



# Bio-X

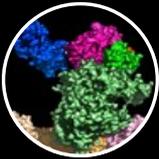
## *Fellowships*

2010-2011

The Bio-X Fellowships are made possible by various gifts in order to promote interdisciplinary research for promising scientists working on projects that bridge the gap between biology and other fields.

Students are encouraged to work collaboratively with professors in different departments or schools, drawing on expertise campus-wide.

NEW ADVANCES IN SCIENCE AND ENGINEERING



## Bio-X Fellowships

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## Bio-X Graduate Student Fellowships 2010



**Jaimie Adelson**  
*Honorary Fellow*  
Neurosciences

*Professor Carla Shatz (Biology, Neurobiology)*

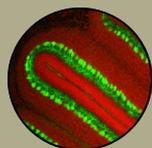
Our brains have the remarkable ability to change and learn. The cerebral cortex has intrinsic mechanisms that limit or promote plasticity by converting neural activity into lasting structural changes at synapses. Jaimie considers the model that, in neurons, two major histocompatibility complex class I genes, Kb and Db, signaling via the innate immune receptor PirB, act as a brake on cortical plasticity. The goal of her research is to “release the brake” in mutant mice lacking these molecules and examine if it is possible to not only increase cortical plasticity but also to promote faster recovery following acute cortical injury.



**Jennifer J. Brady**  
*Bio-X Skippy Frank Fellow*  
Microbiology & Immunology

*Professor Helen M. Blau (Microbiology & Immunology)*

Jennifer’s research focuses on understanding how cells change their fate. How does a cell change its identity, and what factors are important for making this decision? All the cells in our body have an identical genome. What makes cells differ is gene expression, which is controlled by epigenetics, factors such as histone modifications, or DNA methylation (whether the gene is on or off). Jennifer is particularly interested in mechanisms of mammalian DNA demethylation, and she uses a cell fusion based system as a model to understand the factors that control DNA methylation and gene expression.



**Alex Grant**  
Bioengineering

*Professor Craig Levin (Radiology)*  
Alex is working on novel technology for improving PET (positron emission tomography) system performance. PET allows non-invasive cellular and molecular assays of a subject's tissues and is widely used for cancer diagnosis and staging. His project involves using nanophotonic crystals to optically process PET signals in order to achieve faster system response times and eliminate costly processing electronics. This work has the potential to increase PET image signal-to-noise ratio, enabling significant improvements in disease visualization and quantification.



**Andrew Lee**  
Chemical &  
Systems Biology

*Profs. Joseph Wu (Radiology, Medicine) and Paul Wender (Chemistry)*  
Coronary artery disease (CAD) is the leading cause of death in the Western world and is responsible for 1 out of every 5 deaths in America. Stem cell therapy is a novel method of treating CAD through the replacement of injured myocardium with healthy cells capable of restoring contractility to the heart. While initial clinical trials for this therapy have shown some short-term restoration of function, beneficial results have rarely persisted due to donor cell death. Andrew Lee will work to improve donor cell engraftment in the ischemic heart through the development of a pro-survival nanoparticle-molecular transporter complex.



**Jonathan Leong**  
Neurosciences, MSTP

*Professor Thomas Clandinin (Neurobiology)*  
Many functions of the human brain are distinctly—if not uniquely—human, many even unique to specific individuals. Brain function depends on precise patterns of

neuronal connectivity, which are reflected in the morphology of individual neurons within populations. Still, much remains to be learned about the morphological correlates of human brain function—and dysfunction—at this level. Jonathan is developing novel DNA-based molecular machines that will enable him to study neuronal morphology and connectivity, especially long distance connectivity between brain areas, in humans.



**Joanna Mattis**  
Neurosciences

*Professor Karl Deisseroth (Bioengineering, Psychiatry)*

Joanna's research involves optogenetics, a method in which light-activated proteins are used to manipulate specified neuronal circuits within an intact mammalian brain. To expand the utility of this technique, she is working to develop different strategies for targeting these proteins to neuronal populations based on their projection patterns. In addition, she is using optogenetics to study the circuitry that underlies oscillatory network activity within the hippocampus.



**William Noderer**  
Chemical Engineering

*Professor Cliff Wang (Chemical Engineering)*  
The transcription factor p53 is a potent tumor suppressor.  $\gamma$ -irradiation-induced DNA damage can cause oscillations of p53. Does oscillatory behavior aid the cells in responding to DNA damage? William will create an inducible system to manually control p53 oscillations. p53 will be fused to an inducible destabilizing domain, and his constructs will be introduced into p53<sup>-/-</sup> Mdm2<sup>-/-</sup> mouse embryonic fibroblasts (MEF). Using a microfluidic device to control the concentration of a small molecule inducer, William will generate oscillations in p53. The experiment will directly show how p53 oscillations, when compared with constant levels, affect cell survival and gene expression.



**Joo Yong Sim**  
Mechanical Engineering

*Professor Beth Pruitt (Mechanical Engineering)*  
Joo Yong is interested in the interdisciplinary research for micro-electro-mechanical systems (MEMS), mechanics, and mechanobiology. He has been working in the Pruitt Lab and collaborating with the Nelson lab on the mechanics of cell to cell adhesions. He is developing mechanical stimulation systems and custom measurements for studying mechanotransduction of cells and the proteins associated with cell to cell and cell to matrix adhesion including vinculin and E-cadherin. His research will focus on revealing the role of the mechanical loading on regulating the cell adhesion and motility using the high-throughput mechanical stimulation systems and traction microscopy techniques.



**Ryan Squire**  
Neurosciences

*Profs. Tirin Moore (Neurobiology) and Karl Deisseroth (Bioengineering, Psychiatry)*  
The ability to pay attention is a fundamental cognitive function that enables us to selectively process some aspects of our sensory world while ignoring others. Identifying the specific brain cells and circuits that bring about attention is essential for understanding both normal and impaired cognition, yet this is currently beyond the reach of established neurobiological techniques. Ryan's research proposes to apply new technologies from disparate disciplines (e.g., molecular biology, gene therapy, bioengineering) in behaving primates to achieve an unprecedented level of specificity in our knowledge of what cells and circuits underlie cognitive functions such as attention.



**Limor Bursztny**  
Bio-X SIGF  
Bruce and Elizabeth Dunlevie  
Fellow  
Electrical Engineering

*Profs. Mark Horowitz (Electrical Engineering, Computer Science) and Thomas Clandinin (Neurobiology)*  
How do neural circuits perform the computations that drive visually guided behaviors? To answer this question, Limor will use computational approaches and engineering solutions. First, she

would like to define the algorithms used to extract specific types of visual information and to link these features to behavioral modulations. Then, using *in vivo* imaging to record activity and statistical modeling to quantify behavioral responses, she will try to connect these computations to specific neurons. By focusing on a model organism, the fruit fly, she hopes to gain insight into the general mechanisms of neural computation relevant even to humans.



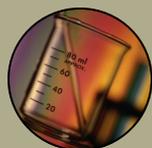
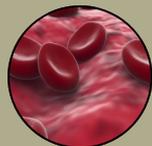
**Remy Durand**  
Bio-X SIGF  
Bruce and Elizabeth Dunlevie Fellow  
Bioengineering

*Professor Karl Deisseroth (Bioengineering, Psychiatry)*  
Noninvasive functional brain imaging has opened a new window into understanding how the brain functions and communicates information; however, the relationship between the activities of neurons and signals measured with functional brain imaging remains poorly understood. Remy's research combines a novel form of neural control called optogenetics with functional magnetic resonance imaging (fMRI) to determine how different types of cells effect fMRI signals and connectivity between brain regions. Remy's work will aid in understanding the function of the normal brain and also the diagnosis and treatment of diseased brain states.



**William Parsons**  
Bio-X SIGF  
Chemistry

*Professor Justin Du Bois (Chemistry)*  
Voltage-gated sodium channels (VGSCs) mediate electrical conduction in neuronal cells and play an essential role in pain sensation. Consequently, VGSC malfunction, improper regulation, and abnormal cellular localization have been implicated in a number of pain pathologies. To better understand the causative link between VGSCs and pain, William has designed small molecule probes derived from the potent VGSC blocker saxitoxin that can be used for multimodal real-time imaging of this protein class. William's studies capitalize on the interplay of complex molecule synthesis, molecular biology, electrophysiology, fluorescent imaging, and live animal experiments to investigate fundamental aspects of VGSC dynamics.



**Aaron Wenger**  
*Bio-X SIGF*  
*Morgridge Family Fellow*  
Computer Science

*Professor Gill Bejerano (Developmental Biology, Computer Science)*

The literature lists a growing number of diseases caused by improper gene regulation; however, the vast majority of the approximately one million regulatory elements in the human genome are of unknown function, and how regulatory logic is encoded in DNA sequence is not well understood. Accurate, comprehensive, and functional annotation of regulatory elements will allow the identification of causative mutations for various diseases and could suggest treatment options. Aaron works to annotate regulatory elements in the human genome by integrating large scale genome-wide experimental measurements, comparative genomics, computational learning methods, and experimental functional validation.



**Xiaoxue Zhou**  
*Bio-X SIGF*  
*Larry Yung Fellow*  
Chemistry

*Professor Lynette Cegelski (Chemistry)*

Xiaoxue is interested in integrating chemistry, biology, and physics to investigate the assembly and function of macromolecular and whole-cell systems. Solid-state NMR is uniquely able to provide a measure of structural and dynamical information for molecular assemblies in their native environments. She wants to employ biophysical and biochemical tools and to design new strategies using solid-state NMR spectroscopy to examine assemblies such as bacterial cell walls (to understand the modes of action of newly discovered antibiotics) and membrane protein CIC-ecl1 (to understand at a molecular and atomic level the structure and mechanism of this Cl<sup>-</sup>/H<sup>+</sup> antiporter).



**Melina Mathur**  
*Bio-X Bioengineering Fellowship*

Understanding the intricacies of cellular metabolism and physiological processes

can lead to the development of novel molecular systems that will improve people's health. Specifically, Melina would like to construct biosensors that will collect temporal and spatial data in a given cellular environment. Such data could then be used to engineer biological counters that trigger specified responses. She is also keen on studying proteins and utilizing protein engineering to design specific ligand-receptor interactions. She believes molecular and cellular engineering will serve as an ideal platform to understand human processes and rationally design therapies to treat human disease.



**Haisam Islam**  
*Bio-X Bioengineering Fellowship*

For his doctorate, Haisam plans to do research in Magnetic Resonance Imaging (MRI) or one of its related techniques. He hopes to work with the acquisition or processing methods of MRI, which will involve understanding MRI hardware, physics, and mathematics. The goal will be to improve MRI in one of many ways, including spatial and temporal resolution and resistance to artifacts, with the purpose of having a better tool for studying brain physiology. This will give other researchers the opportunity to study the brain in more detail or even study different aspects of the brain using a wider range of protocols.



**Remus Wong**  
*Bio-X Bioengineering Fellowship*

Remus plans to pursue research in synthetic biology with specific goals to design, construct, and engineer new biological functions in cells. By combining engineering ideology with basic principles of biological science, he hopes to build artificial biological systems for applications in engineering and medicine as well as to further understand the nature of living systems.

## Bio-X Graduate Student Fellowships 2009



**Aakash Basu**  
Applied Physics

*Professor Zev Bryant (Bioengineering)*

Aakash's goal is to understand how molecular motors couple ATP hydrolysis to the production of mechanical work. In particular, he is attempting to understand the mechanochemistry of DNA gyrase – a type II Topoisomerase that introduces negative supercoils into DNA. He is developing and using single molecule assays to follow the activity of one motor molecule as a function of solution conditions and mechanical perturbations such as tension and torque. Through this study, he wishes to gain a broad understanding of how chemical reactions are coupled to mechanical movements and the general principles that govern the functioning of molecular motors.



**Elsa Birch**  
Chemical Engineering

*Professor Markus Covert (Bioengineering)*

Although viral genomes are relatively short and well studied, there are no reliable treatments for viral infection. This is because the complexity of infection is largely governed by the host machinery that the virus commandeers in order to replicate. Understanding the role of host genes in infection is therefore crucial to the development of new treatment strategies. The Covert lab presents a differential equation population model of *E. coli* infection by bacteriophage lambda. When fit to experimental infection timecourse data for *E. coli* knockouts, the parameters of this model give insight into the particular role of host genes in infection.



**Graham Dow**  
Biology

*Professor Dominique Bergmann (Biology)*

Plants are dependent on their ability to sense and respond to their surrounding environment. In such processes, stomata play a crucial role by controlling the flux of gases between plants and the atmosphere. Stomatal development and

function have been independently described at a molecular and physiological level, but there remains a void in explaining fundamental connections between those paradigms, especially the environmental inputs that direct both. The goal of the Bergmann lab is to elucidate these multi-scale relationships controlling stomata to improve our understanding of plant systems biology and plant-environment interactions.



**Christine McLeavey**  
Neurosciences

*Profs. Scott Delp (Bioengineering, Mechanical Engineering) and Karl Deisseroth (Bioengineering, Psychiatry)*

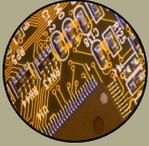
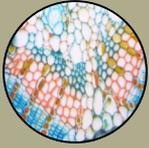
Optogenetic technology allows one to control the activity of individual neurons with pulses of light by genetically inserting photo-activated proteins into the desired neuron. A cation channel, Channelrhodopsin-2 (ChR2), stimulates the neuron when exposed to blue light, while NpHR, a chloride pump, inactivates the neuron when exposed to yellow light. This technology has been used to study brain circuitry, but it will be the first effort to control peripheral neurons to study the peripheral nervous system.



**Alia Schoen**  
Materials Science & Engineering

*Professor Sarah Heilshorn (Materials Science & Engineering)*

The Heilshorn lab intends to develop clathrin as a protein-based template for the creation of hierarchically ordered inorganic nanostructures. Combining theoretical and experimental methods to gain insight into kinetic and thermodynamic processes that regulate the self-assembly of clathrin will enable the prediction and formation of ordered 2D and 3D nanostructured materials. They anticipate these to be widely applicable to other self-assembly systems. They will develop rational design of bi-functional peptides to bridge the biologic-inorganic interface, to enable efficient formation and screening of nanostructured materials for a range of applications.



**Jong Min Sung**  
Applied Physics

*Professor James Spudich (Biochemistry)*  
The objective of Jong's research is to obtain a precise correlation between the mechanical, structural, and biochemical aspects of actomyosin interactions associated with human beta-cardiac myosin cardiomyopathies at a single molecule level. The Spudich lab's hypothesis is that the structural changes caused by the mutations will cause malfunctions of beta-cardiac myosin in terms of 1) force generation roles (step size, force), 2) enzymatic roles (actin-activated ATPase), and 3) coordination between them. To clarify with molecular precision which aspects of chemo-mechanical transduction are altered by selected HCM familial mutations, they will directly measure individual actomyosin interactions using a variety of single molecule tools.



**Nouredine Tayebi**  
Electrical Engineering

*Profs. Nicholas Melosh (Materials Science & Engineering) and Ricardo Dolmetsch (Neurobiology)*

Autism spectrum disorders (ASDs) cause language and social impairments in children. Gene mutations can cause ASDs by altering signaling pathways of Ca<sup>2+</sup> ions in neurons implicated with ASDs. To detect such alterations, the "patch-clamp" technique, which allows for high-resolution current measurements in ion channels, is used; however, low throughput and the destructive nature of the technique prevent observing communications between neurons and long experiment longevity. To mitigate these problems, Nouredine is helping to develop novel chip-based patch-clamp arrays where "nanoposts" are nondestructively fused into neuron membranes. This allows the study of long-term genetic-mutation effects and communication abnormalities between neurons.



**Sanaz Saatchi**  
Bio-X Amgen Fellow  
Bioengineering

*Profs. Charles Taylor (Bioengineering) and Paul Yock (Bioengineering)*

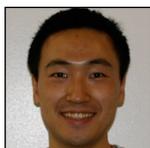
Abdominal aortic aneurysms (AAA) are a life-threatening degenerative disease. A better understanding of the pathological mechanisms that lead to aneurysm formation is essential for the development of effective preventative therapies. Through the use of a novel high resolution imaging technology, coupled with computational analysis and molecular biology techniques, Sanaz's work with the laboratories of Charles Taylor and Paul Yock will characterize the three-dimensional nanometric tissue structure changes and biological events occurring within a blood vessel wall during aneurysm development in an unprecedented manner. These studies will improve their understanding of aneurysm development and may assist in the identification of potential therapeutic targets.



**Liang Liang**  
Bio-X SIGF  
Applied Physics

*Profs. Liqun Luo (Biology) and Mark Schnitzer (Biology, Applied Physics)*

Liang is interested in the organization and information processing principles of neural circuits. She uses the fruit fly olfactory system as a model to study the functional connections in the central nervous system and to characterize where and how the olfactory information is integrated and transformed. She is incorporating advanced fly genetics, light-activated microbial opsins, and genetically-encoded calcium indicators to manipulate and record neuronal activity with high spatiotemporal resolution. The novel noninvasive optogenetic approach will help better understand the neural coding in the olfactory circuitry and to gain insight into the organization principles of neural systems.



**Li Ma**  
Bio-X SIGF  
Statistics

*Professor Wing Wong (Statistics)*

Epistasis are speculated to play important roles in the epidemiology of common diseases. Current methods of testing interactions have achieved limited success and are ineffective in the presence of genetic heterogeneity—when people clinically have the same disease for different genetic reasons. Li's research focuses on developing statistical and computational methods for testing interactions that are robust to genetic heterogeneity. He will use large scale computation to seek genetic patterns that account for a small proportion of the patients.



**Peter Olcott**  
Bio-X SIGF  
Bioengineering

*Profs. Craig Levin (Radiology) and Robert Feigelson (Materials Science & Engineering)*

PET is a non-invasive, *in vivo*, functional, molecular imaging technology—an important tool for clinical disease management and pre-clinical small animal research. Peter wishes to improve the time resolution by more than an order of magnitude over the current generation of time-of-flight (ToF) PET systems by investigating readily available non-linear photonic materials for use as a ToF PET detector instead of scintillation crystals. These materials are not based on fluorescence and have the potential to enable sub-millimeter localization. This would revolutionize PET imaging and greatly improve its performance for characterizing early disease.



**Shawn Ouyang**  
Bio-X SIGF  
Chemical & Systems Biology

*Professor James Chen (Chemical & Systems Biology)* Zebrafish have the unique ability to regenerate several of its tissues (e.g. those of the heart, retina, spinal cord, and fins). Understanding the molecular mechanisms that underlie this process should provide insights into how tissue regeneration is achieved and reveal strategies for their reactivation in humans. Shawn's goal is to decipher the molecular and cellular events associated with larval tail regeneration. He has identified genes that are up-regulated or downregulated in posterior cells after the tail is amputated and is working to determine their roles in the regenerative process.



**Kathryn Montgomery**  
Bio-X Bioengineering Fellowship

*Currently doing lab rotation*

Kathryn is studying the mechanics of bioengineering, especially the investigation of cellular responses to mechanical stimuli. These studies have many applications in the realm of biomaterials and regenerative medicine. Tissue engineering relies on a solid base of biomechanical information. From the molecular to the organism level, biomechanics plays a major role in all systems.



**Rebecca Snyder**  
Bio-X Bioengineering Fellowship

*Professor Sarah Heilshorn (Materials Science & Engineering)*

Rebecca is working on developing *in vitro* mimics of the intestinal stem cell (ISC) niche. ISCs are hypothesized to be one of the most active stem cell populations in the body and reside in a structurally-identified niche environment; however, there are currently no *in vitro* culture conditions that maintain ISC functionality and viability. If ISCs could be successfully cultured, significant progress could be made in the use of regenerative medicine to treat various debilitating GI conditions, including inflammatory bowel diseases (i.e. Crohn's disease, ulcerative colitis, etc.), chemotherapy-induced mucositis, and colorectal cancer.

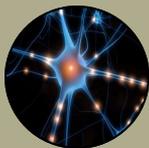
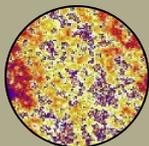


**Yen-Hsiang Wang**  
Bio-X Bioengineering Fellowship

*Professor Christina Smolke (Bioengineering)*

Yen-Hsiang is interested in developing a new approach in physical chemistry to investigate biological systems, especially focusing on *in vivo* whole-cell systems. In Cegelski's lab, he will be focusing on the RNA-small molecules interaction using various techniques. The solid-state NMR magic angle coupling measurement has shown potential for structural and kinetic measurement of macromolecular interaction without high dependency of crystallization. He will use this novel approach to compare ribosome structures of several species in a statistical way. This would allow further detailed studies of RNA structure and functionality and will hopefully be beneficial to novel drug development.

## Bio-X Graduate Student Fellowships 2008



**Mario Diaz de la Rosa**  
Chemical Engineering

*Professor Andrew Spakowitz (Chemical Engineering)*

The Spakowitz lab examines how proteins find their target sites on DNA, a process central to proper cellular function and survival. Of particular interest is the role that DNA conformation, including supercoiling and higher-order chromatin organization, plays in this search. They have developed a novel theoretical framework to address this phenomenon on linear, supercoiled, and nucleosomal DNA, and their predictions will be subsequently verified experimentally. The resulting elucidation of the mechanisms behind target site localization will provide fundamental knowledge of gene regulation processes and the nature of protein-DNA interactions.



**Lisa Gunaydin**  
Neurosciences

*Professor Karl Deisseroth (Bioengineering, Psychiatry)*

Elucidating the neurobiological basis of social behavior is critical to understanding normal human behavior and its dysregulation in psychiatric diseases like autism. Lisa is studying the neural circuits involved in social behavior using light-activated microbial opsins that their lab has engineered for fast optical control of neural activity. These optogenetic tools provide high spatiotemporal resolution in probing the activity of specific cell types within large neuronal populations, which will help elucidate the basic circuit dynamics underlying this complex behavior.



**Tyler Hillman**  
Genetics, MSTP

*Professor Matt Scott (Dev. Biology)*

Tyler's focus is on understanding how cells communicate with one another to influence fate decisions during embryo development and tumor formation. In particular, he studies the gene regulatory interactions controlled by the mammalian Hedgehog signaling pathway. He completed a high-throughput RNA interference screen in search of novel genes that regulate Hedgehog signaling in mammals which resulted in the identification of several genes whose loss results in robust and reproducible inhibition of Hedgehog signaling. He is now following up these hits to better understand how they might regulate this important developmental and oncogenic signaling pathway.



**Ian Marshall**  
Civil & Environmental Engineering

*Professor Alfred Spormann (Civil & Environmental Engineering, Chemical Engineering)*

Complex microbial communities play an important role in a range of environments, including the biodegradation of toxic compounds in groundwater, interactions in the human gut affecting health, and the contribution of agriculture to global atmospheric methane concentrations. Ian is applying novel molecular methods, specifically, tiling DNA microarray, to query the presence and expression of functional genes from a wide range of microbes in the environment to better understand interspecies microbial interactions.



**Andreas Rauschecker**  
Neurosciences, MSTP

*Professor Brian Wandell (Psychology)*

Andreas's work uses several modern imaging modalities, including fMRI and DTI, to understand the neural basis of reading. More than a fifth of the US population reads below their age level, and dyslexia is the most common learning disability. He studies how visual patterns are decoded into words in the normal human brain, which also has relevance for visual object perception in general. To complement this work, he looks at patients who are either suddenly unable to read due to a tumor, stroke, or epilepsy, or who have never been able to read (developmental dyslexia). Finally, he can gain a deeper understanding of the timing of information transfer in the brain during reading by recording electrical signals of patients implanted with subdural electrodes for clinical reasons.



**Mark Sellmyer**  
Chemical & Systems Biology,  
Medicine

*Profs. Tom Wandless (Chemical & Systems Biology) and Michael Longaker (Surgery)*

Mark is interested in developing chemical tools for improving bioscience research and medical therapies. Specifically, he is working on a technology to improve our ability to make genetic changes at targeted sites within our genome and a chemical technology to expand and control hematopoietic stem cells outside of living animals. These projects address major challenges for researchers and clinicians involved with genetic manipulation and stem cell biology. Both projects take advantage of the labs' expertise in molecular biology and synthetic organic chemistry and interface with imaging, immunology, and regenerative medicine.



**Brian Wilt**  
Applied Physics

*Profs. Mark Schnitzer (Biology, Applied Physics) and Karl Deisseroth (Bioengineering, Psychiatry)*

In order to crack the neural code, we require new tools for probing and perturbing neural circuitry *in vivo*. Brian is interested in incorporating these new

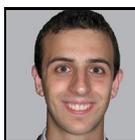
techniques into his lab's expertise with *in vivo* fluorescence microendoscopy. In particular, he is studying innovative strategies for light delivery in optical stimulation experiments with channelrhodopsin and halorhodopsin. He also has interests in novel, fully-automated data analysis techniques for calcium imaging data. His studies concentrate on visual and motor systems, with a particular emphasis on cerebellar ataxia mouse models. These projects draw on his background in physics, optics, applied math, and computer science.



**Gaurav Krishnamurthy**  
*Bio-X Medtronic Fellow*  
Mechanical Engineering

*Profs. D. Craig Miller (Cardiothoracic Surgery) and Ellen Kuhl (Mechanical Engineering)*

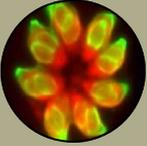
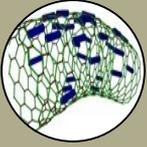
Mitral valve disease affects ~3 million adults each year in the United States. Surgical valve repair is preferred, but valve replacement can be required. Replacement involves implantation of a mechanical or tissue valve, which is associated with anticoagulation/thromboembolic complications and less than ideal durability, respectively. To overcome these limitations, a currently important research goal is to create bioengineered autologous tissue valves. A key component of this thrust is to understand more completely the structure and function of native valves. Using radiopaque marker technology and inverse finite element analysis, Gaurav has quantified, for the first time, the material parameters of the anterior mitral leaflet in the beating heart.



**Adam de la Zerda**  
*Bio-X Skippy Frank Fellow*  
Electrical Engineering

*Professor Sanjiv Sam Gambhir (Bioengineering, Radiology)*

In Adam's research, he develops a new technique for non-invasive imaging of living subjects called 'Photo-acoustic Molecular Imaging.' Using this technique, physicians will be able to monitor various proteins specific to a particular disease, indicating the molecular characteristics of the disease (e.g., whether breast cancer is responding to a chemotherapy or not). He designs a photo-acoustic imaging instrument and a number of molecular contrast agents that produce a photoacoustic signal upon binding to breast cancer cells. His final goal is to integrate the imaging instrument with the cancer-detecting contrast agents by testing them on mice carrying a human breast cancer.



**Viviana Gradinaru**  
*Bio-X SIGF*  
*Colella Family Fellow*  
Neurosciences

*Profs. Karl Deisseroth (Bioengineering, Psychiatry) and Jaimie Henderson (Neurosurgery)*

Deep brain stimulation (DBS) is a powerful therapeutic option for intractable movement and affective disorders (Parkinson's disease, tremor, depression); however, due to the nonspecificity of electrical stimulation, DBS has variable efficacy and can lead to serious side effects, such as speech impairment or paresis. Viviana's research uses precise bioengineering tools to address a critical question in the neurosurgery field: how does DBS exert its therapeutic effects? By using a cell-type specific optical deep brain stimulator developed in the Deisseroth lab, her research investigates the role of specific cell types in PD pathology. These findings could be used to improve the parameters for electrode placement and stimulation in patients.



**Melinda Cromie**  
*Bio-X SIGF*  
Mechanical Engineering

*Profs. Scott Delp (Bioengineering, Mechanical Engineering) and Mark Schnitzer (Biology, Applied Physics)*

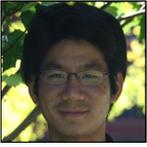
Melinda's goal is to understand the fundamental behavior of muscle by imaging sarcomeres, the smallest units of muscle tissue that contract to generate force. Sarcomeres have never been imaged in humans because they are smaller than the resolution of current clinical imaging modalities. Using a novel microendoscopy system, their laboratory imaged sarcomeres in humans for the first time. Melinda's current work is to use this newly developed system to quantify muscle contractile behavior in healthy humans and in individuals with spinal cord injury to improve surgical treatments that restore muscle function.



**Mihalis Kariolis**  
*Bio-X Bioengineering*  
*Fellowship*

*Professor Jennifer Cochran (Bioengineering)*  
Using yeast surface display and directed evolution, the Cochran lab engineers novel proteins for use in applications ranging from cancer therapy and imaging to wound healing. Mihalis's research is focused on engineering the Agouti-related protein (AgRP) for binding to the integrin  $\alpha 11b\beta 3$ . This integrin is highly expressed on the platelet membrane, and when activated, it engenders aggregation and subsequent clot formation. Though essential to wound healing, aberrant platelet aggregation can lead to myocardial infarctions, embolisms, and strokes. Engineering AgRP to bind specifically to the  $\alpha 11b\beta 3$  integrin would limit platelet activation and subsequently lessen the risk of ischemic events.





**Ton Subsoontorn**  
*Bio-X Bioengineering Fellowship*

*Professor Drew Endy (Bioengineering)*  
Ton is developing a design framework for genetically encoded memory. The memory system is built from *in vivo* machineries and functions inside a living cell. Particularly, he is exploring two alternative approaches: multistabilities of gene expression and site-specific DNA modifications. The challenges are to have fast mechanisms for encoding and decoding information and to have stable storages under stochastic environment inside a cell. This technology will be critical for engineering increasingly more complicated behaviors of a living cell, just as electronic memory systems are crucial for the modern computer.

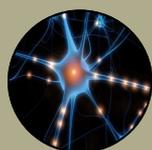


**Grace Tang**  
*Bio-X Bioengineering Fellowship*

*Professor Russ Altman (Bioengineering, Genetics)*  
In recent years, technological advancements have enabled the creation of structural genomics initiatives worldwide. The collective aim is to increase the structural knowledge of proteins and to achieve a thorough coverage of protein structure space. Target selection is therefore focused on proteins with low sequence homology to existing structures; however, this has come at the cost of an increasing number of structures with unknown function. Traditional methods for functional inference are unreliable at low sequence homology. Grace aims to use machine learning algorithms in combination with molecular dynamics to detect local three-dimensional patterns for functional inference.



## Bio-X Graduate Student Fellowships 2007



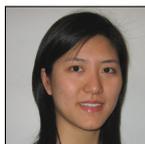
**Kelsey Clark**  
Neurosciences

*Professor Tirin Moore (Neurobiology)*  
The visual world contains far more information than we can process or respond to at any one time. How does the brain select specific stimuli to enter awareness and guide behavior? In addition, goal-driven behavior—from baking a cake to changing lanes on the freeway—often involves 'holding in mind' certain facts about the state of the world. How is task-relevant information selected for entry into memory and maintained in the absence of continued sensory input? To what extent are the same neural circuits involved in processing sensory stimuli used to maintain and manipulate remembered stimuli?



**Jennifer Hicks**  
Mechanical  
Engineering

*Professor Scott Delp (Bioengineering, Mechanical Engineering)*  
Many children with cerebral palsy walk with a crouched posture that prevent them from moving safely and efficiently. Since the body is a complex dynamic system, it is difficult for clinicians to determine why a patient walks in a crouch gait and prescribe an appropriate treatment plan using the current set of tests and assessment techniques. The goal of Jennifer's research is to develop objective tools based on biomechanical simulation and statistical modeling to identify which factors—including muscle weakness, bony deformities, or joint tightness—contribute to a patient's crouch gait and should be corrected with treatment.



**Frances Lau**  
Electrical Engineering

*Profs. Craig Levin (Radiology) and Mark Horowitz (Electrical Engineering, Computer Science)*  
Frances is developing an ultra-high resolution Positron Emission Tomography (PET) system dedicated to breast cancer imaging. PET is a non-invasive, *in vivo*, molecular imaging technology that has shown promise for early identification of breast cancer due to its ability to visualize biochemical changes in malignant tissue well before structural changes occur. She applies hardware design and signal integrity concepts to develop data acquisition electronics that read out and process the small signals detected. She is also using ideas from high speed data communication circuits to propose and design a novel integrated circuit for a future PET system.



**Cory McLean**  
Computer Science

*Professor Gill Bejerano (Developmental Biology)*  
Evolution of cis-regulatory elements may drive the majority of anatomical evolution, yet the mechanisms of cis-regulation of gene expression are poorly understood. Cory has uncovered a number of interesting non-coding genomic regions within vertebrates using the computational tools of high-performance computing, statistics, and natural language processing. He is also investigating roles for machine learning in the discovery of a genomic signature of cis-regulatory elements. Transgenic experiments performed in collaboration with the Kingsley laboratory will help to elucidate the roles of these elements in vertebrate evolution.



**Rebecca Taylor**  
Mechanical Engineering

*Profs. Ellen Kuhl (Mechanical Engineering) and Beth Pruitt (Mechanical Engineering)*

After a heart attack, the heart has limited ability to repair itself. Because cardiomyocytes (CMs) are difficult to culture *in vitro*, there are few options for creating tissue patches to repair the heart. Dynamic cell culture, which provides synchronized electric field pacing and cyclic strain, holds promise for enabling the creation of stem cell-derived CM grafts with regenerative capacity for healing an infarcted heart. Our computational models and newly developed tools utilizing stretchable microelectrode arrays and micropatterned silicone substrates will enable engineers and biologists to create enhanced cell culture platforms for both basic and translational research into CM growth.



**Kitchener Wilson**  
Bioengineering

*Profs. Joe Wu (Radiology) and Paul Yock (Bioengineering, Mechanical Engineering)*  
Graduated 2010

Kitchener's research focused on characterizing human embryonic stem cell differentiation and transplantation, with a specific focus on cardiovascular tissue regeneration. He used genomic and proteomic methodologies such as DNA microarrays and highly sensitive protein arrays to better understand the regulatory networks that govern stem cell behavior as well as *in vivo* molecular imaging techniques to assess their engraftment in mouse models of disease. Of particular interest was the cardiac stem cell "niche," or microenvironment within heart tissue, that promotes their regenerative capacity.



**Larry Wang**  
Materials Science & Engineering

*Profs. Sarah Heilshorn (Materials Science & Engineering) and Andrew Spakowitz (Chemical Engineering)*

The goal of Larry's research project is to understand the structural and behavioral characteristics of quaternary protein structure using the coat-vesicle protein clathrin. This study employs two major approaches in parallel: development of a theoretical model using Brownian dynamics simulation to predict quaternary structure and *in vitro* self-assembly experiments to observe and control the quaternary structure. Clathrin proteins perform their biological functions by self-assembling into cages, and recent reports have begun to elucidate the structure of the individual clathrin molecule and have provided a more detailed static picture of the *in vivo* assembly.

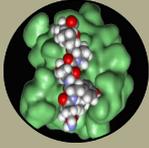
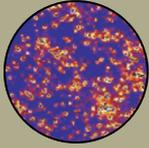


**Sheng Ding**  
Bio-X Bioengineering Fellowship  
(1 year award)

*Professor Annelise Barron (Bioengineering)*

Tissue engineering is an exciting and revolutionary strategy to overcome the problem of donor shortage in tissue transplantation. The Barron lab investigates appropriate scaffolds mimicking the natural extracellular matrices, which deliver the cells to the desired site, provide a space for new tissue formation, and potentially control the structure and function of the new tissue. Sheng's research project is to create protein polymer hydrogels that are enzymatically cross-linked as tissue engineering scaffolds. These new hydrogels are biocompatible and biodegradable. Using genetic engineering, the Barron lab can modify these hydrogels for particular requirements for specific tissue engineering applications by designing the amino acid sequence, chain length, and block spacing of the protein polymers.





**Jacob Hughey**  
*Bio-X Bioengineering  
Fellowship*

*Professor Markus Cover (Bioengineering)*  
The goal of Jacob's work is to provide a quantitative understanding of the intricate circuitry that controls how cells interact with their environment. Currently, he is focusing on the TNF-induced response of the NF- $\kappa$ B network, which is crucially involved in cell proliferation and the innate immune response but is misregulated in many cancers. He is using live cell imaging and mathematical modeling to explain how the dynamics of the network depend on TNF dose. This research will lead to greater understanding of how cells sense and respond to the intensity of environmental signals.



**Jayodita Sanghvi**  
*Bio-X Bioengineering  
Fellowship*

*Professor Markus Cover (Bioengineering)*  
Jayodita has been developing a computational model of the smallest known bacterium, which describes the dynamics of every molecule in the cell and includes the function of every gene. The model involves the integrated understanding of metabolism, replication, transcription, translation, regulation, and more. She has also been developing a means to experimentally validate the model. Manipulation of the virtual cell will enable a better understanding of cell physiology and help uncover unknown cell mechanisms. Future expansion of the model may help predict cell responses to drugs and environmental stresses or provide insight on how to engineer cells to perform desired functions.



**Min-Sun Son**  
*Bio-X Bioengineering  
Fellowship*

*Professor Marc Levenston (Mechanical Engineering)*  
Min-Sun's work in the Soft Tissue Biomechanics Laboratory under Dr. Marc Levenston involves studying gene expressions of various proteins such as collagen, aggrecan, and aggrecanase in the immature and mature bovine meniscus. These proteins are known to have important roles in meniscus degeneration. The meniscus does not have much regenerative capabilities and has been correlated with cartilage degeneration or osteoarthritis; therefore, comparing the protein expression levels in mature and immature tissue will provide helpful insight in fully understanding the mechanism of degeneration. She is also looking at different regions in the meniscus, which are subject to different kinds of mechanical forces in the knee.



**Nan Xiao**  
*Bio-X Bioengineering  
Fellowship*

*Professor Charles Taylor (Bioengineering, Mechanical Engineering)*  
Computational simulations of blood flow dynamics (hemodynamics) enable detailed, quantitative investigation of the role of hemodynamic factors in vascular disease. In order to construct realistic, patient-specific models of blood flow, data from non-invasive measurements must be used to improve the reliability of the simulation. Currently, the goal of the Taylor laboratory is to couple vessel wall-motion data from sequences of CT images with a 3-D computational model incorporating the fluid-structure interaction between blood and blood vessel in order to minimize the differences between observation and simulation. Accomplishing this goal will bring them one step closer to producing realistic, personalized blood flow models that may have important applications in the treatment of vascular disease.

## Bio-X Graduate Student Fellowships 2006



**Edith Arnold**  
Mechanical Engineering

*Profs. Scott Delp (Bioengineering, Mechanical Engineering) and Garry Gold (Radiology)*  
Muscles turn our thoughts into actions. We speak, reach, grasp, and walk because our muscles interpret signals from our brains to produce coordinated forces. Since these forces cannot be measured directly, musculoskeletal models that predict them are powerful resources for basic research and clinical applications. Edith is building a model of the lower limbs that uses measurements of muscle structure to give accurate predictions of force. This project unites muscle physiology, computational modeling, and scientific communication to answer questions about the role of muscle structure in walking; develop models that address variation due to age, sex, and strength; and share these models with the research community.



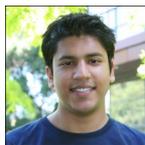
**Jennifer Blundo**  
Mechanical Engineering

*Professor Christopher Jacobs (Mechanical Engineering)*  
The powerful potential of stem cell therapy motivates a better understanding of the basic mechanisms regulating developmental biology. The role of mechanical and electrical forces in the adult physiology and pathology has been well documented, and Jennifer is interested in what clues these phenomena may hold for generating robust, terminally differentiated stem cells. The pluripotent capacity of human embryonic stem cells makes them an attractive source for cell-based myocardial therapy. Specifically, the delivery of cardiac myocytes, which constitute 70-80% of the adult myocardium, may restore tissue viability and function to ischemic tissue damaged by a heart attack. Her research is motivated by the limitations of current methods to derive cardiac myocytes from stem cells. The aim is to increase the differentiation yield of cardiac myocytes through electromechanical conditioning and ultimately the *in vivo* performance of myocardial cell-transplants.



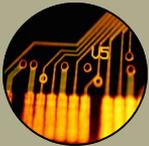
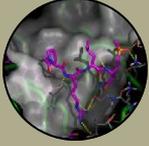
**Ian Chen**  
Bioengineering,  
Medicine

*Professor Sanjiv Sam Gambhir (Bioengineering, Radiology)*  
*Graduated 2008*  
*Medical Student at Stanford University*  
Stem cell therapy has emerged over the past decade as a promising treatment for congestive heart failure. Current clinical studies on cell therapy lack an objective method to noninvasively assess the survival and migration of stem cells following implantation. The goal of Ian's project was to develop a novel multimodality reporter gene for labeling stem cells and monitoring their behaviors in living subjects using a combination of positron emission tomography (PET), optical bioluminescence imaging, and magnetic resonance imaging (MRI). Efforts are underway to develop and validate such a reporter gene in terms of its ability to lead to highly specific and sensitive imaging signals which are reflective of stem cell viability. The development and characterization of such reporter genes should provide a valuable tool for investigators in the future to accurately assess the efficacy of stem cell therapy in humans.



**Sanjay Dastoor**  
Mechanical Engineering

*Profs. Mark Cutkosky (Mechanical Engineering) and Scott Delp (Bioengineering, Mechanical Engineering)*  
Sanjay is researching the application of artificial muscles to robotics and prosthetics through a novel manufacturing method. Electric motors lack many of the dynamic characteristics of biological muscle, limiting their use in biomimetic devices. Electroactive polymer actuators are a promising alternative with muscle-like performance, light weight, low cost, and silent operation. He is developing methods for fabricating these actuators using shape deposition manufacturing, which allows customized geometries, heterogeneous materials, and embedded components.



**Katy Keenan**  
Mechanical  
Engineering,  
Radiology

*Profs. Scott Delp (Bioengineering, Mechanical Engineering), Garry Gold (Radiology), Gary Beaupre (Mechanical Engineering)*  
The goal of Katy's work is to better diagnose cartilage health, enabling early detection of diseases such as osteoarthritis. Currently, because cartilage disease cannot be diagnosed early, there is no metric of cartilage health to non-invasively evaluate restorative therapies. She is combining magnetic resonance imaging techniques with mechanical testing of *ex vivo* cartilage to develop a correlation between imaging parameters and mechanical properties of cartilage. Several of the novel MRI techniques she is using, e.g. sodium, T1 rho, and bound pool fraction maps, are being developed at Stanford. She will translate the correlation between imaging parameters and mechanical properties to *in vivo* imaging of human patients.



**Guillem Pratx**  
Electrical Engineering

*Professor Craig Levin (Radiology)*  
*Graduated 2010*  
Positron emission tomography (PET) is a medical imaging modality that has the powerful capability to non-invasively interrogate cellular and molecular processes occurring deep within the tissue of living subjects; however, advanced image reconstruction methods require more computation than is available in a typical clinical setting. Hence, the goal of Guillem's work was to accelerate the reconstruction by an order-of-magnitude by using off-the-shelf graphics processing units (GPUs) as cost-effective high performance co-processors. This technology will enable the use of advanced reconstruction methods that improve the accuracy of the scans, resulting in more reliable diagnosis.



**Aaron Wang**  
Bioengineering,  
Medicine

*Profs. Charles Taylor (Bioengineering, Mechanical Engineering) and David Liang (Cardiovascular Medicine)*  
*Graduated 2009*  
*Medical Student at Stanford University*  
Development of a novel portable ultrasound cuff with an automated bleed detection algorithm would be useful for medics in the field. The goal of Aaron's study was to evaluate a detection strategy for internal bleeding that employed a well-established theoretical biofluid model, the power law. This law characterizes normal blood flow rates through an arterial tree by its bifurcation geometry. By detecting flows that deviate from the model, they hypothesized that vascular abnormalities could be localized. Their bleed detection metric demonstrated good sensitivity and specificity in computational bleed simulations, *in vivo* rabbit bleed models, and human case studies in dialysis patients.



**Peggy Yao**  
Biomedical Informatics

*Professor Jean-Claude Latombe (Computer Science)*  
In the study of protein-ligand binding, the conformational selection theory suggests that a protein exists as an ensemble of rapidly inter-converting folded conformations and that a ligand selects the most proper conformations to bind to. However, only a small number of conformations can be obtained experimentally, while existing simulation techniques are often too expensive to broadly sample folded conformation space. Peggy's research will focus on designing new methods to efficiently sample protein conformations. She will use the linkage model together with rigidity analysis to develop a new, efficient protein conformation sampling method taking steric clash into account.

**Namiko Abe***Bio-X Paul Berg Biomedical Fellow  
Neurosciences**Prof. Tobias Meyer (Chemical & Systems Biology)  
Graduated 2007*

Although phosphoinositides (PIs) represent a minor fraction of cellular lipids, they are integral components of cell membranes. Recent evidence suggests that PIs not only have a structural role but may also act as important second messengers during membrane trafficking events. The Meyer laboratory in collaboration with Tom Wandless's group developed a chemically-inducible translocation strategy to rapidly synthesize or degrade specific PIs at the plasma membrane. Namiko planned to make improvements upon this chemical strategy while developing new bioengineered probes to manipulate levels of different PIs in specific membrane compartments. She then used these tools to investigate the role of specific PI species in various steps of receptor-mediated endocytosis as well as the synaptic vesicle cycle.

**Bertrand Lui***Bio-X Lubert Stryer Fellow  
Bioengineering**Profs. Jennifer Cochran (Bioengineering) and James Swartz (Chemical Engineering)*

The goal of Bertrand's research is to develop a technology platform which combines yeast surface display and cell-free protein synthesis to engineer proteins for enhanced biological efficacy. It will be demonstrated by evolving epidermal growth factor, which plays a role in the healing process and has great therapeutic potential for wound repair and regenerative medicine.

**Daniel Kimmel***Bio-X Affymetrix Fellow  
Neurosciences,  
Medicine**Professor William Newsome (Neurobiology)*

When we make decisions, we must consider both the costs and benefits associated with each choice. In the world of economics, this problem is often solved by reducing costs and benefits to a common currency, namely money. The Newsome laboratory believes the brain solves the problem similarly by representing benefit, cost, and net value as discrete neural signals. To test this, they

make economic offers to monkeys while they record from or manipulate the activity of neurons underlying the animals' decision to accept or reject their offers. Their results will shed light on the neural basis of value.

**Angela Wu***Bio-X Bioengineering Fellowship**Professor Stephen Quake (Bioengineering)*

Chromatin immunoprecipitation (ChIP) is a powerful assay used to probe DNA-protein interactions. Traditional methods of implementing this assay are cumbersome and require a large number of cells, making it difficult to study rare cancer and stem cells. The Quake lab has designed a microfluidic device (named AutoChIP) to perform sensitive ChIP analysis on low cell numbers in a rapid, automated fashion while preserving the specificity of the assay. The recently demonstrated AutoChIP results from 2,000 cells were comparable to conventional ChIP methods using 50,000–500,000 cells. She is using this device to study oncogene addiction in cancer cells and to do profiling of cancer stem cells. She believes that their device provides a solution to the need for a high sensitivity, rapid, and automated ChIP assay, and in doing so, will change the way we study cancer and enable studies of cancer stem cells that were not possible previously.

**Murtaza Mogri***Bio-X Bioengineering Fellowship**Prof. Karl Deisseroth (Bioengineering, Psychiatry)*

Deep brain stimulation (DBS) is a therapeutic option for intractable neurological and psychiatric disorders, including Parkinson's disease. Because of the heterogeneity of brain tissue, it has been challenging to elucidate the underlying mechanisms of DBS. Using optogenetics, which employs light activated conductance regulators expressed in specific cell types, the Deisseroth laboratory tested a multitude of suggested mechanisms, systematically driving or inhibiting an array of circuit elements in freely moving Parkinsonian rodents. Since the therapeutic effects could be accounted for by stimulation of cortical axons, they are developing noninvasive methods for stimulating these axons as a potential treatment for Parkinson's disease.

## Bio-X Graduate Student Fellowships 2005



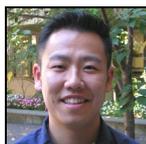
**Afsheen Afshar**  
Electrical Engineering,  
Medicine

*Professor Krishna Shenoy (Electrical Eng.)  
Graduated 2008*  
*Medical Student at Stanford University*  
Afsheen's research with the Shenoy group involved the design and implementation of neural prosthetics that patients can use. He focused his efforts on the paradigm of point-to-point movements, such as those done by typing on a keyboard. Specifically, he developed innovative computational models and algorithms that help elucidate how the brain plans and executes movement. He was concurrently working on improving the electronic infrastructure that could support an extremely fast (i.e., realtime) and accurate 'virtual keyboard' that would allow a patient to type by planning movements to desired keys at desired times. Finally, he collaborated with neurosurgeon Dr. Jaimie Henderson to apply their work to a Parkinson's Disease patient population. Afsheen hoped to bring all these avenues together to help create a real, useful prosthetic.



**Georgios Asimenos**  
Computer Science

*Prof. Serafim Batzoglou (Computer Science)  
Graduated 2009*  
*Director of Science & Engineering at DNAnexus*  
Georgios was developing a next-generation whole-genome alignment pipeline in order to harvest the enormous wealth of genomic data that is becoming available; mainly the 12 *Drosophila* genomes and the impending 20 mammalian genomes. He used these alignments to predict putative functional elements based on constraint of evolution. The challenge was not only to identify such elements, but to understand how they act in the context of specific biological systems. He also investigated new high-throughput experimental techniques to study predicted elements during development of the *Drosophila* embryo.



**David Myung**  
Chemical Engineering,  
Ophthalmology

*Profs. Curtis Frank (Chemical Engineering)  
and Christopher Ta (Ophthalmology)  
Graduated 2008*  
*Co-founder and former president of Biomimmedica, Inc.*  
Corneal blindness affects millions worldwide and requires a corneal transplant. An engineered artificial cornea has the potential to replace the need for human donor tissue while providing better surgical outcomes. David's project was the design, fabrication, and characterization of an artificial cornea based on a novel class of hydrogel polymer alloys. These "biomimetic" materials have demonstrated great potential for emulating the transparency, biomechanics, and regenerative capacity of a human cornea. His aims were to characterize the unique properties of these polymers, engineer them to promote integration with host corneal tissue, and finally to study the cellular response to them *in vitro*.



**Rachel Kalmar**  
Neurosciences

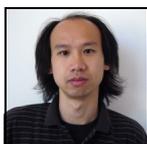
*Profs. Krishna Shenoy (Electrical Engineering) and William Newsome (Neurobiology)  
Graduated 2010*  
Rachel was interested in understanding how ensembles of neurons collectively encode and transmit information and how this neural activity underlies complex behavior and cognition. Using a combination of behavioral, physiological and computational approaches, she explored how the brain computes values, how this computation drives decision making, and the applications of this value assessment in the context of neural prosthetic development.



**Jules VanDersarl**  
Materials Science & Engineering

*Profs. Nicholas Melosh (Materials Science & Engineering) and Michael Longaker (Surgery)*

Jules is involved in exploring new methods to use nanoscale electronics to direct stem cell differentiation in an effort to better understand and control the spatial and temporal events that occur during differentiation. They are developing an active electronic chip that stores signaling chemicals within nano-reservoirs and releases them when activated with an electronic signal. This chip will allow them to extend the spatial and temporal control of soluble signals down to an individual cell for unprecedented control over the local cellular environment.



**Yufeng Yang**  
Neurosciences

*Professor Bingwei Lu (Pathology)*  
Graduated 2009

*Assistant Professor at Fuzhou University*

The goal of Yufeng's project was to examine the dopaminergic neuron associated neural circuitry in fruit fly (*Drosophila*) models of Parkinson's disease, using a combination of genetics, electrophysiology, behavioral analysis, and computational modeling approaches.



**Vincent Chu**  
*Bio-X Pfizer Fellow*  
Applied Physics

*Professor Sebastian Doniach (Applied Physics)*  
Graduated 2009

Ion atmospheres play an important role in the function and formation of tertiary structure in charged nucleic acids; however, current understanding of electrostatics around nucleic acids is poorly understood. Vincent's research was focused on advancing the theory of nucleic acid electrostatics, the creation of computational tools to model these effects, and experimental verification of new theories. Research in this area would lead to new drug designs, molecular sensor designs, and increased knowledge of gene regulation.



**Virginia Chu**  
*Bio-X Bioengineering Fellowship*

*Professor Terence Sanger (Pediatric Neurosurgery)*  
Graduated 2009

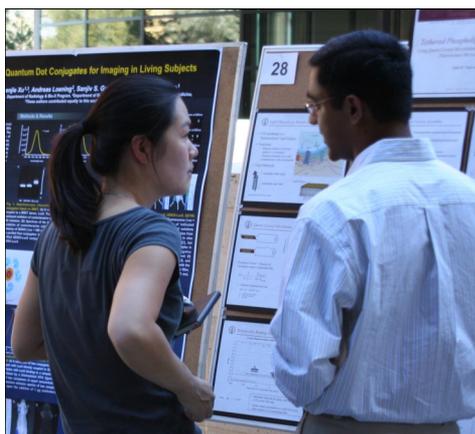
Virginia worked in Dr. Sanger's group to develop a theoretical model for human motor learning. In particular, she was interested in studying motor learning in children and young adults. Various aspects of motor learning were explored to help shed light on its important elements. Virginia also studied children with severe movement disorders in order to learn more about the missing pieces that lead to various motor learning deficits. Using this information, she intended to study "correction" methods to compensate for the missing pieces in light of the model. With a greater understanding of the motor learning deficits, Virginia hoped to develop medical devices and training paradigms to help children with movement disorders learn and further develop their motor skills.



**Mindy Chang**  
*Bio-X Bioengineering Fellowship*

*Professor Tirin Moore (Neurobiology)*

Mindy is interested in using signal processing and computational modeling approaches to understand neural circuits. Her current project involves population analysis of neurons in the visual cortex that encode color and orientation information. Future research will focus on mechanisms of visual attention in modulating neural representations of sensory input.





**Stephen Lee**  
Bio-X Bioengineering  
Fellowship

*Professor Jennifer Cochran (Bioengineering)  
Graduated 2008*

The Cochran lab uses directed evolution and yeast display to create novel protein mutants for therapeutics in wound healing and cancer applications. Stephen's project investigated mutants of human epidermal growth factor (EGF), a protein involved in both of these pathways. *In vitro* assays are being used to study the migratory and proliferative effects of EGF on murine and human fibroblasts. His goal was to demonstrate an EGF mutant with improved migration and proliferation over wild-type to ultimately test *in vivo*.



**Prasheel Lillaney**  
Bio-X Bioengineering  
Fellowship

*Professor Rebecca Fahrig (Radiology)*

The goal of Prasheel's project is to build a hybrid X-Ray/MRI system that will allow Interventional Radiologists more versatility in how they approach various procedures that require MR or X-Ray guidance while still maintaining the image quality and performance offered by a conventional MRI or X-Ray system. Prasheel is currently modeling the electron beam optics in X-ray tubes and determining how the electron beam is affected by the presence of the strong MR fringe field. He is also developing different X-ray tube motor designs that would allow for better tube performance in the hybrid system.



## Bio-X Graduate Student Fellowships 2004



**Relly Brandman**  
Chemical & Systems Biology

*Professor Vijay Pande (Chemistry)*  
*Graduated 2009*

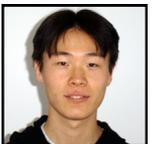
*Research Scientist at Simprota Corporation*  
Inhibitors and activators of proteins can be used to uncover how cells work and to develop new drugs and therapies. The focus of Relly's project was to develop and use computational tools to design modulators specific for particular proteins that would then be experimentally tested.



**David Camarillo**  
Mechanical  
Engineering

*Professor Kenneth Salisbury (Computer Science)*  
*Graduated 2008*

*Asst. Professor in Bioengineering, Stanford University*  
David's research was in the area of biomedical device innovation, specializing in robotically enhanced surgery. He developed technologies for flexible robotic manipulators. These instruments can be tele-operated by a physician or autonomously controlled. His focus was to improve the controllability of such instruments by creating novel algorithms that rely upon solid mechanics models as well as multiple sensory inputs.



**Samuel Kim**  
Chemistry

*Professor Richard Zare (Chemistry)*  
*Graduated 2009*

*Postdoctoral Scholar at POSTECH (South Korea)*  
Microfluidic platforms for single-cell analysis have been developed. The protein chip allows for manipulating individual cyanobacteria cells and quantitatively detecting the proteins in light-harvesting antenna complexes. The DNA chip enables the amplification of genomic DNA from an environmental cyanobacterium and downstream genetic analysis. These platforms, with proper adaptations and improvements, were used to explore the origin and dynamics of the cell-to-cell heterogeneity found in a microbial population or community.



**Andy Loening**  
Bioengineering,  
Medicine

*Professor Sanjiv Sam Gambhir (Radiology, Bioengineering)*  
*Graduated 2006*

*Radiologist at Stanford Hospital*  
Andy's research focused on developing a new class of probes for *in vivo* receptor imaging consisting of bioluminescent proteins fused to receptor ligands. Preliminary work had focused on optimizing the bioluminescent proteins for this purpose through rational and random mutagenesis approaches. He then focused on developing the ligand/ bioluminescent fusion proteins and to validate them both *in vitro* and *in vivo*.

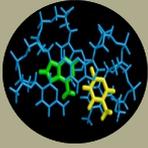


**Sergio Moreno**  
Physics

*Profs. Michael Levitt (Structural Biology) and Sebastian Doniach (Applied Physics)*

Sergio works in Prof. Levitt's group developing a novel computational framework to study large-scale protein movements as they explore their energy landscapes. The method will be applied to proteins under experimental study in Prof. Frydman's lab. They expect that this interdisciplinary collaboration will be very beneficial to both experimentalists and theoreticians as it will help them understand particular protein systems and will provide insight into the general mechanisms by which proteins fold and perform their biological functions.



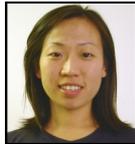


**Leslie Meltzer**  
Neurosciences,  
Neurobiology

*Profs. Theo Palmer (Neurosurgery) and Karl Deisseroth (Bioengineering, Psychiatry)*  
Graduated 2008

*Medical Information Manager at Actelion Pharmaceuticals US*

Leslie's research explored the wiring of new stem cell-derived neurons into intact circuits using techniques bridging bioengineering, neurosurgery, and computer science. She investigated the following critical questions: 1) How are new stem cell-derived neurons wired into the adult mammalian brain? 2) How does wiring of new neurons according to these rules impact memory storage in computational neural networks? and 3) How does wiring of new neurons in this way impact memory storage in behaving animals?



**Sara Zhao**  
Mechanical  
Engineering

*Professor Beth Pruitt (Mechanical Eng.)*  
Graduated 2005

Mechanotransduction, the process by which cells convert mechanical stimuli into cellular signals, is important in many areas of physiology, medicine, and medical device design. The goal of Sara's project was to study the MEC-4 channel complex that mediates sensory mechanotransduction of touch receptor neurons. A biomolecular model would be developed to describe the mechanism of MEC-4 channel complex as mechanoreceptor and its critical role in the whole-cell behavior.



**Amanda Malone**  
Bio-X Bioengineering  
Fellowship

*Professor Christopher Jacobs (Mechanical Engineering)*  
Graduated 2007

*Vice President and Director of Research and Development at Auritec Pharmaceuticals, Inc.*

It is well documented that bone responds to changes in load with corresponding changes in size and density. The Jacob lab believes that Oscillatory Fluid Flow (OFF), generated by pressure gradients in the lacunar cancellous network, is a potent physiological signal that is recognized by bone cells as an anabolic stimulus. While it is known that bone cells respond to fluid flow with various intracellular chemical responses, the actual mechanism that transduces the physical extracellular signal to a chemical intracellular one is not yet known. Amanda hoped to determine the actual molecules that take part in this conversion from a mechanical signal to a chemical one. Her hypothesis was that this mechanotransduction event could be linked to integrins and the phosphorylation of Focal Adhesion Kinase (FAK). FAK is a good candidate for a mechanotransduction molecule in bone cells because it has both structural and enzymatic function and has proved relevant in mechanotransduction in other cell types.

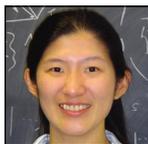


**Adam Grossman**  
Bio-X Bioengineering  
Fellowship

*Profs. Terence Sanger (Pediatric Neurosurgery), Scott Delp (Bioengineering, Mechanical Engineering), and Krishna Shenoy (Electrical Engineering)*  
Graduated 2010

Adam studied children with severe movement disorders in order to generate hypotheses as to the biological cause for their disorders. He collected data from each child—ranging from simple MRI and CT scans to more complex kinesthetic analyses—and hoped the data would help shed light on the specific locations in the brain that may be malfunctioning. Using this information, Adam designed further experiments to test these hypotheses and provide insight for better treatments and potential cures for these diseases. In particular, Adam was interested in determining how and why deep brain stimulation is an effective treatment for some dystonic children and what parameters of the stimulation can be adapted to optimize the benefits of DBS in these children.

## Bio-X Postdoctoral Fellowships



**Yu-Shan Lin**  
*Bio-X Postdoctoral  
Fellowship 2009*  
*Bio-X Fellow*  
Chemistry

*Professor Vijay Pande (Chemistry)*

Mounting research evidence suggests that soluble oligomers of amyloid beta ( $A\beta$ ) peptide play a causal role in Alzheimers disease. This research project describes an interdisciplinary approach to provide valuable insight into the important problem of  $A\beta$  oligomerization. The Pande lab proposes to utilize advanced simulation techniques to provide structural, thermodynamic, and kinetic information on the structure and oligomerization of  $A\beta$  peptides. They shall obtain testable spectroscopic predictions by integrating their simulations with theoretical vibrational spectroscopy.



**Tristan Ursell**  
*Bio-X Postdoctoral  
Fellowship 2009*  
*Bio-X Genentech Fellow*  
Bioengineering

*Professor Kerwyn Huang (Bioengineering)*

Tristan's research has concentrated on the mesoscopic scale, where proteins, lipids, and their aggregates are examined as mechanical elements that respond to stresses in the environment. His goal is to probe the importance of physical and mechanical forces in mechanisms driving cellular organization by integrating approaches from experimental cell biology, biochemistry, and biophysics with theoretical studies based on mechanics, statistical physics, and computational biology. As a consequence, his research will benefit from natural collaborations with faculty from the Schools of Medicine and Engineering.



**Shilpa Sambashivan**  
*Bio-X Postdoctoral  
Fellowship 2007*  
*Bio-X Genentech Fellow*  
Chemical & Systems Biology

*Professor Axel Brunger (Molecular & Cellular  
Physiology)*

*Scientist at NGM Biopharmaceuticals*

The Endoplasmic Reticulum Associated Degradation pathway is an important quality control pathway that is essential for clearing misfolded proteins from cells in a timely manner thus preventing the accumulation of toxic aggregates. Aberrant functioning of the ERAD Pathway has been linked to several diseases including Parkinson's disease. The pathway is highly evolved with specific branches of the pathway dedicated to the clearance of misfolded proteins in different cellular locations. Employing biochemical assays and structural techniques like X-ray crystallography, single-molecule studies, and electron microscopy, the Brunger lab is interested in determining the molecular interactions between misfolded proteins and the various components of the ERAD-L pathway.



**Elena Rykhlevskaia**  
*Bio-X Postdoctoral  
Fellowship 2007*  
*Bio-X Lubert Stryer Fellow*  
Psychiatry

*Profs. Vinod Menon (Psychiatry, Neurosciences) and  
Brian Wandell (Psychology)*

Elena is interested in connectivity aspects of brain organization. She develops data mining algorithms for analysis and modeling of in vivo human brain imaging data to understand how different brain areas interact as part of a large-scale network. Her lab works with the Cognitive and Systems Neuroscience Lab and the Vision, Imaging Science and Technology Activities Lab. To capture the structural backbone of brain networks, they use diffusion tensor imaging (DTI), while functional magnetic resonance imaging (fMRI) is used to infer activity synchronization and information flow among the key network nodes (at rest or when performing a task). She is particularly fascinated with the changes in structural and functional aspects of brain network connectivity due to brain development and aging.



BIO-X AT STANFORD

TO EDUCATE...

TO DISCOVER...

TO INVENT...



**Tiffany Chung**  
*Bio-X Postdoctoral  
Fellowship 2005  
Stanford Faculty  
funded  
Radiology*

*Profs. Jianghong Rao (Radiology) and Sanjiv Sam Gambhir (Bioengineering, Radiology)*  
Tiffany designed small molecule probes for *in vivo* imaging of apoptosis. Because apoptosis takes place through activation of caspases, she planned to develop a bioluminescence imaging system that can directly image the activation of the caspases *in vivo*.



**Sergey Solomatin**  
*Bio-X Postdoctoral  
Fellowship 2005  
Stanford Faculty  
funded  
Chemistry*

*Profs. Steve Chu (Physics, Applied Physics) and Daniel Herschlag (Biochemistry, Chemistry, and Chemical Engineering)*  
Sergey's research will involve the use of single-molecule Fluorescence Resonance Energy Transfer (sm-FRET) to explore the folding dynamics of RNA. In the Herschlag and Chu labs, Sergey is using synthetic and characterization techniques to determine distance changes between labeled sites on a ribozyme molecule.



## Bio-X Fellows—Where are they now?

The Bio-X Fellowship Program has completed seven rounds of funding and has seen a number of students graduate and pursue their careers after Stanford. Below are some highlights from our recent graduates.

### **Amanda Malone, Ph.D.**

*Vice President and Director of Research and Development  
Auritec Pharmaceuticals, Inc.*

Auritec is a small self-owned pharmaceutical company specializing in improving the dosage dependence of FDA-approved drugs. Amanda writes grants and manages research projects which are aimed at reducing the effective dosages required for drugs which may be currently available on the market.

“The Bio-X Program and Fellowship allowed me to do riskier research for my Ph.D. because we didn’t have outside funding for that [specific] project. I think it directly contributed to the success of that work, specifically in the publication of the work in the Proceedings of the National Academy of Sciences.”

### **David Myung, Ph.D.**

*Co-founder and former president  
Biomimedica, Inc.*

Biomimedica, Inc., based in Berkeley, is an early stage, venture backed start-up developing a novel orthopaedic joint repair technology. The idea for the company came out of materials characterization work that David pursued during his graduate research while he was sponsored by the Bio-X Program.

“One of the many ways Bio-X led me to what I’m doing now is by getting me initially connected to people in the device and venture community, and these connections led to others that helped get the company started and funded.”

### **Leslie Meltzer, Ph.D.**

*Medical Information Manager  
Actelion Pharmaceuticals US*

Actelion is an emerging biopharmaceutical company that develops novel therapies for highly unmet medical needs. As the Medical Information Manager, Leslie oversees the team’s function of providing medical and scientific support to physicians and other healthcare providers, patients, and commercial colleagues in sales and marketing.

“The diversity of science [in Bio-X and the Clark Center] enables you to become a real generalist—to feel comfortable jumping into a new field. My work in Bio-X, the Neurosciences Program, and at Stanford allowed me to look for something interesting [when ready to graduate], knowing that I had the ability to learn quickly, solve problems, and work with researchers from many different fields.”



Bio-X Fellows 2008

## Graduated Bio-X Fellows

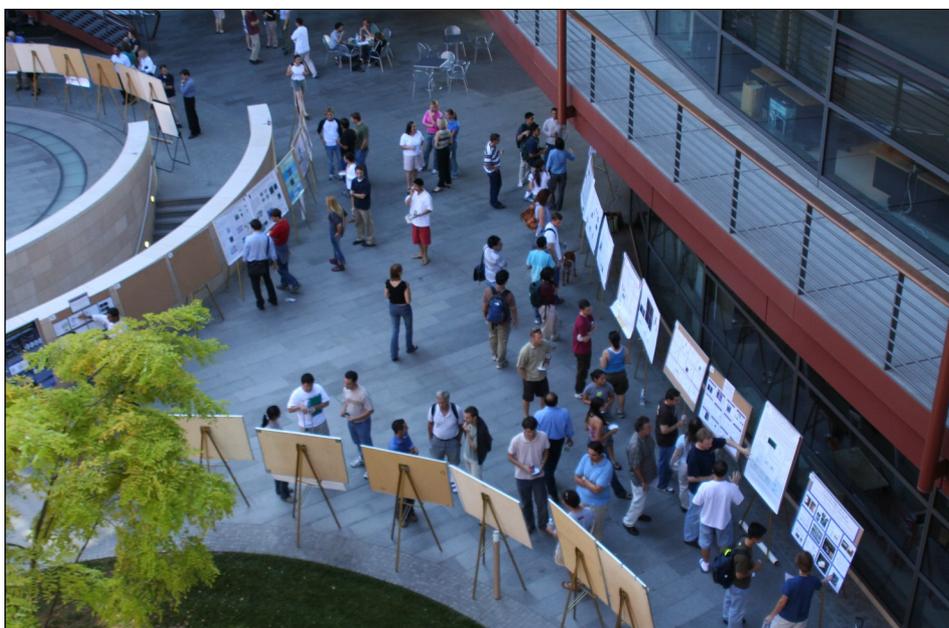
Student	Department	Degree Year
Namiko Abe	Neurosciences	2007
Afsheen Afshar	Electrical Engineering	2008
Georgios Asimenos	Computer Science	2009
Relly Brandman	Chemical & Systems Biology	2009
David Camarillo	Mechanical Engineering	2008
Ian Chen	Bioengineering	2008
Vincent Chu	Applied Physics	2009
Virginia Chu	Bioengineering	2009
Adam Grossman	Bioengineering	2010
Rachel Kalmar	Neurosciences	2010
Samuel Kim	Chemistry	2009
Andreas Loening	Bioengineering	2006
Amanda Malone	Bioengineering	2007
Leslie Meltzer	Neurobiology	2008
David Myung	Chemical Engineering	2008
Guillem Pratx	Electrical Engineering	2010
Aaron Wang	Bioengineering	2009
Larry Wang	Materials Science & Engineering	2008
Kitchener Wilson	Bioengineering	2010
Yufeng Yang	Neurosciences	2009
Sara Zhao	Mechanical Engineering	2005



Bio-X Fellows 2009

## Completed Bio-X Graduate Fellowships

Student	Department	Yr completed
Edith Arnold	Mechanical Engineering	2010
Jennifer Blundo	Mechanical Engineering	2009
Mindy Chang	Bioengineering	2008
Kelsey Clark	Neurosciences	2010
Sanjay Dastoor	Mechanical Engineering	2009
Sheng Ding	Bioengineering	2008
Jennifer Hicks	Mechanical Engineering	2010
Tyler Hillman	Genetics, Medicine	2010
Jacob Hughey	Bioengineering	2010
Kathryn Keenan	Mechanical Engineering	2009
Daniel Kimmel	Neurobiology	2009
Frances Lau	Electrical Engineering	2010
Stephen Lee	Bioengineering	2007
Prasheel Lillaney	Bioengineering	2008
Bertrand Lui	Bioengineering	2009
Murtaza Mogri	Bioengineering	2008
Sergio Moreno	Physics	2007
Jayodita Sanghvi	Bioengineering	2008
Min-Sun Son	Bioengineering	2010
Rebecca Taylor	Mechanical Engineering	2010
Jules VanDersarl	Materials Science & Engineering	2008
Angela Wu	Bioengineering	2009
Nan Xiao	Bioengineering	2010
Peggy Yao	Biomedical Informatics	2010



## Current Bio-X Fellows

Student	Department
Jaimie Adelson	Neurosciences
Aakash Basu	Applied Physics
Elsa Birch	Chemical Engineering
Mario Diaz de la Rosa	Chemical Engineering
Graham Dow	Biology
Alex Grant	Bioengineering
Lisa Gunaydin	Neurosciences
Haisam Islam	Bioengineering
Mihalis Kariolis	Bioengineering
Andrew Lee	Chemical & Systems Biology
Jonathan Leong	Neurosciences, MSTP
Ian Marshall	Civil & Environmental Engineering
Melina Mathur	Bioengineering
Joanna Mattis	Neurosciences
Cory McLean	Computer Science
Kathryn Montgomery	Bioengineering
William Noderer	Chemical Engineering
Andreas Rauschecker	Neurosciences, Psychology
Alia Schoen	Materials Science & Engineering
Mark Sellmyer	Chemical & Systems Biology
Joo Yong Sim	Mechanical Engineering
Rebecca Snyder	Bioengineering
Ryan Squire	Neurosciences
Ton Subsoontorn	Bioengineering
Jong Min Sung	Applied Physics
Grace Tang	Bioengineering
Noureddine Tayebi	Electrical Engineering
Yen-Hsiang Wang	Bioengineering
Brian Wilt	Applied Physics
Remus Wong	Bioengineering



Fellows Event

## Bio-X Endowed SIGF Fellows

<u>Student</u>	<u>Department</u>
Namiko Abe	Neurosciences
Limor Burszty	Electrical Engineering
Melinda Cromie	Mechanical Engineering
Remy Durand	Bioengineering
Viviana Gradinaru	Neurobiology
Daniel Kimmel	Neurosciences, Medicine
Liang Liang	Applied Physics
Bertrand Lui	Bioengineering
Li Ma	Statistics
Peter Olcott	Bioengineering
Shawn Ouyang	Chemical & Systems Biology
William Parsons	Chemistry
Aaron Wenger	Computer Science
Xiaoxue Zhou	Chemistry

## Industry and Donor Sponsored Awards

<u>Student</u>	<u>Department</u>
Jennifer Brady	(Skippy Frank Foundation) Microbiology & Immunology
Vincent Chu	(Pfizer) Applied Physics
Tiffany Chung	(Stanford Faculty funded) Radiology
Adam de la Zerda	(Skippy Frank Foundation) Electrical Engineering
Gaurav Krishnamurthy	(Medtronic Foundation) Mechanical Engineering
Elena Rykhlevskaia	(Lubert Stryer) Psychiatry
Sanaz Saatchi	(Amgen) Bioengineering
Shilpa Sambashivan	(Genentech) Chemical & Systems Biology
Sergey Solomatin	(Stanford Faculty funded) Chemistry
Tristan Ursell	(Genentech) Bioengineering

**Professor Carla Shatz**

Director of Bio-X

James H. Clark Center  
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cshatz@stanford.edu

**Heideh Fattaey, Ph.D.**

Executive Director of Operations and  
Programs

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**Olgalydia Urbano-Winegar**

Bioengineering Student Services  
Manager

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Bio-X Fellows 2010

**Bio-X Program**



To learn more about the Bio-X Program at  
Stanford, please visit the Bio-X website at:

<http://biox.stanford.edu>