Cardiovascular Engineering

- *bio-pacemakers*
- *cardiovascular development*
- *vascular cell mechanics*
- *new paradigms for defibrillation*
- *mechanisms of cardiac arrhythmias*
- *electrocardiographic imaging*

Cardiovascular Engineering integrates physiology, cell and molecular biology, bioelectricity and biomechanics to describe, understand, and re-engineer the cardiovascular systems. The goal is to develop, test, and validate a quantitative and predictive understanding of the systems from an engineering standpoint and to apply that understanding toward the solution of biomedically-relevant problems.

An important feature of this program is its multidisciplinary approach to the study of these systems. Research interests range from the study of ion channels and their protein structure, blood, cardiac, and vascular cells to the human cardiovascular systems in vivo. Topics currently under investigation include: the relationship between the electrical and mechanical activity of the heart; characterizing the electro-mechanical properties of cells and tissue comprising the heart wall; studying the properties and interactions of blood cell surface structures with receptors on endothelial cells, computational modeling of the developing and adult heart during health and disease, developing methods for targeted imaging of heart and vessels, understanding the biochemical and mechanical factors underlying angiogenesis, and describing function at the cellular and organ level with various imaging methods including acoustic, biophotonic, magnetic resonance, and electrocardiographic imaging.

PROGRAM OF STUDY

Program students are expected to take four to six courses in the first year in accordance with the general regulations of the department. The following courses are among those from which students in this program can select:

BME 471 Bioelectrical Phenomena

ESE 482 Digital Signal Processing

MAE 533, 534 Fluid Dynamics I & II

MAE 546 Finite Element Analysis

MAE 547 Advanced Finite Element Analysis

BME 556 Experimental Methods in Biomechanics

BME 557 Cell and Subcellular Biomechanics

BME 559 Intermediate Biomechanics

BME 562 Mechanics of Growth and Development

BME 567 Cardiac Mechanics

BME 568 Cardiovascular Dynamics

BME 573 Applied Bioelectricity

BME 575 Molecular Basis of Bioelectrical Excitation

PROGRAM FACULTY

Philip V. Bayly, Ph.D., *Nonlinear dynamics; quantitative characterization and modeling of brain trauma and development*

Jianmin Cui, Ph.D., *Ion channels in physiology and disease*

Igor R. Efimov, Ph.D., *Mechanisms and therapy of arrhythmia, implantable stimulators, antiarrhythmic therapy, cardiacbioelectric devices, biophotonic imaging*

Sandor J. Kovacs, M.D., Ph.D., *Cardiovascular biophysics, mathematical modeling of diastolic function*

Gregory Lanza, Ph.D., *Targeted contrast agents, molecular imaging*

James G. Miller, Ph.D., *Physical acoustics, cardiac material properties and mechanics, cardiac biophysics*

Jeanne Nerbonne, Ph.D., *Regulation of membrane excitability, structure and function of ion channels*

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

Yoram Rudy, Ph.D., *Cardiac electrophysiology, modeling of the cardiac system, cellular electrophysiology and communication in the heart*

Jin-Yu Shao, Ph.D., *Mechanical properties of white blood cell microvilli, receptor-ligand mechanics*

Larry A. Taber, Ph.D., *Mechanics of cardiovascular and brain development*

Samuel A. Wickline, M.D., *Physical acoustics, cardiac and vascular material properties and mechanical function*

Pamela Woodard, M.D., *CT/ MR cardiac imaging*