**BIEN 201 Mathematical Methods for Bioengineering** (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): MATH 146A or equivalent; first-year standing in the graduate program in Bioengineering. Provides a fundamental grounding in applied mathematics. Enables the provision of problems in biotransport and bioreaction kinetics. Topics include linear differential equations solutions; analytical methods for partial differential equations including separations of variables, similarity transforms, and perturbation methods; and numerical methods for bioengineering, regression techniques, and error analysis.

**BIEN 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 CMDB 220.

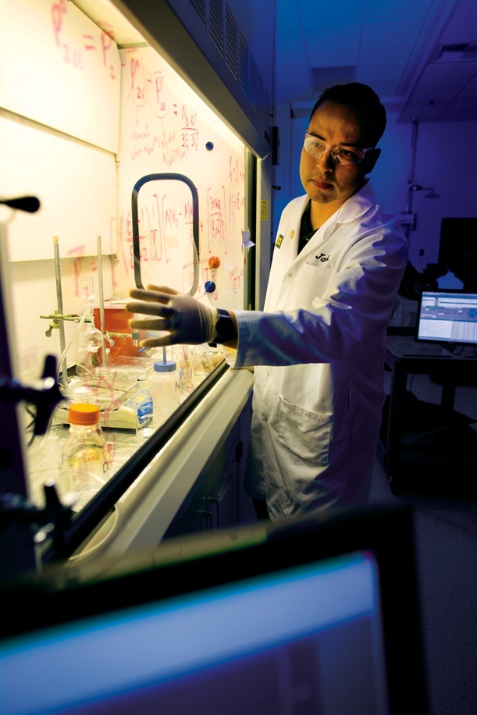
**BIEN 223 Engineering Analysis of Physiological Systems** (4) Lecture, 3 hours; individual study, 3 hours. Prerequisite(s): course work in basic biology, calculus, chemistry, and physics; graduate standing or consent of instructor. Provides a bioengineering approach to the physiological properties and interactions of various mammalian organ systems. Covers the nervous, muscular, cardiovascular, respiratory, and renal systems. Emphasizes the physical and engineering principles governing these systems by applying quantitative and analytical approaches. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor. Credit is awarded for only one of BIEN 223 or BIEN 223V.

**BIEN 224 Cellular and Molecular Engineering** (4) Lecture, 2 hours; discussion, 1 hour; practicum, 3 hours. Prerequisite(s): graduate standing or consent Bioengineering 121 / Programs and Courses of instructor. Emphasizes biophysical and engineering concepts intrinsic to specific topics at the cellular and molecular level. Includes receptor-ligand dynamics in cell signaling and function; DNA replication and RNA processing; cellular and protein sorting; control of gene expression; membrane structure, transport and traffic; biological signal transduction; and mechanics of cell division. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor. Cross-listed with MSE 246. Credit is awarded for only one of BIEN 224/MSE 246 or BIEN 224V.

**BIEN 227 Biophotonics: Laser-Tissue Interactions and Therapeutic Applications** (3) Lecture, 2 hours; term paper, .5 hours; extra reading, 1 hour; written work, 1.5 hours. Prerequisite(s): BIOL 005C, CHEM 001C, CS 005, MATH 046, PHYS 002C, or equivalents. Provides an overview of various types of interactions between lasers and biological tissues. Addresses methods of optical properties measurements, mathematical modeling of light propagation, and selected therapeutic applications of lasers. Includes one or two field trips to medical laser centers to observe laser treatment procedures.

**BIEN 228 Biophotonics: Optical Diagnosis and Measurements** (3) Lecture, 2 hours; outside research, .5 hours; extra reading, 1 hour; written work, 1.5 hours. Prerequisite(s): BIEN 227. Covers the fundamentals underlying optical diagnostic procedures, including absorption and scattering-based techniques. Also addresses physics of optical tweezers and their applications in biological sciences.

**BIEN 233 Computational Modeling of Biomolecules** (4) Lecture, 2 hours; workshop, 2 hours. Prerequisite(s): BIOL 005B; CHEM 112B; MATH 009C or MATH 09HC; PHYS 040B; basic computer programming experience. Introduces computational methods for the quantitative analysis of biomolecular structures at atomic resolution. Aids in understanding the physicochemical properties of biomolecular function, the prediction of biological properties, and the design of new experiments. Forms the basis for structure-based design of proteins with tailored properties and inhibitors of protein function. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor.

**BIEN 234 Orthopaedic Regenerative Engineering and Mechanobiology** (4) Lecture, 4 hours. Prerequisite(s): BIEN 110, BIEN 140A, BIOL 005A, and BIOL 005B, or equivalents; graduate standing or consent of instructor. Introduces advanced biomechanics and mechanobiology of skeletal tissues including bone and cartilage. Provides an understanding of structure-function relationship in biological tissues. Focuses on bone and cartilage regenerative engineering approaches based on scaffolds, stem cells, and mechanotransduction.

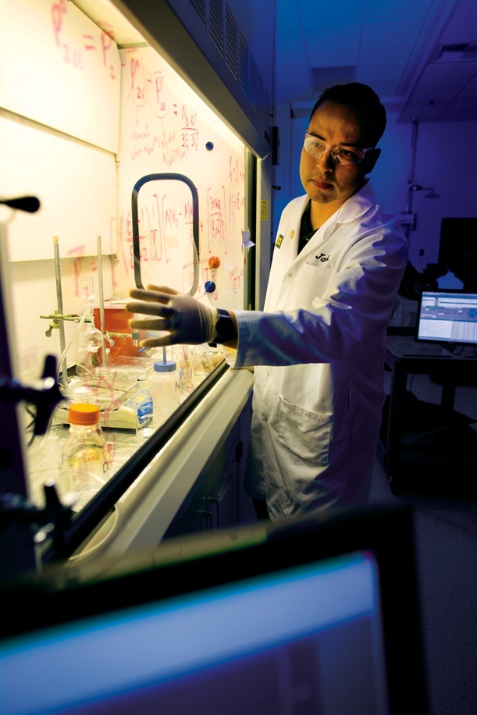
**BIEN 235 Vascular Biomechanics and Engineering** (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 002, BIOL 005A, BIEN 105, or equivalent; graduate standing or consent of instructor. Provides detailed understanding of the crucial role of mechanical forces in guiding blood vessel formation and function in human health and disease. Topics include embryogenesis, wound repair, atherosclerosis, and cancer. Addresses the principles of biomaterials science and regenerative medicine for promoting therapeutic neovascularization.

**BIEN 236 Nanomaterials for Regenerative Medicine** (4) Lecture, 4 hours. Prerequisite(s): BIOL 005C, CHEM 001C (or CHEM 01HC), MSE 001, or equivalents; graduate standing or consent of instructor. Covers recent advances in nanomaterial synthesis, fabrication, and characterization. Focuses on the medical applications of nanomaterials and nanotechnologies. Addresses methods of synthesis of nanomaterials such as nanoparticles, nanotubes, and nanofibers. Includes critical design criteria and assessment methods for properties of nanomaterials to meet medical requirements. Cross-listed with MSE 236.

**BIEN 245 Optical Methods in Biology, Chemistry, and Engineering** (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): CHEM 109 or equivalent; graduate standing; consent of instructor. Covers the origin of fluorescence and other emission processes that modulate the characteristics of molecular emissions. Presents emission-based analytical and bioanalytical methods and techniques. Reviews state-of-the-art instrumentation, including their applicability, limitations, and source. Also provides interpretation and meaning of the measured signals as applied to biological systems. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor. Course is repeatable as content changes. Cross-listed with MSE 226.

**BIEN 249 Integration of Computational and Experimental Biology** (4) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): BIOL 005B; MATH 010B, MATH 046, PHYS 040C; graduate standing. A multidisciplinary introduction to computational methods used to analyze experimental biological data. Introduction to mathematical concepts needed to understand protein structure and dynamics, protein-protein interactions (structures and networks), gene regulatory networks, signal transduction networks, metabolic networks, and kinetic modeling of cellular processes. Also covers techniques used to derive experimental data. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor. Cross-listed with CEE 249. Credit is awarded for only one of BIEN 249/ CEE 249 or BIEN 249V.

**BIEN 251 Biophotonics: Optical Microscopy and Its Biological Applications** (3) S, F, W Lecture, 2 hours; discussion, 1 hour. Prerequisite(s): graduate standing or consent of instructor. Examines the fundamentals of optical system design and system integration in light microscopy. Covers design components, including light sources, lenses, mirrors, dispersion elements, optical fibers, and detectors. Also covers optical system analysis, transfer functions, magnification, resolution, contrast, and molecular, cellular, organ, and organism applications.

**BIEN 260 Special Topics in Bioinstrumentation** (1 or 2) Seminar, 1 hour; term paper, 0-3 hours. Prerequisite(s): graduate standing or consent of instructor. Focuses on advanced technologies in bioengineering studies, such as spectroscopy, microscopy, magnetic resonance imaging, computed tomography, ultrasonography, and biosensors. Students who submit a term paper receive credit for 2 units; other students receive credit for 1 unit. Students who submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable.

**BIEN 261 Special Topics in Biotransport** (1 or 2) Seminar, 1 hour; term paper, 0-3 hours. Prerequisite(s): graduate standing or consent of instructor. Focuses on advanced methods of analysis of biological transport phenomena such as drug distribution, microcirculation, membrane transport, and transport in organs and tissues. Students who submit a term paper receive credit for 2 units; other students receive credit for 1 unit. Students who submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable.

**BIEN 262 Special Topics in Biosignaling** (1 or 2) Seminar, 1 hour; term paper, 0-3 hours. Prerequisite(s): graduate standing or consent of instructor. Focuses on current research in cell signaling and control, including G protein-coupled receptors, signal transduction and cytoskeletal dynamics, and cell adhesion and cell metabolism. Students who submit a term paper receive credit for 2 units; other students receive credit for 1 unit. Students who submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable.

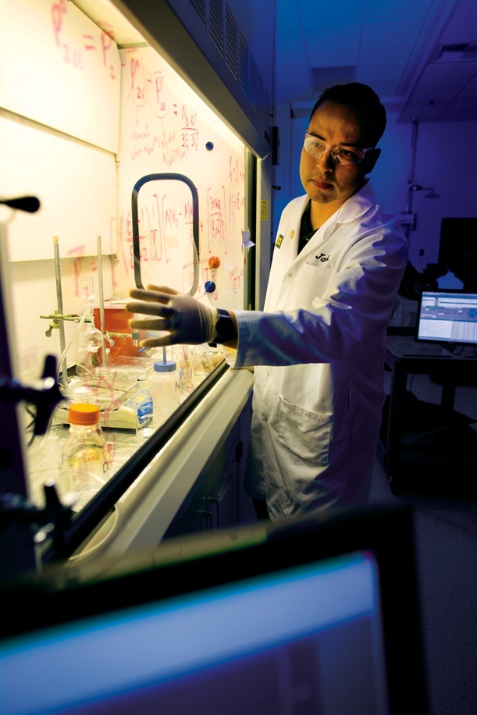
**BIEN 263 Special Topics in Biocomputation** (1 or 2) Seminar, 1 hour; term paper, 0-3 hours. Prerequisite(s): graduate standing; consent of instructor. Focuses on various advanced methods for computational studies of biomolecules and simulations. Includes Brownian dynamics simulations; Monte Carlo methods; normal mode analysis; electrostatic calculations; and free energy calculations. Students who submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable.

**BIEN 264 Biotransport Phenomena** (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BIEN 105 or equivalent; graduate standing or consent of instructor. Covers the mathematical expression and modeling of principles underlying the transport processes of biological systems and biomedical engineering processes. Emphasizes momentum, mass transport, and interpretation of these processes. Topics include advanced development of governing conservation equations and the appropriate constitutive equations for transport in circulation and tissue. May be taken Satisfactory (S) or No Credit (NC) with consent of / 122 instructor and graduate advisor. Credit is awarded for only one of BIEN 264 or BIEN 264V.

**BIEN 266 Special Topics in Biological Nuclear Magnetic Resonance (NMR) Spectroscopy** (1 or 2) Seminar, 1 hour; term paper, 0-3 hours. Prerequisite(s): graduate standing; consent of instructor. Focuses on various advanced methods for the determination of structure, dynamics, and interactions of biomolecules. Utilizes multidimensional and multinuclear NMR spectroscopy. Students who submit a term paper receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable.

**BIEN 268 Bioengineering Experimentation and Analysis** (2) Laboratory, 3 hours; discussion, 1 hour; written work, 2 hours. Prerequisite(s): BIOL 005C, CHEM 001C, CS 005, MATH 046, PHYS 002C or equivalents or consent of instructor. Introduces measurement principles and data acquisition methods related to biomechanics and biochemical and bioelectrical signals from living systems. Addresses the fundamental mechanisms underlying the operation of various sensor types and the modern instruments illustrating noise analysis, filtering, signal processing, and conditioning. Includes experiments aimed at investigating physical responses of cells and tissues to a variety of stimuli.

**BIEN 270 Transport with Reactions in Biological Systems** (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BIEN 264 or equivalent; graduate standing or consent of instructor. Covers the mathematical expression and modeling of principles underlying the transport processes of biological systems reactions and biomedical engineering processes involving reactions. Topics include advanced development of chemical kinetics and reaction mechanisms of biological systems; enzymatic reactions; Michaelis-Menton kinetics; and cell-surface ligand-receptor kinetics. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor.

**BIEN 271 Video Bioinformatics: Multi-scale Analysis of Biological Systems** (2) Lecture, 2 hours. Prerequisite(s): graduate standing or consent of instructor. Introduces the significant range for both the time and spatial scales of biological systems. Includes video imaging techniques, as well as how these spatial and time scales are analyzed for a better understanding of biological function. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor. Cross-listed with EE 271 and GEN 271.

**BIEN 286 Colloquium in Bioengineering** (1) Colloquium, 1 hour. Prerequisite(s): graduate standing or consent of instructor. Colloquia on current research topics in bioengineering and other related fields. Presented by faculty members and visiting scientists. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

**BIEN 290 Directed Studies** (1-6) Individual study, 3-18 hours. Prerequisite(s): graduate standing; consent of instructor and graduate advisor. Faculty-directed individual study of selected topics in Bioengineering. Graded Satisfactory (S) or No Credit (NC). Course is repeatable to a maximum of 9 units.

**BIEN 297 Directed Research** (1-6) Outside research, 3-18 hours. Prerequisite(s): graduate standing; consent of instructor. Provides research opportunities for selected problems in bioengineering. Conducted under faculty supervision. Graded Satisfactory (S) or No Credit (NC). Course is repeatable to a maximum of 15 units.

**BIEN 298 Individual Internship** (1-12) Internship, 2-24 hours; written work, 1-12 hours. Prerequisite(s): graduate standing; consent of instructor. An individual apprenticeship in bioengineering with an approved professional individual or organization and academic work under the direction of a faculty member. Requires a written report. Graded Satisfactory (S) or No Credit (NC). Course is repeatable to a maximum of 16 units.

**BIEN 299 Research for the Thesis or Dissertation** (1-12) Outside research, 3-36 hours. Prerequisite(s): graduate standing; consent of instructor. Designated for research in bioengineering for the M.S. thesis or Ph.D. dissertation. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

**BIEN 302 Teaching Practicum** (1-4) Practicum, 3-12 hours. Prerequisite(s): graduate standing; appointment as a teaching assistant or associate in Bioengineering. Provides supervised teaching in undergraduate courses. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

**BIEN 401 Fundamentals of Proposal Preparation and Ethical Standards in Bioengineering** (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): graduate standing. An introduction to effective proposal preparation and writing for bioengineering-related research. Also covers ethical standards of scientific research related to bioengineering. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor.

**BIEN 402 Effective Writing for Bioengineering Research Publications** (4) Lecture, 4 hours. Prerequisite(s): BIEN 401. An introduction to effective manuscript writing for bioengineering-related research publications.

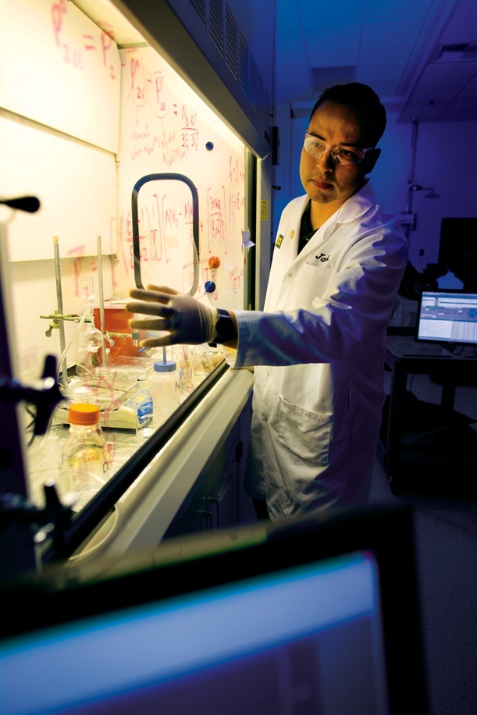
**BIOMEDICAL SCIENCE MEDICAL SCHOOL COURSES**

BIG students have the unique opportunity to study courses offered in the UCR School of Medicine. These courses offer an opportunity for BIG students to have the same broad core science training as received by students enrolled in the M.D. – Ph.D. program. The eligible courses are listed below:

**Last Updated: April 2016**

**BMSC 229 Foundations in Translational Research**  
Covers basic principles of disease processes, genetics, and molecular, cellular, and developmental biology. Case-driven instruction accomplished through lectures and discovery in small group discussions and laboratories.

**BMSC 232 Cardiovascular, Renal, and Respiratory Sciences**  
Covers physiology, pathophysiology, physical diagnosis, and imaging in the cardiovascular, renal, and respiratory sciences. Instruction is driven by cases and accomplished through lectures and discovery in small group discussions, laboratories, and conferences.

**BMSC 233 Gastrointestinal, Endocrine, and Reproductive Health**  
Covers biochemistry, pathophysiology, physical diagnosis, and imaging associated with gastrointestinal, endocrine, and reproductive health. Instruction is driven by cases and accomplished through lectures and discovery in small group discussions, laboratories, and conferences.

**BMSC 234 Musculoskeletal Medicine**  
Covers the musculoskeletal system, biology and pathology of the peripheral nervous system, and physical diagnosis. Utilizes lectures and case studies to accomplish course objectives. Promotes discovery of learning by small group discussions, laboratories, and conferences.

**BMSC 235 Clinical Neurosciences**  
Utilizes lectures and case studies to accomplish course objectives. Promotes discovery of learning by small group discussions, laboratories, and conferences.

**BMSC 260A Topics in Translational Biomedical Research**  
A survey of the mechanisms of common human diseases at the molecular, cellular and organ system levels and the multidisciplinary approaches used for their investigation. Instructional components include lectures, discovery in problem based learning sessions, and independent study.



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**BMSC 260B Topics in Translational Biomedical Research**  
A survey of the mechanisms of common human diseases at the molecular ,cellular and organ system levels and the multidisciplinary approaches used for their investigation. Instructional components include lectures, discovery in problem based learning sessions, and independent study.

**BMSC 260C Topics in Translational Biomedical Research**  
A survey of the mechanisms of common human diseases at the molecular, cellular and organ system levels and the multidisciplinary approaches used for their investigation. Instructional components include lectures, discovery in problem based learning sessions, and independent study.