teaching Entomology at the College Level 1** Seminar, 1 hours. 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.

**ENTM 302 College Teaching Practicum 1 to 4** Practicum/consultation, 3 to 12 hours. Prerequisite(s): graduate standing and consent of instructor. Supervised teaching in college level classes under supervision of the course instructor. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

**ENTM 303 Philosophy and Pedagogy of Teaching Undergraduate Life Sciences 3** Lecture, 1 hour; laboratory, 3 hours; workshop, 1 hours. Prerequisite(s): graduate standing in life sciences. Explores the opportunities and challenges associated with developing an undergraduate course in the life sciences. Emphasizes determining how students learn, as well as exploring contemporary instruction methods that foster student engagement in the classroom. Graded