Discovering the Link Between Vascular Control, Age, and Cardiovascular Disease

As the leading cause of death for both men and women, cardiovascular disease affects over 80 million people each year in the United States. Dr. Frank Dinenno, assistant professor in the School of Biomedical Engineering (SBME) and the Department of Health and Exercise Science, is studying the effects of aging on vascular regulation to gain a better understanding of cardiovascular disease. Many investigators have focused on either the effects of aging on sympathetic nervous system activity at rest and in response to various stressors, or the effects of aging and/or disease on endothelial dysfunction. Dinenno's research attempts to integrate how these two very powerful modulators of vascular tone interact to regulate blood flow and oxygen delivery to peripheral tissues (e.g. skeletal muscle). Working with a team of graduate students, Rick Carlson (research associate), and Dr. Wyatt Voyles, M.D. (Heart Center of the Rockies), Dinenno is seeking to understand the regulation of blood flow and oxygen delivery to skeletal muscle in humans. More specifically, the research is designed to understand how advancing age impacts the “normal” control mechanisms observed in young subjects. Research has found that aging is associated with many changes in the integrative control of the circulation such that blood flow and oxygen delivery to peripheral tissues are compromised in older adults during various physiological stressors. Dinenno’s research is funded through three NIH grants, two from the National Institute on Aging, and one from the National Heart, Lung, and Blood Institute.

State-of-the-art equipment allows for sophisticated and accurate measures of cardiovascular function.

“We believe it is important to understand how aging affects vascular regulation since older adults are characterized by a reduction in exercise capacity and are at greater risk of developing ischemic heart and cerebrovascular disease.”
- Dr. Frank Dinenno

Alumni Spotlight: Maile Ceridon
Traveling the World for Science

It is not every engineer that gets to study at both NASA and in Antarctica, but Maile Ceridon is no ordinary engineer. This Mayo Clinic graduate student has had opportunities of a lifetime, starting at CSU.

While an undergraduate at CSU, Maile worked with Dr. Susan James in the Rocky Mountain Materials Research Lab. She participated in research studying friction and wear between different components of hip and knee replacements. While a sophomore and junior at CSU, she helped build a device that simulated micro gravity that later was tested on NASA’s “vomit comet.” Specifically, she completed mechanical testing on the different polymers modified to reduce friction. Maile continued her research career as a cooperative education student for NASA, where she studied constant force resistant exercise units.

Her favorite part of CSU was the atmosphere. “Even as an undergrad the professors listened to what I could contribute. If I was motivated enough, my professors were always there to guide me in specific directions,” Maile said.

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Katrina Easton would be celebrating graduation. Instead, Katrina’s research with Dr. Chris Kawcak involves the fetlock, or metacarpo-phalangeal joint, the most commonly injured joint in race-horses. She is using \textit{in-vivo} and \textit{in-nitro} methods and finite element analysis to better understand the biomechanics of the joint and determine factors predisposing horses to catastrophic injuries. Katrina enjoys backpacking, running, and snowshoeing, and hopes to improve her climbing this summer.

Susan Yonemura came to CSU after a successful career in the technology industry. She saw a Ph.D. as an opportunity to do research with practical implications, “where the value of her work would not be determined by profits alone.” The inter-disciplinary Ph.D. program appealed to Susan’s desire to understand clinical problems and apply engineering knowledge, develop solutions and improve quality of life for patients.

During her rotation with Dr. Matt Kipper, Susan focused on surface modification for implants. She gained a better appreciation for controlling tissue interfaces which she can apply in her dissertation research with Dr. Sue James, developing improved treatments for intervertebral disc disease. Susan plans to return to the industry setting and looks forward to having a direct impact on bringing new treatments to market. She also plans to spend more time training and entering competitions with her two standard puddles and reading a few good novels.

Through internship experiences in his bachelor’s program, Tim Ruckh discovered his passion for in the biomedical industry.

After completing his master’s in mechanical engineering, Tim knew he wanted to continue to do research. Industry leaders advised him that obtaining his ideal research position would require him to earn his Ph.D.

Tim is completing rotations this semester with Drs. Matt Kipper and Ketul Popat, his Ph.D. co-advisors. “Lab rotations exposed me to areas of research that were completely different than my master’s research and I have gained a more diverse skill set,” explains Tim. The rotations create flexibility for him to propose projects and conduct research in his area of interest.

Tim’s research focuses on electro-spinning of materials to create thin fibers similar to those in the extracellular matrix. He hopes to create a material that will stabilize growth factors. Tim currently plans to enter industry after earning his Ph.D. However, faculty have advised him that as he nears graduation, academia may become more appealing.
Alumni Spotlight
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even though she is currently a graduate student at the Mayo Clinic, Maile can count on her former CSU professors to be quick with a letter of recommendation or an idea for a reference on a particular topic. Maile’s advice for incoming undergrads includes: “Find something that you really enjoy and go after it. If something sparks your interest along the way, don’t hesitate. Ask how to get involved and put yourself in a position to learn more and have a new experience. Ask questions and be aggressive about your education and your knowledge.” She also mentioned that students should enjoy Fort Collins, the mountains, and the opportunity to play outside most days of the year.

Following her graduation from CSU, Maile accepted a fellowship to pursue a Ph.D. in the Department of Physiology and Biomedical Engineering at the Mayo Clinic in Rochester, Minnesota—an institution that only accepts 20-30 graduate students a year. Her research focus is on bronchial circulation and blood flow to the non-gas exchanging airways, specifically researching this circulation in heart failure patients versus healthy patients. Maile is researching changes in pulmonary function as well as functional abnormalities, regulation of flow through the bronchial circulation, and the cost and work of breathing.

Her graduate research has allowed her the opportunity to travel to Antarctica with current mentor, Dr. Bruce Johnson. While in Antarctica, Maile was part of a team studying acute hypoxia, determining whether genetic or biochemical markers predetermined altitude sickness. For six weeks the team took blood samples and collected data on pulmonary function, blood pressure, heart rate and other physiological functions, comparing samples across people and locations. The team is currently analyzing the data. Maile’s favorite part of the project was “being able to study science while being in Antarctica.”

Her advice for graduate students is to “stay involved in something outside of your work. Graduate school is hard and it is easy to get caught up in the culture of just science, but you need to maintain something of yourself and your identity. Get involved in something outside of your work, and keep your life balanced.”

Maile believes the CSU faculty were key in getting her interested in biomedical engineering and that the program gave her a solid logical and scientific basis for solving problems in the Mayo Clinic.

As for the future, Maile intends to complete a post doctoral fellowship, after which she plans to remain in research and academia.

Dr. Susan James Hails from New Zealand

D r. Susan James, director of CSU’s School of Biomedical Engineering, is spending a year at the University of Canterbury developing an international, collaborative research effort between UC’s Centre for Bioengineering and the School of Biomedical Engineering at CSU. The team, including Professor James, Senior Lecturer Dr. Mark Staiger, from UC’s Mechanical Engineering Department, and Dr. Tim Woodfield from the Biomaterials and Tissue Engineering (BioMATE) research group within UC’s Centre for Bioengineering has just been awarded $26,000 from the Brian Mason Scientific and Technical Trust to kick start the research.

The team is leading a project that will take the first steps towards replicating the structural and physiological properties of the human intervertebral disc. Dr. Staiger explained that in most developed countries, lower back pain is the leading cause of chronic disability in adults aged 18-45, and absenteeism due to back pain is second only to the common cold. “The commercial market for solutions to lower back pain continues to grow and researchers are now trying to develop biomimetic intervertebral disc replacements that mimic the natural disc and can be used as a clinical alternative to spinal fusion,” Dr. Staiger said. “The UC project aims to replicate the properties of the disc using novel biomimicking methods and biomaterials with the aim of producing a replacement for degenerated or damaged discs.”

“... collaboration will be of great benefit to the Canterbury region by allowing access to the combined world-class expertise in place at both Colorado State University and the University of Canterbury, with the potential for student exchanges through a recent international memorandum of understanding signed by both universities.”

- Dr. Staiger, University of Canterbury

“My sabbatical here at UC has introduced me to the potential of electrospinning for the creation of nanofibres that mimic those found in the extracellular matrix of the human body. Building a collaboration with Dr. Staiger has led to this exciting project using his state-of-the-art electrospinning techniques and some of the novel biopolymers developed in my lab at Colorado State University. This is truly a great example of how international collaboration can lead to new research and eventually new healthcare technologies.”

- Dr. Susan James

(Left to right) Jason Kerr, Dr. Susan James, Julian Phillips, and Dr. Mark Staiger.
**Upcoming Seminars:**

**March 27**
Paul Hudnut, Director of Venture Development, and Dr. Henry Nowak, Director of the Center for Entrepreneurship, CSU College of Business; *Entrepreneurship in the Life Sciences Industry*

**April 3**
Dr. Raja Ghosh, Department of Chemical Engineering, McMaster University; Canada Research Chair in Bioseparations Engineering; *Hydrophobic Interaction Membrane Chromatography, An Effective Tool for Purification: Analysis and Detection of Antibodies*

**April 10**
Sean Hays, Summit Toxicology, TBA

**April 17**
Dr. Kenneth Solen, Department of Chemical Engineering, Brigham Young University; *Hemoincompatibility: A Multi-Variable Problem that Requires Multi-Variable Examination*

**April 24**
Dr. Ozan Akkus, Weldon School of Biomedical Engineering, Purdue University; *An Electrochemically Induced Collagen Assembly Process for Synthesis of Biomimetic Tendon-Like Materials*

**May 1**
Dr. Brian Tracy, Department of Health and Exercise Science, Colorado State University; *Variability of Neuromuscular Output in Human Aging*

**May 8**
Dr. Wei Tan, Department of Mechanical Engineering, University of Colorado at Boulder, TBA

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**SBME Seminar Series Kicks Off**

To further the interdisciplinary mission of the School of Biomedical Engineering (SBME), advanced degree seeking students are required to attend a weekly seminar series. Seminar speakers include industry leaders, professors from leading biomedical engineering academic programs, and our own excellent faculty. Students learn about recent trends in research and network with leaders in the field. The seminar series is open to the public.

This semester we have been honored to have the following industry and faculty members present seminars:

**Dr. William Dernell**, Department of Clinical Sciences, Colorado State University; *Pulmonary Delivery of Chemotherapeutics: Applications and Animal Modeling*

**Dr. Diego Krapf**, Department of Electrical and Computer Engineering, Colorado State University; *Nanopores as Single-Molecule Sensors*

**Dr. Amy Pruden**, Department of Civil and Environmental Engineering, Colorado State University; *Antibiotic Resistance Genes as Emerging Environmental Contaminants*

**Dr. Paul Schmidt**, Chief Scientific Officer, PR Pharmaceuticals; *Results for Sustained Release Drug Delivery to the Eye to Treat Retinal Disease*

**Dr. Ivan Vesely**, Founder and Chief Scientific Officer, ValveXchange Inc.; *Heart Valve Tissue Engineering*

**Dr. Ravi Bellamkonda**, Wallace H. Coulter Department of Biomedical Engineering at Georgia Tech/Emory; *Using Nanoscale Contrast Agents to Probe the Vascular Leakiness of Tumors to Predict the Effects of Systemic Chemotherapy*

**Dr. Steve Simske**, Principal Scientist, Hewlett Packard; *Security Printing and Imaging at HP Labs*

**Dr. Daniel Gustafson**, Department of Clinical Pharmacology, Colorado State University; *Pharmacokinetic Modeling Approaches in Oncology: Pre-Clinical and Clinical Applications*