Promising Research in Diabetic Care:  
**Vascular Tissue and Cellular Engineering**

**Daria Narayneva, PhD**

Diabetes is a growing epidemic in the world, with 8.3% of the population afflicted in the U.S. alone (National Diabetes Information Clearinghouse, 2011). In people with diabetes, excess glucose in the blood can cause blood vessels to become thicker and less elastic, inhibiting blood flow and leading to a number of serious cardiovascular problems. But what if we could reverse these harmful effects by harnessing the body’s natural ability to heal itself? Dr. Daria Narayneva’s laboratory, the Vascular Tissue and Cellular Engineering Lab, is working to improve tissue engineering by manipulating the formation of capillaries, or the angiogenesis process. So far, attempts to recreate a native-like capillary network in engineered tissues have been largely unsuccessful, so Dr. Narayneva’s lab aims to better understand the mechanisms of capillary formation and to develop new strategies for inducing a rapid angiogenic response and long-term survival of human capillary (endothelial) cells for tissue engineering applications—research that can have profound effects on the treatment of diabetes patients.

**Diabetic Wound Regeneration**

Chronic non-healing ulcers are a major complication and cause of morbidity and mortality in diabetic patients. These diabetic ulcers represent a significant healthcare burden and are responsible for more than 42,500 non-traumatic lower-limb amputations. Current treatment methods are often inadequate for timely and complete healing, so the VACE lab is investigating new approaches to addressing the pathophysiological abnormalities caused by diabetes. Insufficient angiogenesis is a major factor contributing to impaired wound healing of diabetic ulcers. Narayneva and colleagues are working to develop a new approach to treat chronic diabetic ulcers by modifying the microenvironment of the ulcer using a novel angiogenic scaffold material.
Biophysics of Diabetic Wound Healing

Low-amplitude electric field (EF) is an important component of wound-healing response and can promote vascular tissue repair; however, the mechanisms of action on endothelium remain unclear. Sheikh, Taghian, Hemingway, Cho, Kogan, and Narmoneva tested the results of both high and low frequency non-thermal electric signals on cell response with diabetic wounds. Their results provide evidence for a novel intracellular mechanism for EF regulation of endothelial angiogenic response, with important implications for EF-based therapies for vascular tissue regeneration.

Cardiac Fibrosis

The VACE lab recently conducted research into the effects of diabetic conditions on cardiac fibroblasts and the extracellular matrix (ECM). In heart disease, fibroblast cells in the myocardium rapidly increase, leading to excess production of ECM proteins, and ultimately, cardiac fibrosis. The VACE lab discovered inherent differences in cell responses to short-term and chronic exposure to high glucose and diabetic conditions.

Collaborations

- Bing Hinton, Pediatric Cardiology, CCHMC
- Yigang Wang, UC Pathology
- Andrei Kogan, UC Physics
- Sundeep Keswani, Fetal Surgery, CCHMC

Right: Researchers in the Vascular Tissue and Cellular Engineering lab. From left to right: Hodari-Sadiki James, Toloo Taghian, Tugba Erden, and Dr. Daria Narmoneva.

Picrosirius red staining

Fibrillar col fibers (yellow, orange or red)
Reticular col fibers (green)