

THE INSTITUTES AT NORTHWESTERN MEDICINE

# NORTHWESTERN UNIVERSITY FEINBERG SCHOOL OF MEDICINE CENTER FOR MOLECULAR CARDIOLOGY



# CENTER FOR MOLECULAR CARDIOLOGY

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Cardiovascular disease (CVD) remains the number one cause of death in the United States. Approximately 610,000 people die of cardiovascular disease every year, accounting for one in every four deaths. In 2016, the economic cost of CVD was an astounding \$207 billion.<sup>1</sup> Although we have made significant progress in our treatment of cardiovascular disease, there is an urgent and unmet need to develop new treatments to reduce the immense burden on patients, families, and society.

### Center for Molecular Cardiology

The Center for Molecular Cardiology (CMC) at Northwestern University Feinberg School of Medicine is one of the premier molecular cardiology research centers in the world. At Northwestern, we have designed a center to address unmet needs in cardiovascular research. The Center houses the research enterprise of world-renowned cardiac scientists and provides a supportive training environment for future leaders in this field. Currently, the Center houses 15 full-time research and clinical faculty. The Center's mission is to accelerate improvement in cardiac care for patients by leveraging the collaborative breakthroughs from our interdisciplinary team of scientists. We fulfill our mission through collaborative research across disciplines, training future leaders in the field, and disseminating our findings globally to molecular cardiologists.

CMC director, Dr. Hossein Ardehali, is a professor of Medicine-Cardiology and Pharmacology, as well as the senior associate director and chair of Admissions for the Medical Scientist Training Program at Northwestern University. Since his move to Northwestern University more than a decade ago, Dr. Ardehali has been successful in obtaining independent grant funding and in mentoring trainees who have moved on to become successful independent investigators. Dr. Ardehali's research focuses on the role of mitochondria and metabolism in cardiovascular disease, with a particular emphasis on the role of mitochondrial iron in this process. He has published manuscripts in several journals, including *Cell Metabolism*, *Journal of Clinical Investigation*, *Proceedings of the National Academy of Sciences* or *PNAS*, and *EMBO Molecular Medicine*.



“Through our Center for Molecular Cardiology, we are leading breakthrough, cutting-edge research to create more effective diagnostic tools and treatments for various cardiovascular diseases, including heart failure and coronary artery disease.”

Hossein Ardehali, MD, PhD, FACC, FAHA, Professor of Medicine-Cardiology, Professor of Pharmacology, Senior Associate Director and Chair of Admissions, Medical Scientist Training Program, and Director of the Center for Molecular Cardiology

### CMC Research Areas

#### Cardiac Metabolism

We recently discovered novel mechanisms to regulate energy production and utilization in the heart. Through this, we also have determined the role of certain proteins in improving energy efficiency of the heart. These findings are transformational since those with heart failure have hearts that are “energy starved.” Future research in this area has the potential to dramatically improve patient care.

#### Collaborative research:

- Includes studies analyzing the role iron plays in heart disease. We know that too much iron causes heart disease, thus studies are being conducted to assess the effects of iron reduction in cardiovascular disease.

#### Cardiac Regeneration

Our scientists utilize pluripotent stem cells that are generated from a patient's blood. This powerful approach allows us to study the molecular basis of various cardiovascular disorders and determine whether novel therapies can be developed to treat these disorders.

#### Collaborative research:

- Includes determining how anti-cancer drugs cause damage to the heart. We analyze this by using human-induced pluripotent stem cells from patients with a previous history of cardiac toxicity due to cancer drugs.
- Includes using human-induced pluripotent stem cells to uncover the molecular basis of atrial fibrillation and other cardiac arrhythmias to improve diagnosis and treatment.

#### Cardiac and Vascular Development

The molecular pathways of heart development are not well understood. We know that the mRNA binding proteins and certain other proteins play critical roles in this process. A better understanding of vascular development may shed light into the causes of heart failure.

### ***Collaborative research:***

- Includes studying vascular and heart development in different stages of embryonic development, and using stem cell differentiation to determine which genes play a role in development.

### **Cardiac Aging**

The molecular mechanism of heart aging is not known. We have evidence that plasminogen activator inhibitor-1 (PAI-1) protein and iron accumulation contribute to aging.

### ***Collaborative research:***

- Includes studying the effects of various reagents and genetic modifications on the young and aging heart.

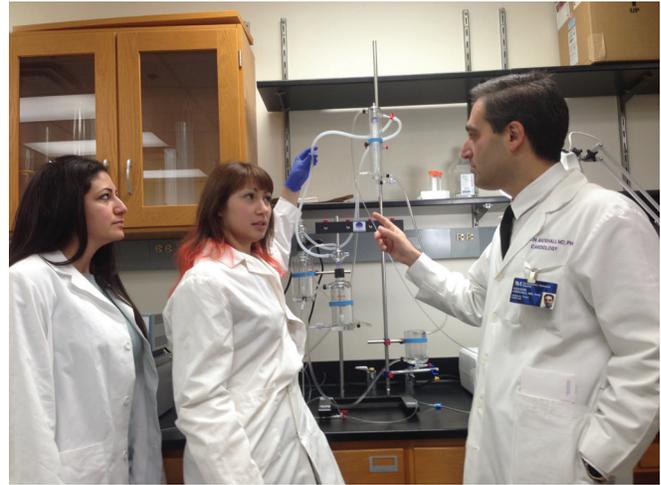
In addition to our research, our Cardiovascular Genetics Program provides personalized medicine and genetic screening for those with a high risk of developing cardiovascular disease or a family history. Ultimately, we are striving to prevent the onset of illness.

### **Scientists Charting a New Course**

The following members of the Center for Molecular Cardiology are conducting cutting-edge research to create more effective diagnostic tools and treatment for various cardiovascular diseases, including heart failure and coronary artery disease:

#### **Hossein Ardehali, MD, PhD, FACC, FAHA Professor of Medicine-Cardiology, Professor of Pharmacology, Senior Associate Director and Chair of Admissions, Medical Scientist Training Program, and Director of the Center for Molecular Cardiology**

Dr. Ardehali is an internationally recognized scientist studying the metabolic basis of cardiovascular disease and cardiac regeneration. He has received several awards, including the American Heart Association (AHA) Basic CV Sciences Young Investigator Award, the Jeremiah Stamler Distinguished Young Investigator Award, and the Schweppe Foundation Award. He is a fellow of the AHA and the American College of Cardiology, and serves on numerous AHA committees, including the AHA Basic CV Sciences Leadership Committee and the AHA Council Operations Committee. He is the secretary-treasurer of the American Society for Clinical Investigation and has been nominated by the National Heart, Lung, and Blood Institute for the Presidential Early Career Award for Scientists and Engineers twice in the past.



#### **Rishi Arora, MD, Associate Professor of Medicine-Cardiology**

Dr. Arora's research focuses on understanding the molecular mechanisms underlying atrial fibrillation, which is the most common heart rhythm disorder. His laboratory examines the role that the autonomic nervous system, fibrosis, and oxidative stress have on the development of an atrial fibrillation substrate.

#### **Paul W. Burridge, PhD, Assistant Professor of Pharmacology**

Dr. Burridge's research concentrates on modeling chemotherapy-induced cardiomyopathy and heart failure using human-induced pluripotent stem cell-derived cardiomyocytes, endothelial cells, and fibroblasts. This allows recapitulation of a patient's off-target cardiotoxic response to drugs such as anthracyclines and tyrosine kinase inhibitors.

#### **Alfred George, MD, Magerstadt Professor and Chair, Department of Pharmacology**

Dr. George's research program is focused on the structure, function, pharmacology, and molecular genetics of ion channels in the heart. His laboratory has contributed greatly to understanding the mechanisms by which ion channel mutations cause a variety of inherited disorders of membrane excitability, including congenital cardiac arrhythmia susceptibility.

#### **Tsutomu Kume, PhD, Professor of Medicine-Cardiology and Pharmacology**

Dr. Kume's research interests focus on cardiovascular development and disease, cardiovascular stem/progenitor cells, and vascular biology.

**Daniel C. Lee, MD, MSC, FACC, Assistant Professor of Medicine-Cardiology and Radiology**

Dr. Lee is a cardiologist specializing in MRI who has led many multi-institutional studies. He serves as co-director of Cardiovascular Magnetic Resonance Imaging and director of the Northwestern University Cardiovascular Imaging Core Laboratory within the Center for Molecular Imaging.

**Elizabeth M. McNally, MD, PhD, Director of the Center for Genetic Medicine, Elizabeth J. Ward Professor of Genetic Medicine, and Professor of Medicine-Cardiology and Biochemistry and Molecular Genetics**

A world-renowned cardiovascular geneticist, Dr. McNally was recruited to Northwestern from the University of Chicago in 2014. Dr. McNally is a practicing clinical cardiologist and treats patients with inherited cardiomyopathies, Marfan Syndrome, inherited arrhythmia syndromes such as Long QT, and early onset coronary artery disease.

**Paul T. Schumacker, PhD, Professor of Pediatrics-Neonatology, Medicine-Pulmonary and Critical Care, and Cell and Molecular Biology**

Dr. Schumacker seeks to advance scientific knowledge related to the cellular and molecular mechanisms that underlie cardiac, vascular, and pulmonary diseases. A central focus of his laboratory has been directed at understanding the mechanisms of oxygen sensing that allow vascular, cardiac, and lung cells to detect changes in oxygen availability.

**Sanjiv J. Shah, MD, Associate Professor of Medicine-Cardiology**

Dr. Shah's research focuses on the development, pathophysiology, and treatment of heart failure with preserved ejection fraction, including diastolic heart failure and pulmonary hypertension. His research studies span from basic physiologic studies to clinical physiologic studies to epidemiologic studies.

**Edward B. Thorp, PhD, Assistant Professor of Pathology**

Dr. Thorp's laboratory is focused on cardiovascular wound healing. This includes the causes and consequences of inflammation resolution after ischemic injury in the myocardium, and secondary atherosclerosis. Additionally, the Thorp laboratory studies how hypoxia, metabolic, and lipid perturbations affect CV inflammation.

**Douglas E. Vaughan, MD, Irving S. Cutter Professor and Chair, Department of Medicine**

The main focus of Dr. Vaughan's research is the role of PAI-1 in a variety of biological and pathological processes, including thrombosis, cardiac fibrosis, and aging. He also has been very active in developing PAI-1 antagonists for clinical applications.

**J. Andrew Wasserstrom, PhD, Jules J. Reingold Professor of Medicine**

Dr. Wasserstrom's research is focused on normal and abnormal intracellular calcium cycling in different models of cardiac arrhythmias and heart failure. His laboratory uses high-resolution confocal imaging to study calcium cycling in the heart.

**Lisa D. Wilsbacher, MD, PhD, Assistant Professor of Medicine-Cardiology**

The goal of Dr. Wilsbacher's research is to define key signaling pathways in cardiac development and cardiomyocyte maintenance in the setting of pathological stress. Currently, the laboratory investigates a G protein-coupled receptor protein and its unexpected role in cardiomyocyte proliferation and cardiac development.

**Ming Zhao, PhD, Associate Professor of Medicine-Cardiology**

Dr. Zhao has expertise in molecular imaging in the heart and the vasculature. He is experienced in multi-modality imaging technology development for clinical translation.

**A Call for Your Support**

We recognize that every positive contribution we have made to discovery, care, training, and outreach in the field of cardiology has been made possible by donors who entrusted us with their philanthropic support. We invite interested friends to join us in propelling the compelling research and training efforts of the **Center for Molecular Cardiology** through gifts of outright support and endowment.

<sup>1</sup> Mozzafarian D, Benjamin EJ, Go AS, et al. on behalf of the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics—2016 update: a report from the American Heart Association. *Circulation*. 2016;133:e38-e360.

**For more information about supporting the Center for Molecular Cardiology, please contact:**

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