

CBNS 127. Behavioral Control Systems (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CBNS 120/PSYC 120; CBNS 124/PSYC 124 strongly recommended. An analysis of the principles of nervous system operation from the processing of sensory inputs for object recognition and localization to the organization of central patterns for generation of sequenced motor output. Cross-listed with PSYC 127.

CBNS 128. Immunology (3) Lecture, 3 hours. Prerequisite(s): BIOL 005C; PHYS 002C; PHYS 02LC; BCH 100 or BCH 110A. A study of humoral and cellular immunology. Topics include lymphoid systems, cells, antigens, antibodies, antibody formation, cellular immunity, and tumor and transplantation immunology. Diseases and altered immune states associated with each topic are discussed in detail. Cross-listed with BIOL 128.

CBNS 150. Cancer Biology (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BCH 110C or BIOL 107A; CBNS 101 is recommended (may be taken concurrently). The origin, development, and treatment of cancer are explored with emphasis on molecular mechanisms. Topics such as oncogenes, tumor suppressors, cell cycle and differentiation, AIDS, and hereditary and environmental factors in the development of cancer are covered. Cross-listed with ENTX 150.

CBNS 169. Human Embryology (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 005A, BIOL 005B, BIOL 005C or consent of instructor. An in-depth study of normal human development from conception through the early postnatal period. Demonstrations use microscopic and other materials specifically adapted for the course. Some consideration is given to abnormal development.

CBNS 190. Special Studies (1-4) Individual study, 3-12 hours. Prerequisite(s): upper-division standing; consent of instructor and department chair. Individual study to meet special curricular needs. Grading basis to be determined in consultation with the instructor and department chair. Course is repeatable to a maximum of 12 units.

CBNS 194. Independent Reading (1-2) Individual study, 3-6 hours. Prerequisite(s): consent of instructor. Individual reading under faculty direction. Course is repeatable to a maximum of 4 units.

CBNS 197. Research for Undergraduates (1-4) Outside research, 3-12 hours. Prerequisite(s): either sophomore standing and one course in Cell Biology and Neuroscience or upper-division standing; consent of instructor. An introduction to laboratory research conducted under faculty supervision. Students who submit a written report or give an oral presentation receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable.

CBNS 199. Senior Research (1-4) Outside research, 3-12 hours. Prerequisite(s): senior standing; consent of instructor. Original research undertaken under the direction of a faculty member. Students who submit a written report or give an oral presentation receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable.

Cell, Molecular, and Developmental Biology

Subject abbreviation: CMDB

College of Natural and Agricultural Sciences
Peter W. Atkinson, Ph.D., Director
Graduate Program, 1140 Batchelor Hall
(800) 735-0717 or (951) 827-5621
cell.ucr.edu

Professors

Michael Adams, Ph.D. (Cell Biology and Neuroscience/Entomology)
Peter W. Atkinson, Ph.D. (Entomology)
Julia Bailey-Serres, Ph.D. (Botany and Plant Sciences)
James Baldwin, Ph.D. (Nematology)
Nancy Beckage, Ph.D. (Entomology/Cell Biology and Neuroscience)
Katherine Borkovich, Ph.D. (Plant Pathology and Microbiology)
Richard Cardullo, Ph.D. (Biology)
Wilfred Chen, Ph.D. *President's Chair*, (Chemical and Environmental Engineering)
Xuemei Chen, Ph.D. (Botany and Plant Sciences)
Carl Cranor, Ph.D. (Philosophy)
Shou-Wei Ding, Ph.D. (Plant Pathology and Microbiology)
Brian Federici, Ph.D. (Entomology)
Sarjeet S. Gill, Ph.D. (Cell Biology and Neuroscience)
Leah Haimo, Ph.D. (Biology)
Bradley Hyman, Ph.D. (Biology)
Howard Judelson, Ph.D. (Plant Pathology and Microbiology)
Xuan Liu, Ph.D. (Biochemistry)
David Lo, Ph.D., M.D. (Biomedical Sciences)
Manuela Martins-Green, Ph.D. (Cell Biology and Neuroscience)
Dmitri Maslov, Ph.D. (Biology)
Thomas Miller, Ph.D. (Entomology)
Ashok Mulchandani, Ph.D. (Chemistry)
Eugene Nothnagel, Ph.D. (Botany and Plant Sciences)
Michael Pirrung, Ph.D. *President's Chair* (Chemistry)
Alexander Raikhel (Entomology)
Natasha Raikhel (Botany and Plant Sciences)
A.L.N. Rao, Ph.D. (Plant Pathology and Microbiology)
Victor Rodgers, Ph.D. (Bioengineering)
Neal L. Schiller, Ph.D. (Biomedical Sciences)
Jerome S. Schultz, Ph.D. (Bioengineering)
John Y.-J. Shyy, Ph.D. (Biomedical Sciences)
Frances Sladek, Ph.D. (Cell Biology and Neuroscience)
B. Glenn Stanley, Ph.D. (Cell Biology and Neuroscience/Psychology)
Daniel Straus, Ph.D. (Biomedical Sciences)
Prudence Talbot, Ph.D. (Cell Biology and Neuroscience)
Linda L. Walling, Ph.D. (Botany and Plant Sciences)
Yinsheng Wang, Ph.D. (Chemistry)
Shizhong Xu, Ph.D. (Botany and Plant Sciences)
Zhenbiao Yang, Ph.D. (Botany and Plant Sciences)
Jian-Kang Zhu, Ph.D. *President's Chair* (Botany and Plant Sciences)
Raphael Zidovetzki, Ph.D. (Cell Biology and Neuroscience)

Professors Emeriti

Robert Heath, Ph.D. (Botany and Plant Sciences)
Helen Henry, Ph.D. (Biochemistry)
Anthony H.C. Huang, Ph.D. (Botany and Plant Sciences)
Elizabeth M. Lord, Ph.D. (Biochemistry)
Charles F. Louis, Ph.D. (Biochemistry)
Anthony W. Norman, Ph.D. (Biochemistry/Biomedical Sciences)

Associate Professors

Christopher Bardeen, Ph.D. (Chemistry)
Maksim Bazhenov, Ph.D. (Cell Biology and Neuroscience)
Monica J. Carson, Ph.D. (Biomedical Sciences)
Quan Cheng, Ph.D. (Chemistry)
Margarita Currás-Collazo, Ph.D. (Cell Biology and Neuroscience)
Scott N. Currie, Ph.D. (Cell Biology and Neuroscience)
Kathryn DeFea, Ph.D. (Biomedical Sciences)
Iryna M. Ethell, Ph.D. (Biomedical Sciences)
Hailing Jin, Ph.D. (Plant Pathology and Microbiology)
Isgouhi Kaloshian, Ph.D. (Nematology)
Paul Larsen, Ph.D. (Biochemistry)
Stefano Lonardi, Ph.D. (Computer Science and Engineering)
Christian Lytle, Ph.D. (Biomedical Sciences)
Morris F. Maduro, Ph.D. (Biology)
Ernest Martinez, Ph.D. (Biochemistry)
Cengiz Ozkan, Ph.D. (Mechanical Engineering)
Mihri Ozkan, Ph.D. (Electrical Engineering)
Frank Sauer, Ph.D. (Biochemistry)
Patricia S. Springer, Ph.D. (Botany and Plant Sciences)

Assistant Professors

Jeffrey B. Bachant, Ph.D. (Cell Biology and Neuroscience)
Thomas Eulgem, Ph.D. (Botany and Plant Sciences)
Todd Fiacco, Ph.D. (Cell Biology and Neuroscience)
Venugopala Gonehal, Ph.D. (Botany and Plant Sciences)
Jiayu Liao, Ph.D. (Bioengineering)
Karine G. Le Roch, Ph.D. (Cell Biology and Neuroscience)
Julia Lyubovitsky, Ph.D. (Bioengineering)
Wenbo Ma, Ph.D. (Plant Pathology and Microbiology)
James Ng, Ph.D. (Plant Pathology and Microbiology)
Constance I. Nugent, Ph.D. (Cell Biology and Neuroscience)
Anand Ray, Ph.D. (Entomology)
Noboru Sato, Ph.D. (Biochemistry)
Barley Smith, Ph.D. (Botany and Plant Sciences)
Jan Walter, Ph.D. (Plant Pathology and Microbiology)
Emma Wilson, Ph.D. (Biomedical Sciences)
Laura Zanello, Ph.D. (Biochemistry)
Nicole zur Nieden, Ph.D. (Cell Biology and Neuroscience)

The Cell, Molecular, and Developmental Biology Graduate Program is an interdepartmental program offering M.S. and Ph.D. degrees to students seeking advanced training in these disciplines. The program focuses on the bridge between basic and applied research and on the interface between cell, molecular, and developmental biology. Participating faculty are drawn from numerous biological sciences departments whose research interests in cell, molecular, and developmental biology span

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biomedical to agricultural problems, and students in the program benefit from unique training opportunities.

Students seeking admission into the program should meet all general requirements of the Graduate Division as printed in the Graduate Studies section of this catalog.

Graduate Program

The Cell, Molecular, and Developmental Biology program offers the M.S. and Ph.D. degrees in Cell, Molecular, and Developmental Biology.

Admission Applicants should have adequate undergraduate course work in chemistry (two years), physics (one year), calculus (one year), statistics (one course), biochemistry (one course), and biology (two years, including a course in genetics and two courses among cell, molecular, or developmental biology). Applicants with strong academic records but with deficiencies in preparation for graduate training may be admitted and must rectify undergraduate deficiencies early in the first two years of residence. Applicants must submit GRE General Test scores (verbal, quantitative and analytical).

Course Work All students must complete the following core of course work:

1. One graduate-level course in cell biology (BIOL 200/CMDB 200, BPSC 237, or NRSC 200A/PSYC 200A)
2. One graduate-level course in molecular biology (BIOL 201/CMDB 201, BCH 211, BPSC 231/BCH 231, BMSC 202, or NRSC 200B/PSYC 200B)
3. One graduate-level course in developmental biology (BPSC 232, CMDB 202)

Each student must enroll in the program seminars (CMDB 257, CMDB 258) each time they are offered. Upon entry into the program, each student meets with a guidance committee, which recommends a course of study commensurate with the student's interests and background.

Master's Degree

The Cell, Molecular, and Developmental Biology program offers an M.S. degree.

Plan I (Thesis) Students complete the course work above, enroll in one graduate seminar course in cell, molecular, or developmental biology (BCH 230(EZ), BIOL 281(E-Z)/CMDB 281(E-Z), BPSC 240, BCH 289/BIOL 289/NRSC 289/PSYC 289), and undertake a research project leading to a thesis.

Each student must complete 36 units of course work, of which at least 24 units must be in the graduate series (200 level) in the biological sciences. No more than 12 units in courses numbered 290-299 may be taken to fulfill the 24-unit requirement. Candidates for the M.S. degree must defend their thesis at a public oral presentation.

Normative Time to Degree Two years

Doctoral Degree

The Cell, Molecular, and Developmental Biology program offers a Ph.D. degree.

Degree Requirements

1. Completion of the course work listed above
2. One additional graduate course in cell, molecular, and developmental biology
3. Two graduate seminar courses in cell, molecular, or developmental biology (BCH 230 (E-Z), BIOL 281 (E-Z)/CMDB 281 (E-Z), BPSC 240, BCH 289/BIOL 289/ CHEM 289/ENTM 289/NRSC 289/PSYC 289)
4. A research project leading to a dissertation
5. Oral public defense of dissertation

Written and Oral Qualifying Examinations

Doctoral students are advanced to candidacy following successful completion of written and oral qualifying examinations. Students write a proposal detailing the rationale, specific aims, and approaches to be undertaken for their proposed dissertation research prior to taking the oral qualifying examination.

Dissertation Candidates must successfully defend their dissertation research in a public oral presentation.

Teaching Requirement Students must fulfill a two-quarter teaching requirement.

Career Opportunities

There is a high demand in industry and academia for scientists with training in cell, molecular, and developmental biology. Students matriculating from the program are well trained in this field and successfully obtain positions in biotechnology, including biomedical and agricultural industries, and at colleges and universities nationwide.

Normative Time to Degree Five years

Graduate Courses

CMDB 200. Cell Biology (4) W Lecture, 3 hours; seminar, 1 hour. Prerequisite(s): BCH 110A or BCH 110B or equivalent (may be taken concurrently); BIOL 102 or equivalent; BIOL 113 or BIOL 114 or CBNS 101 or equivalent. An examination of the structure and function of eukaryotic cells and their components with emphasis on the key experiments that provide the foundation for our current knowledge. Covers topics such as cell membranes, intracellular trafficking, cell-to-cell interactions, motility, and the cytoskeleton. Cross-listed with BIOL 200.

CMDB 201. Molecular Biology (4) F Lecture, 3 hours; seminar, 1 hour. Prerequisite(s): BCH 110A or BCH 110B or equivalent (may be taken concurrently); BIOL 102 or equivalent; BIOL 107A or equivalent. Covers the structure and inheritance of genetic material, the regulation of gene expression at the cellular and molecular level including molecular mechanisms for regulation of gene transcription, posttranscriptional regulation at the level of messenger RNA stability, processing, editing and translation, methods for gene mapping, and positional cloning. Cross-listed with BIOL 201.

CMDB 202. Developmental Biology (4) S Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CBNS 101 or equivalent. An examination of development, beginning with the principles that underlie developmental studies of all multicellular organisms. Focuses on plants, insects, and fungi but introduces other model systems. Topics are taken from the current literature.

CMDB 204. Genome Maintenance and Stability (4) S Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BCH 110C or BIOL 107A; BIOL 113 or BIOL 114 or CBNS 101; BIOL 102 is strongly recommended. Emphasizes chromosome-based processes that maintain genome integrity and ensure accurate genome transmission during cell division. Topics are drawn from the primary literature and include chromatin structure and composition, DNA repair and recombination, telomere function and chromosome maintenance, mitotic chromosome segregation, and checkpoint surveillance mechanisms. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor. Cross-listed with BCH 204 and ENTX 204.

CMDB 205. Signal Transduction Pathways in Microbes and Plants (4) S Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): graduate standing in the biological sciences, BIOL 107A or BIOL 113 or BIOL 114 or CBNS 101; or consent of instructor. Advanced topics in signal transduction pathways that regulate growth and development in plants and prokaryotic and eukaryotic microbes. Areas covered include two-component regulatory systems; quorum sensing; signaling via small and heterotrimeric G proteins; mitogen-activated protein kinase cascades; cAMP signaling; photoreceptors; plant hormone signaling; responses to low-oxygen stress; calcium signaling; and plant pathogenesis. Cross-listed with BCH 205, BPSC 205, GEN 205, MCBL 205, and PLPA 205.

CMDB 206. Gene Silencing (3) Lecture, 2 hours; discussion, 1 hour. Prerequisite(s): graduate standing, BIOL 107A or CBNS 101; or consent of instructor. An in-depth coverage of mechanisms, functions, and applications of RNAi and related gene regulatory pathways guided by small RNAs such as siRNAs and miRNAs in plants and animals. Cross-listed with GEN 206 and MCBL 206.

CMDB 207. Stem Cell Biology (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CBNS 101 or equivalent, graduate standing; or consent of instructor. Introduces animal and human stem cell biology and the application of stem cell biology to medicine.

CMDB 208. Bioethics (1) Discussion, 1 hour. Prerequisite(s): graduate standing or consent of instructor. Introduces bioethics, with an emphasis on the medical and social implications of stem cell biology. **Cranor in charge**

CMDB 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 ENTM 210 and MCBL 210. **Raikhel**

CMDB 220. Chemical Genomics Design Studio (2) Lecture, 1 hour; practicum, 4 hours. Prerequisite(s): Course work in cell biology, genetics, combinatorial chemistry; or consent of instructor; graduate standing. Explores chemical genomic research approaches. Emphasizes critical thinking; advanced planning of

time-consuming tests of hypotheses and experimental caveats, trade-offs, and options. Taught in a case-study approach, teams consist of students with engineering, biology, computational sciences, and chemical backgrounds. Teams generate an interdisciplinary chemical genomic research project. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor. Cross-listed with BIEN 220. **Schultz**

CMDB 230. Molecular Plant-Microbial Interactions (3) Lecture, 2 hours; discussion, 1 hour. Prerequisite(s): BCH 100, BIOL 120/MCBL 120/PLPA 120, or equivalents. A study of the physiology of host-pathogen interactions with emphasis on the metabolism of diseased plants, nature of pathogenicity, and defense mechanisms in plants. Cross-listed with BPSC 230, GEN 230, and PLPA 230. **Eulgem, Jin**

CMDB 250. Special Topics in Cell, Molecular, and Developmental Biology (1-2) F, W, S Seminar, 1-2 hours. Prerequisite(s): graduate standing. Oral presentations and intensive small-group discussion of selected topics in the area of special competence of each participant. Content emphasizes recent advances in the topic area and varies accordingly. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

CMDB 257. Seminar in Cell, Molecular, and Developmental Biology (1) F Seminar, 1 hour. Prerequisite(s): graduate standing. Lectures by visiting scholars on current research in cell, molecular, and developmental biology. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

CMDB 258. Graduate Student Seminar in Cell, Molecular, and Developmental Biology (1) S one 1-day seminar. Prerequisite(s): graduate standing in Cell, Molecular, and Developmental Biology. An interdisciplinary seminar consisting of student presentations of original research and discussion of current research topics in cell, molecular, and developmental biology. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

CMDB 281 (E-Z). Seminar in Cell Development, Structure, and Function (2) F, W, S Seminar, 2 hours. Prerequisite(s): graduate standing; consent of instructor. Lectures, discussions, and demonstrations by students, faculty, and invited scholars on selected subjects concerned with the principles of cell development, structure, and function. E. Cell Biology; F. Molecular Biology; G. Developmental Biology. Segments are repeatable. Cross-listed with BIOL 281 (E-Z).

CMDB 290. Directed Studies (1-6) Individual study, 3-18 hours. Prerequisite(s): graduate standing; consent of instructor and graduate advisor. Individual study, directed by a faculty member, of specially selected topics in cell, molecular, and developmental biology. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

CMDB 292. Concurrent Analytical Studies in Cell, Molecular, and Developmental Biology (2-4) Outside research, 6-12 hours. Prerequisite(s): graduate standing. Elected concurrently with an appropriate undergraduate course, but on an individual basis. Students are required to submit one or more graduate papers based on research or criticism related to the course. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

CMDB 297. Directed Research (1-6) Outside research, 3-18 hours. Prerequisite(s): graduate standing. Research and experimental studies conducted under the supervision of a faculty member on specially

selected topics in cell, molecular, and developmental biology. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

CMDB 299. Research for the Thesis or Dissertation (1-12) Outside research, 3-36 hours. Prerequisite(s): graduate standing. Original research in an area selected for the advanced degree. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

Professional Course

CMDB 301. Teaching of Cell, Molecular, and Developmental Biology at the College Level (1) Seminar, 1 hour. Prerequisite(s): graduate standing. A program of weekly meetings and individual formative evaluations required of new teaching assistants. Covers instructional methods and classroom/section activities most suitable for teaching Biology. Conducted by the Teaching Assistant Development Program. Graded Satisfactory (S) or No Credit (NC).

CHASS F1RST

Subject abbreviation: CHFY
College of Humanities, Arts, and Social Sciences

Geoff Cohen Ph.D., Academic Coordinator
1609 Humanities and Social Sciences
(951) 827-7831; Chassf1rst.ucr.edu

Committee in Charge

Steven Brint, Ph.D. (Sociology)
Tracy Fisher, Ph.D (Women's Studies)
Michael Jayme, M.F.A. (Creative Writing)
Vorris Nunly, Ph.D. (English)
Georgia Warnke, Ph.D. (Philosophy)

CHASS F1RST provides first-year students with courses designed to help with the transition to UCR, a major research university setting, which involves high academic standards and rigorous course work. The courses offer students the resources and tools necessary to excel in the first year and beyond. They take place within a "learning-communities" framework so that students can successfully integrate into campus life.

Lower-Division Courses

CHFY 001 (E-Z). CHASS F1RST Humanities Course (5) Lecture, 3 hours; assignment of the remaining hours varies from segment to segment. Prerequisite(s): first-year freshman standing in the College of Humanities, Arts, and Social Sciences. A College of Humanities, Arts, and Social Sciences course designed to introduce students to the humanities and to academic life. Segments of CHFY 001 (E-Z), CHFY 002 (E-Z), and/or CHFY 003 (E-Z) may be thematically and pedagogically linked.

CHFY 002 (E-Z). CHASS F1RST Fine Arts Course (5) Lecture, 3 hours; assignment of the remaining hours varies from segment to segment. Prerequisite(s): first-year freshman standing in the College of Humanities, Arts, and Social Sciences. A College of Humanities, Arts, and Social Sciences course designed to introduce students to the fine arts and to academic life. Segments of CHFY 001 (E-Z), CHFY 002 (E-Z), and/or CHFY 003 (E-Z) may be thematically and pedagogically linked.

CHFY 003 (E-Z). CHASS F1RST Social Science Course (5) Lecture, 3 hours; assignment of the remaining hours varies from segment to segment. Prerequisite(s): first-year freshman standing in the College of Humanities, Arts, and Social Sciences. A College of Humanities, Arts, and Social Sciences course designed to introduce students to the social sciences and to academic life. Segments of CHFY 001 (E-Z), CHFY 002 (E-Z), and/or CHFY 003 (E-Z) may be thematically and pedagogically linked.

CHFY 010. CHASS Gateway Lecture Course (5) Lecture, 3 hours; discussion, 1 hour; workshop, 1 hour. Prerequisite(s): first-year freshman standing in the College of Humanities, Arts, and Social Sciences. A College of Humanities, Arts, and Social Sciences course designed to introduce freshmen to the College's annual theme.

Chemical and Environmental Engineering

Subject abbreviations: CEE, CHE, ENVE
The Marlan and Rosemary Bourns
College of Engineering

Yushan Yan, Ph.D., Chair
Department Office, A242 Bourns Hall
(951) 827-2859; www.cee.ucr.edu

Professors

Wilfred Chen, Ph.D., *President's Chair*
Robert Haddon, Ph.D. (Chemistry/Chemical and Environmental Engineering)
Mark R. Matsumoto, Ph.D.
Ashok K. Mulchandani, Ph.D.
Joseph M. Norbeck, Ph.D. *W. Ruel Johnson Professor*
Jianzhong Wu, Ph.D.
Charles Wyman, Ph.D., *Ford Motor Company Chair in Environmental Engineering*
Yushan Yan, Ph.D.

Associate Professors

David R. Cocker, Ph.D.
Nosang Myung, Ph.D.

Assistant Professors

Akua A. Asa-Awuku, Ph.D.
David Cwiertrny, Ph.D.
David Kisailus, Ph.D.
Sharon Walker, Ph.D., *John Babbage Chair in Environmental Engineering*
**

Adjunct Professors

Marc A. Deshusses, Ph.D.
Rex Hjelm, Ph.D.
Ashutosh Sharma, Ph.D.
Wayne Miller, Ph.D.

Cooperating Faculty

Christopher Amrhein, Ph.D. (Environmental Sciences)
Matthew J. Barth, Ph.D. (Electrical Engineering)
John Y.-J. Shyy, Ph.D. (Biomedical Sciences)
Paul J. Ziemann, Ph.D. (Environmental Sciences)