



### **BIO-X “Frontiers in Interdisciplinary Biosciences”**

An introduction to cutting-edge research involving interdisciplinary approaches to bioscience and biotechnology, intended for both specialists and non-specialists. Organized and sponsored by the Stanford Bio-X Program. Three seminars each quarter address a broad set of scientific and technical themes related to interdisciplinary approaches to important issues in bioengineering, medicine, and the chemical, physical and biological sciences.

Leading investigators present the latest breakthroughs and endeavors that cut broadly across many core disciplines. Pre-seminars introduce basic concepts and provide background for non-experts. Registered students attend all pre-seminars in advance of the primary seminars, others welcome. Prerequisite: keen interest in all of science, engineering, and medicine with particular interest in life itself. Recommended: basic knowledge of mathematics, biology, chemistry, and physics. 1 unit, Aut, Win, Spr Quarters (Robertson)

#### **1999-2000**

**Steven Block**, Stanford University

“Using Optical Tweezers to Study Biological Motors”

**Axel Brunger**, Yale University

“Towards a Molecular Understanding of Neurotransmission”

**Stanley Prusiner**, University of California - San Francisco

“Dissecting the Etiologies of Degenerative Diseases & Developing Therapeutics through Studies of Prions”

**W.E. Moerner**, Stanford University

“Shedding Light on Single Biomolecules”

**Stuart Schreiber**, Harvard University

“Chemical Genetics”

**Daniel Branton**, Harvard University

“Nanopore Sequencing: Characterizing Single Molecules in Milliseconds”

**Mimi Koehl**, University of California - Berkeley

“Smelling with Hairy Little Noses and Feeding With Hairy Little Legs”

**Julie Theriot**, Stanford University

“Protein Polymerization and Force Generation in Cell Motility”

**John Doyle**, California Institute of Technology

“Robustness, Necessity and Biological Complexity”

#### **2000-2001**

**Richard Zare**, Stanford University

“Some Dreams of Using Mass Spectrometry for Proteomics”

**Mu-Ming Poo**, University of California, Berkeley

“Local and Distributed Synaptic Modifications in Neural Networks induced Patterned Stimulation”

**David Stuart**, University of Oxford, UK

“Piecing together how dsRNA viruses work as miniature, self-assembling, factories”

**Adam Arkin**, University of California, Berkeley  
"Comparative regulatory motif analysis in cellular sensing and switching"

**David Walt**, Tufts University  
"Optical Sensor Microarrays: From high throughput screening to artificial onfaction"

**Alice Gast**, Stanford University  
"Ordering in Two-Dimensions - Physical Chemistry Lessons from Proteins"

**Jeffrey Hubbell**, Swiss Federal Institute of Technology and University of Zurich  
"Materials-Based Therapeutics: Blending the Boundaries between the Drug and the Drug Carrier"

### **2001-2002**

**Ken Salisbury**, Stanford University  
"Robotic and Virtual Surgery"

**Irv Weissman**, Stanford University  
"Biology and Transplantation of Stem and Progenitor Cells"

**David Agard**, University of California, San Francisco  
"Tackling Cellular Structure in 3D: Pushing the limits of light and Electron Microscopy"

**Alexander Van Oudenaarden**, MIT  
"Challenging Physics Problems in Quantitative Biology: Noise, Self-organization, and Pattern Formation"

**Paul Rainey**, University of Oxford  
"The causes of ecological diversity: insights from experimental bacterial populations"

**Simon Tavare**, University of Southern California (Cancelled)  
"Mapping stem cell fates in the human colon: a statistical approach"

**Joanne Chory**, Salk Institute for Biological Studies  
"Light, brassinosteroids, and plant development"

**Stephen Harrison**, Harvard University  
"Putting together a virus ... and taking it apart"

**Jill Helms**, University of California-San Francisco  
"Mechanical Stimuli and Molecular Signals Mediating Skeletal Tissue Regeneration"

**Charles Turner**, Indiana University  
"Why isn't the human skeleton built to last?"

### **2002-2003**

**Krishna Shenoy**, Stanford University  
"Toward Neural Control of Prosthetic Devices"

**Larry S. B. Goldstein**, University of California San Diego /HHMI  
"Molecular Motor Proteins in Neuronal Signaling & Disease"

**Rama Ranganathan**, UT Southwestern/HHMI  
"Information Flow in Protein Molecules"

**Erik Winfree**, Caltech  
"Biomolecular Computing with DNA"

**Stephen Quake**, Caltech  
"Sequence, Structure, Function: A Journey in Biophysics from Technology to Science"

**Joachim Frank**, Wadsworth Institute/HHMI

"The Ribosome: Dynamics of Structure and Ligand Interactions as Inferred by Cryo-Electron Microscopy"

**Ralph Weissleder**, Harvard University

"Advances in Molecular Imaging"

**Anthony Atala**, Harvard University

"Tissue Engineering, Stem Cells and Cloning: Applications for Regenerative Medicine"

**Larry McIntire**, Rice University

"Effect of Mechanical Forces on Gene Expression in Vascular Cells: Implications for Tissue Engineered Arteries"

### **2003 – 2004**

**Michael Kahana**, Dept. Psychology, Brandeis University

"From Oscillations to Neuronal Activity - The Neurophysiology of Human Spatial Navigation"

**Kristi Anseth**, University of Colorado Boulder

"Engineering Gels to Control Cell Function and Tissue Development"

**Gene Myers**, University of California, Berkeley

"Efficient Algorithms for Comparing Genomes"

**Stuart Goodman**, Stanford University

"The Foreign Body Reaction to Orthopaedic Implants"

**Thomas V. O'Halloran**, Northwestern University

"Posttranslational Regulation of Superoxide Dismutase: Aggregation State control by Metals, Oxygen and the Copper Chaperone, CCS"

**Peter F. Davies**, University of Pennsylvania

"The Focal Origin of Atherosclerosis: Integration of genomics into hemodynamic endothelial Mechanotransduction *in vivo*"

### **2004-2005**

**Mark Denny**, Stanford University

"Calculating Catastrophes: The Probability and Consequences of Environmental Coincidence"

**Carolyn Larabell**, UCSF

"Cryo X-ray tomographic imaging of cells with synchrotron radiation"

**Frances Arnold**, Caltech

"Design by Directed Evolution"

**Wing Wong**, Stanford University

"Transcriptional profiling and cis-regulatory analysis in embryonic stem cells"

**Don Engelman**, Yale University

Special Seminar, "Folding and Evolution of Membrane Proteins"

**Christine Schmidt**, University of Texas at Austin

"Engineering Strategies for Functional Nerve Repair"

**Bernhard Palsson**, UCSD

"Bringing genomes to life: the use of genome-scale *in silico* models"

**Paul Thompson**, UCLA

"Analyzing Brain Changes in Alzheimer's Disease, Development, and Schizophrenia"

**John Spudich**, University of Texas

"Rhodopsins: Transducing Light to Biological Energy and Vision in the Microbial World"

**Rakesh Jain**, Harvard University  
"Imaging the inner workings of solid tumors: A 25 year odyssey"

## 2005-2006

**Chris Chen**, University of Pennsylvania  
"Forces, form and stem cell function: Mechanotransduction at the cellular and multicellular scale"

**James Miller**, Washington University in St. Louis  
"Nonlinear ultrasonic imaging: a tool for probing normal and diseased hearts"

**Giulio Tononi**, University of Wisconsin  
"Sleep and synaptic homeostasis: new ideas about sleep function"

**Mario Capecchi**, University of Utah  
"Gene Targeting into the 21st Century: Mouse Models of Human Disease from Cancer to Neuropsychiatric Disorders"

**Marius Clore**, NIH  
"Insights into recognition in transient macromolecular complexes using NMR"

**Subra Suresh**, MIT  
"Nanomechanics of living cells and human disease states"

**Daniel Chiu**, University of Washington  
"Single molecule methods for probing synaptic function"

**Ron Weiss**, Princeton University  
"Synthetic biology: from bacteria to stem cells"

**Jennifer Cochran**, Stanford University  
"Engineering Proteins for Therapeutic Applications"

## 2006-2007

**Andrew Link**, Vanderbilt University  
"Systematic Proteomic Analysis of Eukaryotic Translation Complexes"

**Channing Robertson**, Stanford University  
"Bio-X/Clark Center: The Beginnings"

**James Swartz**, Stanford University  
"Engineering Biology without Cells: Science and Applications"

**Kevan Shokat**, UCSF  
"Chemical Genetic Analysis of Normal and Disease Physiology"

**Sebastian Bonhoeffer**, ETH  
"Recombination and drug resistance in HIV-1: An evolutionary perspective"

**Tillman Gerngross**, Dartmouth College  
"Engineering the yeast secretory pathway for the production of human glycoproteins"

**Erich Jarvis**, Duke University  
"Insights from birdsong into the neurobiology of language"

**Xiaowei Zhuang**, Harvard University  
"Single-molecule and super-resolution optical imaging of biomolecules and cells"

**Danesh Moazed**, Harvard University  
"Chromosome-Associated RNAi and its Role in Heterochromatin Assembly and Function"

## 2007-2008

**Jennifer J. Kohler**, UT Southwestern Medical Center

"Glycosylation in the Golgi: Understanding and exploiting a biosynthetic machine"

**Taher Saif**, University of Illinois at Urbana-Champaign

"Cellular mechano-sensitivity – a new paradigm in the understanding of learning and memory"

**Annelise Baron**, Stanford University

"A biomimetic lung surfactant with peptoid analogs of the hydrophobic surfactant proteins"

**Alice Ting**, Massachusetts Institute of Technology

"Chemical reporters for live cell imaging"

**Tzung Hsiai**, University of Southern California

"Shear stress and oxidative stress: Implication for MEMS sensors"

**Bruce Rosen**, Department of Radiology, MGH

"Frontiers in Multimodal Brain Imaging"

**Benoit Roux**, The University of Chicago

"Free energy landscape and the function of biomolecules"

**Farshid Guilak**, Duke University

"Functional Tissue Engineering of Cartilage"

**Brenda Schulman**, St. Jude Children's Research Hospital

"Osteoarthritis and fat: The good, the bad, and the ugly"

## 2008-2009

**Matthew Rabinowitz**, Stanford University

"An Informatics Technology using Arrays for Reliable Single-Cell Genetic Diagnosis"

**Robert Seyfarth and Dorothy Cheney**, University of Pennsylvania

"Baboon metaphysics: The evolution of a social mind"

**Frans De Waal**, Emory University

"On the Possibility of Animal Empathy"

**Jonathan Weissman**, UCSF

"Genome-wide *in vivo* analysis of translation with sub-codon resolution by ribosome profiling"

**Terence Hwa**, UCSD

"On growth, antibiotics, and evolution"

**Judith Frydman**, Stanford University

"Molecular Origami: the complex art of protein folding in the cell"

**Ellen Kuhl**, Stanford University

"The Virtual Heart: A Multiscale Continuum Approach towards Computational Cardiology"

**Susan Mango**, The University of Utah

"Molecular basis of organ formation"

**Josh Sanes**, Harvard University

"Synaptic circuitry in the visual system"

## 2009-2010

**Denis Wirtz**, John Hopkins University  
“The biophysical basis of laminopathies”

**Nicole King**, University of California, Berkeley  
“Choanoflagellate morphogenesis, interspecies signaling and the origin of animal multicellularity”

**David Jaffray**, University Toronto  
“Advancing the Image-guidance Radiotherapy Paradigm: Investigations in Nanotechnology”

**Anthony Leonardo**, Janelia Farm Research Campus of the HHMI  
“Neuronal and behavioral dynamics underlying prey capture in the dragonfly”

**Bob Langer**, MIT  
“Biomaterials and biotechnology: From the discovery of angiogenesis inhibitors to the development of drug delivery systems and the foundation of tissue engineering”

**Eric Siggia**, Rockefeller University  
“Predicting the course of evolution”

**Peter Tyack**, Woods Hole Oceanographic Institute  
“Using electronic tags to discover how toothed whales echolocate to find and capture prey in the deep ocean”

**Joseph Wang**, UCSD  
“Can Man-Made Nanomachines Compete with Biomotors?”

**Joanna Aizenberg**, Harvard University  
“Bio-inspired, reconfigurable, “spiny” surfaces: En route for adaptive materials”

## 2010-2011

**Frank Bova**, University of Florida  
“20 years of Radiosurgery and Image Guided Surgery”

**Douglas A Lauffenburger**, MIT  
“Integrative Analysis of Biophysical and Biochemical Processes Governing Cell Migration”

**Daniel Beard**, Medical College of Wisconsin  
“Systems Analysis of Metabolic Function in the Heart—from Molecules to Cells to Whole-Organ Function”

**Dan Roden**, Vanderbilt University  
“Personalizing Medicine the Vanderbilt way”

**Fred Chang**, Columbia University  
“How cells divide in the middle”

**Gregory Petsko**, Brandeis University  
“Specific Inhibition of Nucleation of Alpha-Synuclein Aggregation As a Therapeutic Strategy for Parkinson's Disease”

**David Botstein**, Princeton University  
“Coordination of Growth Rate, Cell Cycle, Stress Response and Metabolic Activity in Yeast”

**David Weitz**, Harvard University  
“Fluctuations and dynamic arrest in cells”

**Peter Wolynes**, University of California, San Diego  
“Recent Successes of the Energy Landscape Theory of Protein Folding”

## 2011-2012

**Rafael Irizarry**, John Hopkins University  
Epigenetic variation as a driving force for development and cancer

**Barak Cohen**, Washington University in St. Louis  
Thermodynamic models of cis-regulation

**Kevin Haigis**, Harvard University  
In vivo systems biology of inflammatory signaling in the GI tract

**Mehmet Toner**, Surgery, Harvard  
Bioengineering and Clinical Applications of Circulating Tumor Cell (CTC) Chip

**Hang Lu**, Georgia Institute of Technology  
Microtechnologies for High-throughput High-content Developmental Biology and Neurogenetics

**Thomas Steitz**, Yale University  
From the Structure and Function of the Ribosome to New Antibiotics

**Jacob Schaefer**, Washington University, St. Louis, MO  
Carbon partitioning, metabolism, and cell-wall structure in leaves under elevated CO<sub>2</sub> conditions using in vivo <sup>11</sup>C and <sup>13</sup>C labeling

**Jonathan Stamler**, Case Western Reserve University  
Protein S-nitrosylation and potential for therapeutic allostery

**Steven Henikoff**, Fred Hutchinson Cancer Research Center  
Mapping genome-wide nucleosome dynamics

## 2012 – 2013

**Sebastian Seung**, MIT  
Relating activity and connectivity in neural networks

**Jay Groves**, University of California, Berkeley  
Spatial organization and the mechanics of signal transduction at the single molecule level

**Philipp Keller**, Janelia Farm Research Campus, Howard Hughes Medical Institute  
Reconstructing neural development

**Eero Simoncelli**, New York University  
Probing sensory representations with metameric stimuli

**Ratmir Derda**, University of Alberta  
Discovery of ligands from genetically-encoded libraries of synthetic molecules

**Jill Mesirov**, Broad Institute  
Computational Approaches to Genomic Medicine

**Douglas DeSimone**, The University of Virginia  
Mechanical Force and the Regulation of Morphogenesis

**David Haussler**, UC Santa Cruz  
Big data and new models needed to study DNA variation in evolution and cancer

**Lloyd Minor**, Stanford University  
Navigating the Labyrinth of the Inner Ear: Achieving "Balance" as a Clinician Scientist