The Department of Bioengineering, at the University of California, Riverside, is the newest department at the Bourns College of Engineering. Established in 2006 by Distinguished Professor and Member of the National Academy of Engineering, Jerome S. Schultz, the department’s mission is to forge future leaders in bioengineering while focusing on solutions to critical themes that impact advanced bioengineering and biomedical engineering research.

The department’s interdisciplinary research and educational training effort extends through BIG (Bioengineering Interdepartmental Graduate Program), joining faculty members throughout the University of California, Riverside who are dedicated to this mission.

Now one of the most diverse programs, Bioengineering at UCR is already recognized for its many accomplishments including ranking 3rd in the nation in 2011 for its students receiving NSF Graduate Research Fellowships.

Please enjoy this brief introduction to our program. For more information please visit bioengineering.ucr.edu.

The Beginning
Department: May 2006
BIG Program: December 2006

Students
Total Undergraduate Students: 323
Total Graduate Students: 90
Graduate Student Demographics:
Total Ph.D. Students: 66
% Ph.D. Domestic Students: 78
% US Underrepresented Minorities: 41
% Female: 46

Total Extramural Funding
$4.5 million
Funding Institutions:
American Soc. of Laser Medicine & Surgery
Beckman Initiative for Macular Disease
UC Discovery
GAANN
National Institutes of Health
National Science Foundation

Degrees Offered
BS, MS, BS/MS, PhD

Faculty
Total Faculty: 12, 1 Adjunct
BIG Faculty: 40

Awards and Honors:
AAAS Fellows (4)
ACS (1)
AIChe (1)
AIMBE Fellows (4)
BMES Fellow (1)
California Engineers’ Council Distinguished Educator Award (1)
National Academy of Engineering (1)
NIH Pathway to Independence Award (1)
NSF BRIGE (2)
NSF Career (1)
Orange County Engineering Council Distinguished Educator Award (3)
100 Chemical Engineers of the Modern Era (1)
Research Focus Areas

Biomaterials and Regenerative Medicine
optical nano-materials; polymeric scaffolding; high-throughput screening; 3D biomaterials; 3D tissue engineered scaffolds and bioreactors; nanomedicine; vascular tissue engineering; biodegradable implants
Anvari, Ghosh, Liao, Liu, Lyubovitsky, Nam, Vullev

Biomedical Imaging
optical coherence tomography; biophotonic technologies; non-invasive monitoring; image guided spectroscopy; optical neuroimaging; nonlinear optical microscopy and spectroscopy
Anvari, Lyubovitsky, Park, Schultz, Sun, Vullev

Computational Bioengineering
bioinformatics; modeling of biomolecular structure, dynamics and interactions; protein and peptide design; crowded protein osmotic pressure; modeling of cellular signaling pathways; image processing and analysis; computational drug discovery
Morikis, Park, Rodgers

Medical Devices
microfluidic devices; device fabrication, characterization, in vitro evaluation and in vivo assessment; bioreorbable medical implants; devices for orthopedic surgery, spinal surgery, and endovascular procedures; chip-based devices for FRET assay
Grover, Liao, Liu, Park, Rodgers, Sun, Vullev

Molecular and Cellular Engineering
biomolecules/biomolecular interactions; mechanotransduction; signal transduction pathways; regulation of immune system; metabolic controls; intracellular biosensors
Ghosh, Liao, Morikis, Nam, Rodgers, Vullev
### Bioengineering Core Faculty

<table>
<thead>
<tr>
<th>Name</th>
<th>Research Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bahman Anvari</td>
<td>biophotonics, cell membrane electromechanics, polymeric and biological nano-materials</td>
</tr>
<tr>
<td>Kaustab Ghosh</td>
<td>cellular biomechanics, vascular tissue engineering, organ regeneration</td>
</tr>
<tr>
<td>William Grover</td>
<td>diagnostics, biomaterials, biophysics, diagnostics, pharmacology, medical devices microfluidics, sensors</td>
</tr>
<tr>
<td>Jiayu Liao</td>
<td>high-throughput screening, signal transduction</td>
</tr>
<tr>
<td>Huinan Liu</td>
<td>biomaterials for tissue regeneration, controlled drug delivery, and medical implants</td>
</tr>
<tr>
<td>Julia Lyubovitsky</td>
<td>3D soft biomaterials, tissue engineered models, biomedical imaging and sensing</td>
</tr>
<tr>
<td>Dimitrios Morikis</td>
<td>immunophysics and immunoengineering, drug discovery, structural bioinformatics</td>
</tr>
<tr>
<td>Jin Nam</td>
<td>orthopaedic tissue engineering, polymeric scaffolding, mechanobiology in stem and skeletal cells</td>
</tr>
<tr>
<td>B. Hyle Park</td>
<td>optical coherence tomography, optical neuroimaging</td>
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<tr>
<td>Victor G. J. Rodgers</td>
<td>crowded protein analysis, signaling processes and cellular reactions, traumatic brain injury treatment</td>
</tr>
<tr>
<td>Jerome S. Schultz</td>
<td>biosensors, membrane separations, transport in tissues</td>
</tr>
<tr>
<td>Shu-Wei Sun</td>
<td>MRI techniques for neural diseases (Loma Linda University, School of Medicine)</td>
</tr>
<tr>
<td>Valentine Vullev</td>
<td>biophysics, microfluidics and charge transfer</td>
</tr>
</tbody>
</table>
Anvari Lab

Research Focus: biophotonics, nanomedicine

Summary of Research

Dr. Anvari’s research is directed towards development and application of optical methods for biological measurements, imaging, and therapy. Specifically, current research areas include: fabrication and application of self-assembled and optically-active nano-materials for imaging, and phototherapy of disease; and use of optical trapping methods to study the electromechanical properties of cell membranes.

Selected Publications

Bongsu Jung and Bahman Anvari, "Virus-Mimicking Optical Nanomaterials: Near Infrared Absorption and Fluorescence Characteristics and Physical Stability in Biological Environments", ACS Applied Materials & Interfaces, 2013: 5(15), 7492-7500


Recent Awards and Honors

EAGER Grant, National Science Foundation, 2011
AAAS Fellow (American Association for the Advancement of Science, 2010
AIMBE Fellow (American Institute for Medical and Biological Engineering), 2008
NIH/NIDCD R01 Grant, 2006
Summary of Research

Dr. Ghosh’s research focuses on vascular biomechanics and bioengineering. His lab works at the interface of basic and applied science to (1) understanding how cell-and extracellular matrix (ECM)-dependent mechanical cues regulate blood vessel formation (neovascularization) and function in both health and disease, and (2) developing instructive biomaterials that leverage the body’s endogenous bone marrow-derived vascular stem/progenitor cells to promote in situ neovascularization and tissue regeneration. To achieve this goal, his lab integrates the multidisciplinary principles and techniques related to cellular and tissue biomechanics, vascular biology, biomaterials science and regenerative medicine. Since both newly forming and mature tissues rely critically on blood vessels for efficient nutrient and oxygen supply, this research has important therapeutic implications for promoting tissue regeneration, ameliorating post-ischemic tissue hypoxia and improving the functionality of artificially engineered tissues and organs.

For more information regarding the Ghosh Lab, visit http://www.engr.ucr.edu/~kghosh/

Selected Publications


Grover Lab

Research Focus: sensors, diagnostics, biomaterials, biophysics, pharmacology, microfluidics

Summary of Research
Dr. Grover’s lab develops precision tools for measuring and exploiting the fundamental physical properties of micron-scale objects like cells, microorganisms, and particles. For example, the density of a cell (its mass-to-volume ratio) changes during important processes like growth, apoptosis, and malignant transformation. Using a microfluidic mass sensor with femtogram resolution, Dr. Grover made the first precision measurements of the density of single living cells. His lab is now adapting this technique to study microorganism development, characterize biomaterials, monitor blood products, screen drug compounds, and identify environmental pollutants. In another project, Dr. Grover’s lab is developing microfluidic devices capable of separating mixtures of cells or particles based on their different densities and other physical properties. Since all objects have these fundamental physical properties, Dr. Grover’s research has applications in fields as diverse as cell biology, materials science, forensics, environmental science, and pharmacology.

Selected Publications


Summary of Research

Dr. Liao's research focuses on new technology developments for both basic biomedical research and high-throughput screenings and applications to understand mechanisms of protein-protein interactions in sumoylation and G protein-coupled receptors. The major technologies being developed include quantitative and high-throughput Förster Resonance Energy Transfer (FRET) technologies for protein-protein interaction, multi-step biochemical reaction, protease assay, and high-efficient chemo-selective peptide conjugation on glass surface for bioassays. Dr. Liao has made important discoveries of sumoylation and novel G-protein coupled receptors (GPCRs), including a novel immunosuppressant, first non-peptide agonist for GLP1 receptor and rapamycin for stem cell pluripotency disruptions.

Selected Publications


**Liu Lab**

**Research Focus:** biomaterials, tissue regeneration, nanomedicine

**Summary of Research**

The Biomaterials and Nanomedicine Laboratory (BNL) integrates biomaterials-cells-tissues to repair or replace diseased or injured tissues. Directed by Dr. Liu, the research lab bridges new discoveries in nanotechnology, tissue engineering, and controlled drug delivery with basic science in materials, chemistry, biology, and medicine to closely mimic natural tissues in terms of their surface, chemistry, highly ordered nano-to-macro hierarchical structures, and associated physicochemical, mechanical, and physiological properties. In addition, BNL also researches materials design, fabrication, characterization, in vitro and in vivo assessment of biomaterials at the molecular, cellular and tissue level.

**Selected Publications**


**Recent Awards and Honors**

International Journal of Nanomedicine
Certificate of Merit Award, 2011
MARC/SRC Faculty Travel Award, Federation of American Societies for Experimental Biology (FASEB), 2011
NSF BRIGE Award, 2011
Acta Award for Primary Contributions to the Paper Published in Acta Biomaterialia, 2009
Sigma Xi Outstanding Graduate Research Award for Contributions to Future Science and Technology, 2008
Graduate Excellence in Materials Science (GEMS) Award, The American Ceramic Society, 2008
The Joukowsky Family Foundation Outstanding Dissertation Award, 2008
2012 Hellman Fellowship Award.
Lyubovitsky Lab

Research Focus: 3D soft materials, tissue engineered models, sensing

Summary of Research
Dr. Lyubovitsky’s laboratory is developing new, comprehensive approaches for design, development and characterization of protein-based materials for sensing applications.

The current interests are:
1) Design and synthesis of protein-based materials and characterization of their properties
2) Extending protein-based materials research to study materials' interactions with tissues
3) The extracellular matrix (ECM) imaging of normal and pathological states of tissues
4) Development of sub-cellular functional assays in 3D tissue engineered models

Selected Publications


Recent Awards and Honors
Faculty Fellowship, UC Regents, 2010
NSF Early Career Development Award, 2009
NSF BRIGE Award, 2009
Hewitt Medical Fellowship (Beckman Laser Institute, UCI), 2003-2006
Young Investigator Travel Award, Society of Molecular Imaging, 2004
Dr. Morikis practices cross-disciplinary research in the fields of bioengineering, biopharmaceutical discovery, biophysics, structural biology, and computational chemistry. His current work focuses on immune system function and regulation, design of proteins and peptides with tailored physicochemical and biological properties, drug discovery against autoimmune and inflammatory diseases, and development of structural bioinformatics methods.

Selected Publications


Summary of Research

Skeletal diseases such as osteoarthritis and osteoporosis afflict more than 40 percent of all adults and more than 70 percent of aging populations. Our laboratory focuses on the utilization of intrinsic (scaffolding) and extrinsic (applied forces) biomechanical stimulation on the cells (stem cells and primary skeletal cells) in order to develop methodologies for repairing damaged skeletal tissues. Specifically, we investigate how to control stem cell differentiation to chondrocytes and osteoblasts for cartilage and bone regeneration through the development of mechano-responsive polymeric 3D-scaffolds and the application of biomechanical stimulation to such engineered skeletal tissues in a bioreactor.

Selected Publications


J. Nam, P. Perera, J. Liu, L. Wu, T. Butterfield and S. Agarwal, Transcriptome-wide gene regulation by gentle treadmill walking during the progression of moniodoacetate induced arthritis, Arthritis and Rheumatism 63(6), 1613-25 (2011)- featured on journal cover

Park Lab

Research Focus: optical coherence tomography, neurological applications

Summary of Research

Dr. Park’s research focuses on the development and application of optical imaging for the study of the structure and function of nerves. Much of the work in his lab utilizes optical coherence tomography (OCT), a non-contact optical modality that generates cross-sectional images similar in size and geometry to histological sections. Just as different stains can be used to enhance the contrast in histology, various extensions of OCT provide additional visualization modes but without the use of exogenous contrast agents and in a way that allows for in vivo real-time monitoring of two- and three-dimensional features. Current projects span multiple spatial scales, from analysis of single neurons to observation of changes in the brain, and include: 1) an optical electrode for detection of slight transient structural changes associated with action potential propagation in single axons, 2) non-destructive optical quantification of myelination during injury and regeneration of peripheral nerve bundles, and 3) real-time monitoring of optical scattering changes in the brain during the onset and progression of cerebral edema.

Selected Publications


Summary of Research

Dr. Rodgers is the director of the B2K Group (Biotransport and Bioreaction Kinetics Group). His primary research focus is on analyzing and developing biomedical engineering systems using fundamental grounding in transport phenomena, thermodynamics, and kinetics. His research is largely interdisciplinary and results in collaborations with colleagues primarily in medicine, pharmacy, and biomedical sciences. The depth of this research enables B2K members to enjoy the opportunity to function both in theoretical mathematical analysis and experimental observation capacities. The current research of the B2K focuses on crowded protein contributions in biologically observed transport, decoupling of mass transfer from mechanotransduction in endothelial cell signaling, development of devices to reduce brain edema resulting from TBI (traumatic brain injury) and mucosal vaccination.

Selected Publications


Summary of Research

Dr. Schultz’s research has led to new optically based biosensors and a fundamental understanding of the transport through synthetic membranes and tissues. His study of biosensors involves the utilization of biomolecules that have recognition functions—e.g., antibodies, membrane proteins, bioreceptors—to provide the selectivity capability of sensor probe devices. Most recent projects include the development of a biosensor for warfarin, an anti-coagulant drug, and an implantable sensor for glucose for diabetics. Current studies on membranes relate to the selectivity of protein transport through the pores in the nuclear membrane. In addition, Professor Schultz has embarked on bio-imaging studies based on the properties of muon particles for the non-invasive monitoring of blood oxygenation in living tissue.

Selected Publications


Sun Lab

Research Focus: developing MRI techniques for understanding neural diseases

Summary of Research
Dr. Sun’s research focuses on investigating the technologies which can improve the non-invasive examination of the central nervous system (CNS). His current projects are trying to address critical issues in Multiple Sclerosis (MS) and Alzheimer’s disease (AD), in particular, to understand the mechanisms related to axonal degeneration in these diseases. In MS, the visual pathway is the commonly affected region. He has developed technologies specifically for the visual system, which includes high resolution Diffusion Tensor Imaging (DTI) for microstructural changes in optic nerves and tracts, Manganese-Enhanced MRI (MEMRI) for axonal transport in the visual pathway, Optical Coherence Tomography (OCT) for retina layers, and Visual Evoked Potential (VEP) to measure the function of the visual system. His research projects are highly translational and have significant clinical impacts.

Selected Publications


Valentine Vullev
Assistant Professor
MS&E 235
Phone: (951) 827-6239
Email: vullev@ucr.edu

Summary of Research
Dr. Vullev’s laboratory focuses on the fundamental and advanced concepts of physical organic chemistry and biophysics, combined with various fabrication techniques. His research addresses important issues in bioengineering at a broad range of spatial and temporal scales: from sub-nanometer to hundreds of micrometers, and from femtoseconds to minutes. His main focus areas include bioinspired charge-transfer systems for solar-energy conversion, and biofunctional interfaces and microfluidics for biosensing and single-molecule applications.

Selected Publications


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Recent Awards and Honors
Regents of University of California, Faculty Development Award, 2009
University of California, Riverside, Medical School Program, Student Research Mentoring Recognition, 2009
Philip L. Levins Memorial Prize awarded by the American Chemical Society, Northeastern Section, 2001
Sigma Xi honor society, elected a Full Member, 2013
BIG Participating Faculty

CHEMICAL & ENVIRONMENTAL ENGINEERING

Xin Ge, synthetic antibody library construction
Ashok Mulchandani, biosensors and biodetoxification
Nosang Myung, nano-devices
Sharon Walker, biofilms, bioremediation
Ian Wheeldon, high throughput biomaterials synthesis

COMPUTER SCIENCE & ENGINEERING

Tao Jiang, bioinformatics, computational molecular biology
Stefano Lonardi, computational molecular biology, data compression

ELECTRICAL ENGINEERING

Bir Bhanu, computer vision, machine learning
Mihri Ozkan, integrating quantum dots with cells

MECHANICAL ENGINEERING

Guillermo Aguilar, medical lasers
Elisa Franco, biological feedback
Cengiz S. Ozkan, self-assembly of structures and nanofabrication
Masaru P. Rao, biomedical microdevice development
Thomas F. Stahovich, computational design tools
Hideaki Tsutsui, biomedical microdevices, stem cell engineering
Kambiz Vafai, microcantilever arrays for bioanalysis

Bourns College of Engineering

UNIVERSITY OF CALIFORNIA

UC RIVERSIDE
BIG Participating Faculty

BOTANY & PLANT SCIENCES

Sean Cutler, chemical genomics
Thomas Girke, comparative genomics, data mining, cellular networks
Eugene Nothnagel, control of biosynthesis in the golgi apparatus
Natasha Raikhel, vacuolar trafficking through the secretory system

CELL BIOLOGY & NEUROSCIENCE

Sarjeet Gill, neuroscience Cell membrane transport
Manuela Martins-Green, wound healing and tumor development
Prue Talbot, effects of cigarette smoke on processes in stem cells
Nicole Zur-Nieden, differentiation of osteocytes

CHEMISTRY

Christopher J. Bardeen, transport processes occur in complex systems
David Bocian, energy-transducing systems, molecular photonic devices
Quan Cheng, biosensing and imaging arrays
Robert C. Haddon, electronic structure & properties of materials
Cynthia K. Larive, ligand-protein interactions, metabonomics
Thomas H. Morton, mechanisms of receptor-ligand interactions
Michael Marsella, electromechanical actuators

ENTOMOLOGY

Michael E. Adams, signaling in the nervous system
Anupama Dahanukar, insect sensory neurons

PHYSICS & ASTRONOMY

Umar Mohideen, signal transmission in the human brain
Harry W. K. Tom, nonlinear optics, surface science
BIG Participating Faculty

PSYCHOLOGY
G. John Andersen, computational models of high level visual processing
Khaleel A. Razak, development of sensory processing

BIOMEDICAL SCIENCES
Devin K. Binder, neurosurgery
David Johnson, enzyme mechanism analysis
David Lo, mucosal vaccines
John Shyy, genetics of biomechanic effects on cells

Humanities & Social Sciences
School of Medicine

University of California
UC Riverside
Centers and Facilities

Center for Bioengineering Research
The new Center for Bioengineering Research (CBR) is the focus of research activities of the Department of Bioengineering in cooperation with other UC Riverside engineering and science departments. CBR also serves as the research arm for BIG and provides extraordinary additional interdisciplinary research opportunities for students. Some current projects include the development of nanoparticles for laser treatment of cancer, mechanism of hearing, mechanism of charge transfer in biological systems, non-invasive monitoring of neurological systems, drug design against macular disease and microfluidic devices for detecting infectious agents.

Stem Cell Center
The California institute for Regenerative Medicine has approved our proposal for establishment of a Stem Cell Core Facility at UCR. This proposal will bring approximately $2.8 million dollars to UCR for renovation and establishment of a new core facility that will provide human embryonic stem cells to researchers. It will also provide laboratory space for conducting stem cell research.

Center for Plant Cell Biology
The Institute for Integrative Genome Biology and its affiliated Centers (Center for Plant Cell Biology and the Center for Disease Vector Research) are organized around four centralized shared-use core instrumentation facilities that offer advanced tools in bioinformatics, microscopy, proteomics, and genomics to campus faculty and students.

Analytical Chemistry Instrumentation Facility
Housed in the Department of Chemistry, this facility consists of the Nuclear Magnetic Resonance (NMR) Facility, the Southern California Mass Spectrometry (SCMS) Facility, the Small Molecule X-ray Crystallography (SMXC) Facility, and the Optical Spectroscopy (OS) Facility. The Chemistry Dept. also houses a “hot-lab” for isotopic labeling.

Bioinformatics Core Facility
This core, run by Dr. Thomas Girke, contains several workstations, servers, and clusters to run advanced bioinformatics/cheminformatics software tools, to host a wide range of databases and to perform large-scale computing. The available hardware resources include six dual-bootable PC workstations (Linux/Win), two dual-bootable Power Macs (Linux/OS X), one SGI Octane 2 modeling workstation, two high-end servers and a 64-CPU Linux Cluster. Over 100 bioinformatics software tools are available to researchers on campus via remote access.

W. M. Keck Foundation Proteomics Facility
This suite, run by Dr. Songqin Pan, is equipped with state-of-the-art mass spectrometers including oMALDI MS/MS, Q-TOF ESI MS/MS, and LC-MALDI prep systems, and a 2D-gel system for protein separation.