Richard Anthony VanCuren, Ph.D., Professional Researcher (Air Pollution Research Center)

Graduate Study. The Graduate Group in Avian Sciences offers an M.S. degree program to students who wish to pursue specialized advanced work on avian species. Specializations students may choose include behavior, nutrition, physiology, reproduction, pathology, immunology, toxicology, food chemistry, management, ecology, genetics, comparative incubation, environmental physiology, and cellular and developmental studies using wild and domestic birds as experimental animals. Both master’s degree plans, theses or comprehensive examination, are available.

Preparation. Applicants should have undergraduate preparation in a field appropriate to the course of study selected, including courses in most of the following subjects: general biology, general and organic chemistry, biochemistry, avian biology, genetics, nutrition, physiology, and statistics.


Biochemistry and Molecular Biology

See Biochemistry, Molecular, Cellular and Developmental Biology, on page 189; Molecular and Cellular Biology, on page 463.

Biochemistry and Molecular Biology (A Graduate Group)

The Biochemistry and Molecular Biology program has merged with the Cell and Developmental Biology program to form Biochemistry, Molecular, Cellular, and Developmental Biology (BMCDB); see Biochemistry, Molecular, Cellular and Developmental Biology, on page 189.

Group Office. 2278 Life Sciences 530.752.9091; http://biosci3.ucdavis.edu/GradGroups/BMCDB/

Biological Chemistry

See Medicine, School of, on page 427.

Biochemistry, Molecular, Cellular, and Developmental Biology

Daniel Starr, Ph.D., Chairperson of the Group 530.754.6083

Group Office. 2278 Life Sciences 530.752.9091; http://biosci3.ucdavis.edu/GradGroups/BMCDB/

Faculty

Iannis, Adamopoulos, Ph.D., Associate Professor (Medical Division of Internal Medicine, Rheumatology)

Jawad Al-Bassam, Ph.D., Assistant Professor (Molecular and Cellular Biology)

John Albeck, Ph.D., Assistant Professor (Molecular and Cellular Biology)

F. Javier Arsuaga, Ph.D., Professor (Mathematics, Molecular and Cellular Biology)

Shota Atsumi, Ph.D., Associate Professor (Chemistry)

Enoch Baldwin, Ph.D., Associate Professor (Molecular and Cellular Biology)

Jacqueline Barlow, Ph.D., Professor (Microbiology and Molecular Genetics)

Peter Barry, Ph.D., Professor (Pathology)

Andreas Baumann, Ph.D., Professor (Medical Microbiology and Immunology)

Peter A Beal, Ph.D., Professor (Chemistry)

Alan Bennett, Ph.D., Professor (Plant Sciences)

Donald M. Bens, Ph.D., Professor (Pharmacology)

Charles Bevis, Ph.D., Professor (Medical Microbiology and Immunology)

Linda F. Bisson, Ph.D., Professor (Viticulture and enology)

Edward Blumwald, Ph.D., Professor (Plant Sciences)

Laura Borodinsky, Ph.D., Assistant Professor (Physiology and Membrane Biology)

Alexandreot Borsky, Ph.D., Associate Professor (Pathology)

Siobhan Mary Brady, Ph.D., Associate Professor (Plant Biology)

Nadean L. Brown, Ph.D., Associate Professor (Cell Biology and Human Anatomy)

Sean Burgess, Ph.D., Professor (Molecular and Cellular Biology)

Marie E. Burns, Ph.D., Professor (Cell Biology and Human Anatomy)

Judy Callis, Ph.D., Professor (Molecular and Cellular Biology) Academic Senate Distinguished Teaching Award

Kermit L. Carraway, Ph.D., Professor (Cancer Center UCDMC)

Luis G. Carvaljal-Carmona, Ph.D., Assistant Professor (Biochemistry and Molecular Biology)

Frederic Chedin, Ph.D., Associate Professor (Molecular and Cellular Biology)

Hongwu Chen, Ph.D., Professor (Pharmacology and Molecular Medicine)

Tsung-Yu Chen, Ph.D., Professor (Neurology)

Xinbin Chen, Ph.D., Professor and Director (VM. Surgical and Radiological Science)

Hwai-Jong Cheng, Ph.D., Professor (Neurobiology, Physiology, and Behavior, Pathology)

Joanna Chiu, Ph.D., Assistant Professor (Entomology)

Sean Collins, Ph.D., Assistant Professor (Microbiology and Molecular Genetics)

Gino A. Cortopassi, Ph.D., Professor (VM. Molecular Biosciences)

Sheila David, Ph.D., Professor (Chemistry)

Scott Dawson, Ph.D., Associate Professor (Microbiology and Molecular Genetics)

Michael S. Denison, Ph.D., Professor (Environmental Toxicology)

Megan Dennis, Ph.D., Assistant Professor (Biochemistry and Molecular Medicine)

Elva Diaz, Ph.D., Associate Professor (Medical Pharmacology and Toxicology)

Savithramma P. Dinesh-Kumar, Ph.D., Professor (Plant Biology)

Georgia Drakoulaki, Ph.D., Assistant Professor

Bruce Draper, Ph.D., Associate Professor (Molecular and Cellular Biology)

Joanne Engbrecht, Ph.D., Professor (Molecular and Cellular Biology)

Marc Facciotti, Ph.D., Associate Professor (Biomedical Engineering)

Robert H. Fairclough, Ph.D., Associate Professor (Neurology)

Michael Ferns, Ph.D., Professor (Physiology and Membrane Biology, Anesthesiology and Pain Medicine)

Oliver Fiehn, Ph.D., Professor (Molecular and Cellular Biology)

Diasymou Fioravante, Ph.D., Assistant Professor (Radiation Biology, Physiology and Behavior)

Andrew Fisher, Ph.D., Professor (Chemistry, Molecular and Cellular Biology)

Paul G. FitzGerald, Ph.D., Professor (Cell Biology and Human Anatomy)

Annaleise K. Franz, Ph.D., Associate Professor (Chemistry)

Christopher Fraser, Ph.D., Assistant Professor (Cell Biology and Cellular Biology)

J. David Furlow, Ph.D., Professor (Neurobiology, Physiology, and Behavior)

Charles S. Gasser, Ph.D., Professor (Molecular and Cellular Biology)

Angela Gelli, Ph.D., Associate Professor (Medical Pharmacology and Toxicology)

Dominic C. Genets, Ph.D., Associate Professor (VM. Anatomy and Cell Biology)

Paramita Ghosh, Ph.D., Associate Professor (Urology, Biochemistry and Molecular Medicine)

Cecilia Girolami, Ph.D., Professor (VM. Molecular Biosciences)

Thomas M. Glaser, Ph.D., Professor (Cell Biology and Human Anatomy)

Aldrin Gomes, Ph.D., Assistant Professor (Neurobiology, Physiology and Behavior, Physiology and Membrane Biology)

Giachi Gong, Ph.D., Assistant Professor (Cell Biology and Human Anatomy)

John Gray, Ph.D., Assistant Professor (Neurology)

Paul Hagerman, Ph.D., Professor (Biochemistry and Molecular Medicine)

Nabuko Hagiwara, Ph.D., Associate Professor (Internal Medicine: Cardiovascular Medicine)

Fawaz Haj, Ph.D., Professor (Nutrition)

Bruce D. Hammock, Ph.D., Professor (Entomology and Nematology) Academic Senate Distinguished Teaching Award

John H. Harada, Ph.D., Professor (Plant Biology) Academic Senate Distinguished Teaching Award

Dominik Haudenschild, Ph.D., Associate Professor (Orthopaedics, Biomedical Engineering)

Johannes W. Hell, Ph.D., Professor (Pharmacology)

Wolfgang Heyer, Ph.D., Professor (Microbiology and Molecular Genetics)

Henry Ho, Ph.D., Assistant Professor (Cell Biology and Human Anatomy)

Mary Horne, Ph.D., Assistant Adjunct Professor (Pharmacology and Molecular Biology)

Mark Hsing, Ph.D., Assistant Professor (Neurobiology, Physiology and Behavior, Physiology and Membrane Biology)

Neil Hunter, Ph.D., Professor (Biochemistry and Molecular Genetics, Cell Biology and Human Anatomy)

Kentaro Inoue, Ph.D., Professor (Plant Sciences)

Yoshikita Izumiya, Ph.D., Assistant Professor (Dermatology)

Li En Jao, Ph.D., Assistant Professor (Cell Biology and Human Anatomy)

Celina Juliano, Ph.D., Assistant Professor (Molecular and Cellular Biology)

Ken Kaplan, Ph.D., Professor (Molecular and Cellular Biology)

Junio Kim, Ph.D., Associate Professor (Pediatrics)

Paul Knoepfler, Ph.D., Associate Professor (Cell Biology and Human Anatomy)

Anne Knowland, Ph.D., Professor (Cardiovascular Physiology, Pharmacology)

Artym Kopp, Ph.D., Professor (Population Biology, Evolution and Ecology)

Ian Korf, Ph.D., Professor (Plant Cell Biology)

Stephen C. Kowalczykowski, Ph.D., Distinguished Professor (Microbiology and Molecular Genetics)

Anna La Torre, Ph.D., Assistant Professor (Cell Biology and Human Anatomy)

J. Clark Lagarias, Ph.D., Distinguished Professor (Molecular and Cellular Biology)

Janine LaSalle, Ph.D., Professor (Microbiology)

Jerold A. Last, Ph.D., Professor (Pulmonary Medicine)

Walter Leal, Ph.D., Professor (Molecular and Cellular Biology)

Julie A. Leary, Ph.D., Professor (Molecular and Cellular Biology, Chemistry)

Jian-Jian Li, Ph.D., Professor (Radiation Oncology)

Su-Ju Lin, Ph.D., Professor (Microbiology and Molecular Genetics)

Yu-Fung Lin, Ph.D., Associate Professor (Physiology and Membrane Biology, Anesthesiology and Pain Medicine)

Bo Liu, Ph.D., Professor (Plant Biology)

Su Hao Lo, Ph.D., Professor (Biochemistry and Molecular Medicine)
Soichiro Yamada, Ph.D., Associate Professor (Biomedical Engineering)
Wei Yao, Ph.D., Associate Adjunct Professor (Medical Science)
Aiming Yu, Ph.D., Associate Professor (Biochemistry and Molecular Medicine)
Kostas Karbalis, Ph.D., Assistant Professor (Pathology)
Philipp Zerbe, Ph.D., Assistant Professor (Plant Biology)
Min Zhao, Ph.D., Professor (Dermatology, Ophthalmology)
Chengi Zhou, Ph.D., Associate Professor (Biochemistry and Molecular Medicine)
Karen Zito, Ph.D., Associate Professor (Neurobiology, Physiology, and Behavior)

Graduate Study. The Graduate Group in Biochemistry, Molecular, Cellular, and Developmental Biology offers programs of study and research leading to the M.S. and Ph.D. degrees. While an M.S. may be obtained while pursuing a Ph.D., only Ph.D applications will be accepted. Biochemistry, Molecular, Cellular, and Developmental Biology is a broad interdisciplinary program.

Preparation. Appropriate preparation is an undergraduate degree in a biological or physical science. Preparation should include a year of calculus, physics, general chemistry and organic chemistry, and courses in statistics, biochemistry, genetics and cell biology.

Graduate Advisers. F. McNally (Molecular and Cellular Biology, E. Diaz (Pharmacology), R. Tucker (Med: Cell Biology), R. Fairclough (Neurology), T. Powers (Molecular and Cellular Biology), L. Rose (Molecular and Cellular Biology), J. Engrebecht (Molecular and Cellular Biology), C. Fraser (Molecular and Cellular Biology), E. Baldwin (Molecular and Cellular Biology), M. Draper (Molecular and Cellular Biology), K. Karraway (Med: Biochemistry and Molecular Medicine), K. Zito (Center for Neuroscience), D. Genetos (Vet. Anatomy & Cell Biology), M. Singer (Microbiology and Molecular Genetics), K. B. Draper (Molecular and Cellular Biology)

Courses in Biochemistry, Molecular, Cellular, and Developmental Biology (BCB)

Graduate

210. Molecular Genetics and Genomics (3) Lecture/discussion—3 hours. Prerequisite: Biological Sciences 101 and Molecular & Cellular Biology 121, or equivalent. Pass One restricted to graduate students. Emphasizes molecular and genomic approaches to address fundamental biological questions. Introduces and emphasizes the core concepts of genetics and genomics.

211. Macromolecular Structure and Function (3) Lecture—3 hours. Prerequisite: Biological Sciences 102, or the equivalent, or consent of instructor. Pass One restricted to graduate students. Emphasizes the use of molecular biological techniques to address experimental approaches used to critically address scientific questions.

213. Developmental Biology (3) Lecture—3 hours. Prerequisite: undergraduate biology course or consent of instructor. Pass One restricted to graduate students. Focuses on fundamental principles in embryonic development that guide applications of modern cellular and genetic approaches to understanding developmental mechanisms. Emphasis on experimental approaches used to critically address scientific questions.

214. Molecular Biology (3) Lecture—3 hours. Prerequisite: course 211, or equivalent, or consent of instructor. Pass One restricted to graduate students. Investigation of the basic cellular processes in prokaryotes and eukaryotes that govern the central dogma of molecular biology (DNA-RNA-protein). No credit for students that have taken course 221C. — S. (J.) Chedin, Fraser, Heyer

215. Graduate Reading Course (2) Discussion—10 hours. Prerequisite: graduate standing or consent of instructor. Restricted to graduate students. Development of critical reading skills through study of major paradigm advances in specialized fields of biochemistry, molecular, cell, and developmental biology. Emphasis on active learning and student participation. Guided analysis of literature and major advances in field of study. May be repeated two times for credit when topic differs. — S. (J.) Chen, Fairclough, Genetos, Giulivi, Inoue, Vashishth

220L. Advanced Biochemistry Laboratory Rotations (5) Laboratory—15 hours. Prerequisite: course 210 and 211 (may be taken concurrently) and 120L or the equivalent. Open to graduate students. Two five-week assignments in BMCDB research laboratories. Independent research problems with emphasis on methodologies/procedural work, experimental design, proposal writing and oral communication of results. May be repeated two times for credit. — F. W. (F. S.) Albeck, Baldwin, Haudenschild, Tian

251. Molecular Mechanisms in Early Development (3) Lecture—3 hours. Prerequisite: graduate standing or consent of instructor; introductory background in developmental biology and/or cell biology recommended. Analysis of the early events of development including germ cells and other stem cells, gametogenesis, meiosis, imprinting, fertilization, genetically engineered organisms, egg activation and establishment of embryonic polarity with focus on cellular processes including gene regulation and cell signaling. Offered in alternate years. — F. Draper

255. Molecular Mechanisms in Pattern Formation and Development (3) Lecture—3 hours. Prerequisite: graduate standing or consent of instructor; introductory background in developmental biology and/or genetics recommended. Genetic and molecular analysis of mechanisms that control animal development after fertilization. Special emphasis on experimental approaches used to critically address scientific questions. — F. (S.) Fritz

257. Cell Proliferation and Cancer Genes (3) Lecture—1 hour; seminar—1 hour. Prerequisite: course 221C and 221D or equivalents. Genetic and molecular alterations that contribute to the conversion of normal cells to cancers, emphasizing regulatory mechanisms and pathways. Critical reading of current literature in C. elegans, Drosophila, and mammalian cell culture systems. Offered in alternate years. — F. Nattle, Rose

290. Seminar (1) Seminar—1 hour. Prerequisite: consent of instructor and/or graduate standing. Presentation and discussion of faculty and/or student research. (S/U grading only) — F. W. (S. W.)

298. Group Study (1-5) Prerequisite: consent of instructor. (S/U grading only) — F. W. (S. W.)

Fall 2011 and on Revised General Education (GE) AEH—Arts and Humanities; SE—Science and Engineering; SS—Social Sciences; ACGH—American Cultures; DD—Domestic Diversity; DL=Oral Skills; GL=Quantitative; SL=Scientific; VL=Visual; WC=World Cultures; WE=Writing Experience Pre-Fall 2011 General Education (GE): ArtHum—Arts and Humanities; ScInge—Science and Engineering; SocSci—Social Sciences; Div—Domestic Diversity; Wrtg—Writing Experience Quarter Offered: F=Fall, W=Winter, S=Spring, Su=Summer; 2017/2018 offering in parentheses
Biological and Agricultural Engineering

Biological and Agricultural Engineering

[College of Agricultural and Environmental Sciences and College of Engineering]
Bryan M. Jenkins, Ph.D., Chair of the Department
Department Office, 2030 Bainer Hall, 530-752-0102,
http://bae.engineering.ucdavis.edu

Faculty
Gail M. Bornhorst, Ph.D., Assistant Professor
Juliana de Moura Bell, Ph.D., Assistant Professor
(Food Science and Technology)
Irwin Donis-Gonzalez, Ph.D., Assistant Extension Specialist
Zhihong (Julia) Fan, Ph.D., Associate Professor
Fatimah A. Fadhilah, Ph.D., Professor
D. Ken Giles, Ph.D., Professor
Mark E. Grismer, Ph.D., Professor
(land and Water Resources)
Bryan M. Jenkins, Ph.D., Professor Emeritus
Tina Jeoh, Ph.D., Associate Professor
Michael J. McCarthy, Ph.D., Professor (Food Science and Technology)
Nitin N. Nalini, Ph.D., Associate Professor (Food Science and Technology)
Ning Pan, Ph.D., Professor (Textiles and Clothing)
David C. Slaughter, Ph.D., Professor (Textiles and Clothing)
Shrinivas V. Upadhyaya, Ph.D., Professor
Jean S. VanderGheynst, Ph.D., Professor
Stavros V. Vougioukas, Ph.D., Assistant Professor
Ruifang Zhang, Ph.D., Professor
Emeriti Faculty
William J. Chancellor, Ph.D., Professor Emeritus
Pichiau (Paul) Chen, Ph.D., Professor Emeritus
Michael J. Delwiche, Ph.D., Professor Emeritus
Roger E. Garrett, Ph.D., Professor Emeritus
John R. Goss, M.S., Professor Emeritus
Bruce R. Hartsough, Ph.D., Professor Emeritus
David J. Hills, Ph.D., Professor Emeritus
John M. Krocha, Ph.D., Professor Emeritus
Miavel A. Maritit, Ph.D., Professor Emeritus
Kathryn McCarthy, Ph.D., Professor Emeritus
R. Larry Merson, Ph.D., Professor Emeritus
John A. Miles, Ph.D., Professor Emeritus
Stanton R. Morrison, Ph.D., Professor Emeritus
Raul H. Ramirez, Ph.D., Professor Emeritus
Richard E. Plant, Ph.D., Professor Emeritus
James W. Rumsey, M.S., Senior Lecturer Emeritus
Thomas R. Rumsey, Ph.D., Professor Emeritus
Verne H. Scott, Ph.D., Professor Emeritus
R. Paul Singh, Ph.D., Distinguished Professor Emeritus
James F. Thompson, M.S., Extension Specialist Emeritus
Wesley N. Wallander, Ph.D., Professor Emeritus
Wesley E. Yates, M.S., Professor Emeritus

Affiliated Faculty
Tien-Chieh Hung, Ph.D., Assistant Adjunct Professor
Kurt Konbloth, Ph.D., Assistant Adjunct Professor
Zhangli Pan, Ph.D., Adjunct Professor
Herbert Schone, Ph.D., Biological Researcher
Mir Shafii, Ph.D., Lecturer

Major Programs and Graduate Study. For the Bachelor of Science program, see the major in Engineering: Biological and Agricultural, on page 256; for graduate study, see also Graduate Studies, on page 387.

Minor Programs. The Department of Biological and Agricultural Engineering offers two minors through the College of Agricultural and Environmental Sciences: Geographic Information Systems and Precision Agriculture.

The minor in Geographic Information Systems is open to all majors, including those in engineering. This minor is for students interested in information processing of spatial data related to remote sensing for geographical and environmental planning and related areas.

The minor in Precision Agriculture is open to all majors, including those in engineering, and acquaints students with recent developments and their applications to agriculture, in geographic information systems, global positioning systems, and variable rate technologies.

The Department of Biological and Agricultural Engineering also administers three minors through the College of Engineering in Energy Science and Technology, Energy Efficiency, and Energy Policy.

Courses. Courses are listed under Applied Biocatalysts, Systems Technology, and Engineering: Biological and Agricultural (Biological Systems Engineering).

Biological Sciences

[College of Biological Sciences]
Biological Academic Success Center (BASC), 1023 Sciences Laboratory Building, 530-752-0410; http://basc.ucdavis.edu/

Faculty
The Biological Science major and the Bodega Marine Laboratory Spring Quarter Program are offered jointly by the departments of the college. The faculty in the college are members of the Department of Evolution and Ecology; Microbiology; Molecular and Cellular Biology; Neurobiology, Physiology, and Behavior; Plant Biology.

The Program. The Biological Science major is broad in concept, spanning the numerous core disciplines of biology. The Bachelor of Science (B.S.) and Bachelor of Arts (A.B) programs include preparatory work in mathematics, general and organic chemistry, physics, and introductory level biology, as well as upper division core classes emphasizing the breadth of biological sciences. Students in the B.S. degree program complete additional upper division coursework, for which they may choose classes from a variety of different areas such as molecular biology and genetics, animal behavior, plant growth and development, bioinformatics, marine biology, forensics, and microbiology. Students in the Bachelor of Arts (A.B) program can pursue upper division coursework outside of the biological sciences. Research and internships are encouraged in both programs.

Career Alternatives. Both degree programs prepare students for admission to graduate schools or professional schools, leading to either a variety of professional health careers or further study in basic and applied areas of biology. They provide suitable preparation for careers in teaching, biological and biotechnological research with various governmental agencies or private companies, government regulatory agencies, environmental consulting, biomedical illustration and writing, pharmaceutical sales, biological/environmental law, and biomedical engineering.

A.B. Major Requirements:

Preparatory Subject Matter ........................................... 45-57

Biological Sciences 2A-2B-2C ........................................ 15
Chemistry 2A-2B ....................................................... 10
Chemistry 8A-8B or 118A-118B-118C .................................. 6-12

Mathematics 17A-17B or 21A-21B ...................................... 8
Physics 1A-1B or 7A-7B-7C ......................................... 6-12
(Recommended: Chemistry 2C and Math 17C or 21C)

Depth Subject Matter ............................................. 28-36

Biological Sciences 101 ............................................... 4
Biological Sciences 105 .............................................. 3-6
(201-202) .............................................................. 10
Statistics 100 .................................................................. 4
Evolution and Ecology 100 ......................................... 4
* Select one course from each topic.
** Environmental Science and Policy 100 or Evolution and Ecology 101 .......................................................... 4
** Microbiology: Food Science and Technology 102, 162, 170 .......................................................... 3-4
** Animal Physiology, Behavior or Development: Biological Sciences 104, Molecular and Cellular Biology 150, Neurobiology, Physiology, and Behavior 101, 102, 141 .......................................................... 3-5
** Plant Physiology or Development: Plant Biology 105 **, 111, 112, 113, 116 ** .......................................................... 3-5

Laboratory Requirement
Select course(s) for a minimum total of 6 hours/week of laboratory or field work from the list of courses below.

** PIB 105 or PIB 116 may fulfill the topic area and laboratory requirement.

Courses with 3 hours lab or field work/week (select two): Evolution and Ecology 110, 117, 119, 140, 180A, 180B; Exercise Biology 104L, 115; Microbiology 103I; Neurobiology, Physiology and Behavior 101, 101L, 121, 129; Plant Biology 117, 119, other courses with approval of the master adviser.

Courses with 6 hours lab or field work/week (select one): Biological Sciences 180L; Evolution and Ecology 105, 106, 108, 112L, 114; Exercise Biology 106L; Food Science and Technology 104L, Microbiology 104L, 105I; Molecular and Cellular Biology 120L, 140L, 160L; Neurobiology, Physiology and Behavior 111L, 114P; Plant Biology 102, 105**, 116**, 148; other courses with approval of the master adviser.

Total Units for the Major ........................................... 73-93

B.S. Major Requirements:

Preparatory Subject Matter ........................................... 56-66

Biological Sciences 2A-2B-2C ........................................ 15
Chemistry 2A-2B ....................................................... 15
Chemistry 8A-8B or 118A-118B-118C .................................. 6-12
Mathematics 17A-17B-17C or 21A-21B ................................ 21C recommended .......................................................... 8-12
Physics 7A-7B-7C .......................................................... 12

Depth Subject Matter ............................................. 42-51

Genetics: Biological Sciences 101 .................................. 4
Biochemistry: Biological Sciences 105 (or 102 + 103) .................. 3-6
Cell Biology: Biological Sciences 104 ................................ 3
Statistics 100 .................................................................. 4
* Select one course from each topic.
** Evolution: Evolution and Ecology 101 or Environmental Science Policy 100 .......................................................... 4
** Microbiology: Microbiology 102, 104, 162, 170; Food Science & Technology 104 .......................................................... 3-5
** Animal Physiology, Behavior or Development: Neurobiology, Physiology and Behavior 101, 102, 141; Molecular and Cellular Biology 150 .......................................................... 3-5
** Plant Physiology or Development: Plant Biology 105 **, 111, 112, 113, 116 ** .......................................................... 3-5

Laboratory Requirement
Select course(s) for a minimum total of 6 hours/week of laboratory or field work from the list of courses below.