

Molecular, Cellular & Systems Engineering

- *sequence-structure-function relationships of cell surface receptors and ion channels*
- *mechanisms of protein-protein and protein-DNA interactions*
- *protein aggregation, self-assembly and protein homeostasis*
- *engineering approaches to model and manipulate biological systems and networks*

Biological systems are complex and are built on interactive hierarchical structures, which are encoded by genetic information and respond to cues through an intricate network of regulatory and signaling networks. These networks display emergent properties through non-linear control and dynamical responses that span multiple length and time scales. Complex diseases such as aging-related disorders, cardiovascular diseases, and cancers are associated with aging-related degradation or catastrophic failures of protein-protein and protein-nucleic acid interaction networks. The development of modern therapeutics requires an integrated approach that builds on structure-function relationships at the molecular and cellular levels, and predicting/anticipating emergent properties / responses at the tissue/system level.

The Molecular Cellular & Systems Engineering (MCSE) thrust within Biomedical Engineering brings together a group of individuals within and beyond the department who study interactions and dynamics at the molecular and cellular level to enable phenotyping, manipulation, and engineering of complex biological systems. The approaches include a combination of biophysical studies that focus on molecular & cellular interactions, self assembly, high throughput genomic and proteomic methods, advanced imaging methods, and multiscale computational methods.

PROGRAM OF STUDY

Students in the program must satisfy general Biomedical Engineering Department degree requirements. Recommended electives can be selected from the following list:

BME 521 Kinetics of receptor-mediated processes

BME 537 Computational molecular biology

BME 559 Intermediate biomechanics

BME 572 Biological neural computation

PROGRAM FACULTY

Jan Bieschke, Ph.D., Mechanisms of neurodegeneration, macromolecular self-assembly and proteostasis networks

Michael Brent, Ph.D., *Bioinformatics and systems biology*

Barak Cohen, Ph.D., Evolution of complex traits; Synthetic Biology for Engineering Gene Expression

Jianmin Cui, Ph.D., *Ion channel structure-function relationship, biophysics of ion channels*

John Cunningham, Ph.D., Machine learning for neural systems; network models for motor cortex computation

Gautam Dantas, Ph.D., Antibiotic resistance, synthetic biology, Human microbiome, metagenomics;

James Havranek, Ph.D., DNA-binding specificity; Computational design of novel protein-nucleic acid interfaces

Jin-Moo Lee, M.D./Ph.D. Plaque formation and processing in Alzheimer's disease and cerebral familial angiopathy

Timothy Lohman, Ph.D., Helicase-catalyzed DNA unwinding and ssDNA translocation, ssDNA-protein interactions

Garland Marshall, Ph.D., *Molecular design, protein structure and function*

Robi Mitra, Ph.D., *High throughput diagnostics and DNA sequencing*

Kristen Naegle, Ph.D., Control of signaling networks by post-translational modifications, machine learning methods

Colin Nichols, Ph.D., *Molecular aspects of potassium channels*

Rohit Pappu, Ph.D., *Protein aggregation in neurodegeneration, transcriptional regulation by disordered proteins*

Jay Ponder, Ph.D., *Computational chemistry and algorithm development*

Barani Raman, Ph.D., Receptor-mediated processing of complex sensory signals, neuromorphic engineering

Jin-Yu Shao, Ph.D., *Blood coagulation, cell and tissue mechanics, inflammation, molecular biomechanics*

Joseph Henry Steinbach, Ph.D., Function of transmitter-gated membrane channels, Pharmacology, Synapse Biology

Gary Stormo, Ph.D., *Protein-DNA interactions, RNA structure, mathematical modeling*

S. Joshua Swamidass, M.D., Ph.D., High throughput screening, machine learning, Cheminformatics

Larry Taber, Ph.D., *Morphogenesis theory & modeling, heart & brain development*

Xiaowei Wang, Ph.D., Gene targeting by miRNAs, Role of miRNA in cancer development