Cardiovascular Biology: From Molecules to Man

Pioneering Research

Cardiovascular researchers at the University of Missouri-Columbia head vibrant, innovative, well-funded, productive, and highly interactive research teams focusing on critical questions in cardiovascular biology. These scientists use state-of-the-art techniques to learn the causes of cardiovascular disease at the cellular, molecular, and genetic levels. What they discover is integrated at the whole organ level and translated into patient care. For example, these researchers are defining basic mechanisms through which blood flow is controlled to develop drugs and therapies to treat disorders such as heart failure, stroke, diabetes, peripheral vascular disease, and restenosis. A world-class program in exercise biology examines the impact of lifestyle interventions on the mechanisms, incidence, and severity of cardiovascular disease. Emerging areas of interest focus on nanomedicine, stem cell therapy, and regenerative medicine to treat patients.

Multidisciplinary Approaches

The success of the cardiovascular research enterprise at the University of Missouri-Columbia results from a unique approach to research. A cross-section of investigators from many fields and disciplines focus their efforts on one disease. These scientists and clinicians represent more than 20 specialties, from genetics to pharmacology and physiology to preventive cardiology, attacking cardiovascular problems through basic research, clinical investigation, and discovery-based patient care.

Translating Discoveries from the Bench to the Bedside

Despite major advances in treatment, cardiovascular disease remains the leading cause of death in both men and women in our nation. A key goal of Cardiovascular Research at the University of Missouri-Columbia is to translate discoveries made at the laboratory bench to clinical treatment of patients afflicted with cardiovascular disease. Working together, scientists and clinicians bring their unique perspectives to generate novel ideas and reduce the time it takes to translate discoveries from the laboratory to new treatments for patients.

Advanced Technology

State-of-the-Art Imaging

- Atomic Force Microscopy can quantify binding forces between adhesive molecules expressed by vascular tissue and the extracellular matrix or circulating cells, examine cell topography, and study cell mechanics and mechanotransduction mechanisms.
- TIRF and FRET Microscopy is used to localize molecules at the nanometer scale, providing a means to study their physical interactions and co-regulatory signaling functions.
- Multi-Photon and Confocal Microscopic Imaging are powerful techniques to optically section cardiovascular tissue, allowing signaling events and protein distributions to be 3-dimensionally visualized in subcellular structures.
- Quantitative Fluorescence Microscopy is used to examine vasomotor responses in arterioles, fluid and solute exchange in capillaries, and adhesive interactions between circulating cells (leukocytes, platelets, tumor cells) and postcapillary venules in the living microcirculation.
- Micro-PET, Micro-CT, and Bioluminescence Imaging allows for non-invasive visualization of metabolic events, fine detail of anatomical structures, cell localization, and changes in gene expression in the same animal over extended periods of time.
- Time-lapse Videomicroscopy is employed to examine the mechanisms of endothelial tube formation and cell invasion in 3-dimensional constructs of the extracellular matrix that surrounds blood vessels.
- Intravascular Ultrasound permits non-invasive assessment of atherosclerotic plaque progression, intimal/medial thickness, and vascular reactivity testing.
- Patch Clamp Analysis is applied to examine signaling mechanisms that modulate ion fluxes across channels in vascular smooth muscle and endothelial cell membranes.
- Laser Capture Microdissection is used to isolate single cells from the complex internal milieu of the vascular wall, skeletal muscle, and heart.

Molecular Methods such as qRT-PCR and Western blot analysis, protein and gene transfection, microarrays, electrophoretic mobility shift assays, and siRNA approaches are used to quantify and modulate gene expression in vascular cells and intact microvessels.

These techniques are applied in cell culture models, isolated arterioles and venules, isolated organelles, skinned cardiac myocytes, isolated organs ex vivo, intact microvascular networks, whole animals, and in some cases, human subjects.

Unique Animal Models

The University of Missouri – Columbia is one of a handful of research institutions that have Schools of Medicine and Veterinary Medicine located on the same campus. This allows our cardiovascular researchers to collaborate with experts in animal science to develop models of cardiovascular disease in pigs, a species whose cardiovascular system is very similar to humans. In addition, mutant mice, rats, and pigs that lack or overexpress specific gene products and chimeric animals developed from these animals are used to probe the functions of the genes and proteins of interest.

The UNIVERSITY of MISSOURI
Training the Next Generation

For those interested in pursuing a career in biomedical research, our quest for research excellence and emphasis on continued development and expansion of research programs serves to ensure a stimulating and nurturing environment for producing the next generation of highly competitive biomedical scientists. Our nationally recognized programs for doctoral and postdoctoral education are supported by three prestigious NIH Training Grants, one of which has been continuously funded for nearly 30 years. The second training grant focuses on cardiovascular adaptations to exercise training. Our newest training grant couples guidance under the direction of a physician, an "inventor" scientist, and a biomedical investigator with the goal of developing a clinically relevant device or approach as the dissertation project.

We offer both Masters and Doctoral degree programs in the disciplines of Pharmacology and Physiology and in Biomedical Sciences. We are committed to the preparation of students for rewarding research careers in academia, industry, or government. Entering students will take core courses to broaden their fundamental knowledge in physiology, pharmacology, molecular and cellular biology, and biochemistry. From that point forward, each student's course of study and experimental work are designed to provide a program that best develops capabilities in their area of interest. Taking advantage of our unique cross-disciplinary interactions, the student can choose laboratories located in Medical Pharmacology and Physiology, Internal Medicine, Biomedical Sciences, Dalton Cardiovascular Research Center, Center for Diabetes and Cardiovascular Health, Bioengineering, Life Sciences Center, or the VA Hospital.

Our major emphases are to teach students how to: 1) pose relevant research questions in the form of hypotheses; 2) design experiments that rigorously address these postulates; 3) organize, analyze, interpret, and present research findings; 4) compose scientific manuscripts for publication; and 5) prepare research grant applications. We also emphasize the development of communication skills by our students who typically present department seminars and posters at national meetings. Our approach to graduate education provides the intellectual framework necessary for understanding the integrative function of living organisms at the molecular, cellular, organ, and whole body levels and how these findings translate to clinical medicine in the form of new treatment modalities for patients afflicted with cardiovascular disease.

Columbia, MO

The cardiovascular research and educational activities outlined herein occur in a thriving and expanding university environment in a delightful, family-oriented "college town" that is repeatedly listed in the Top Cities to Live in America. Located halfway between St. Louis and Kansas City, Columbia offers a wide variety of outdoor activities, eclectic dining, diverse cultural events, a lively music scene, and renowned NCAA collegiate sports. Affordable housing is located within walking distance or very short commutes to the centrally located campus, which is situated immediately adjacent to the bustling downtown shopping, business, and restaurant district.

Contact Us

On behalf of the large cadre of cardiovascular scientists at the University of Missouri-Columbia, we encourage you to explore our programs and the exciting research and educational opportunities we offer.

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