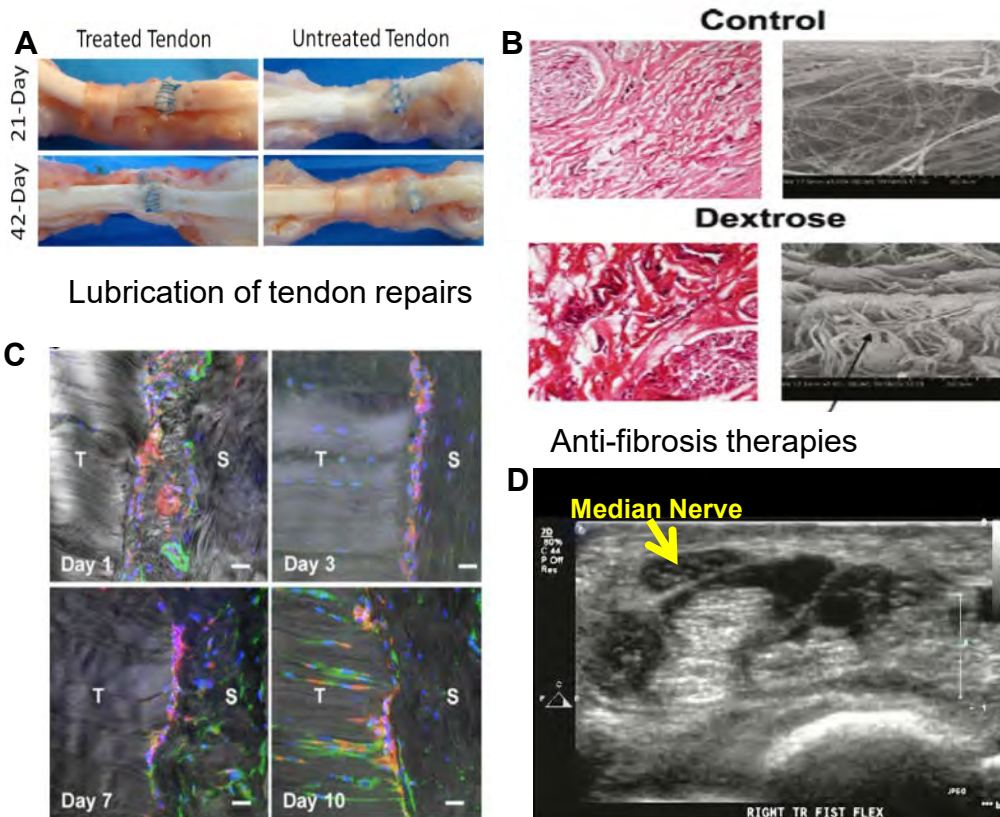
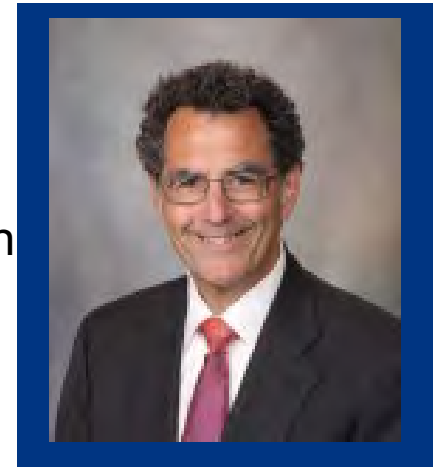


# Peter C. Amadio, M.D.

## Tendon and Soft Tissue Biology Laboratory

Carpal Tunnel Syndrome, Tendon Repair and Reconstruction



Lubrication of tendon repairs

Anti-fibrosis therapies

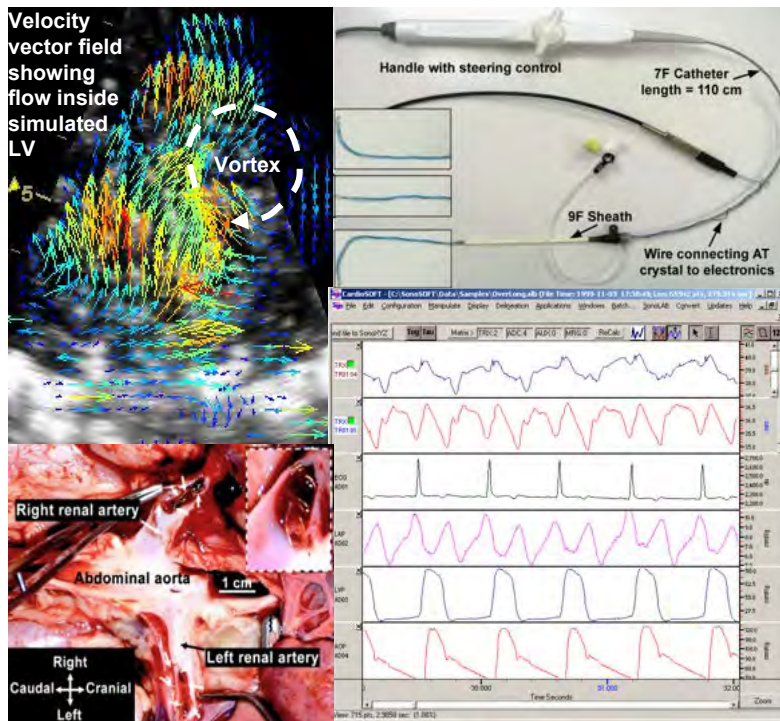
Stem cell transplant for tendon healing Carpal tunnel biomarkers

- Flexor tendon repair and Carpal Tunnel Syndrome
  - Tissue engineering to heal and reconstruct tendons.
  - Mechanisms of soft tissue fibrosis.
  - Physiological biomarkers for carpal tunnel syndrome
- Examples of some of our recent study results
  - **Figure A.** lubricated tendons heal with less scarring
  - **Figure B.** novel animal model to test anti-fibrosis therapies
  - **Figure C.** autologous transplanted stem cells migrate into and help heal tendon
  - **Figure D.** CTS Dynamic Ultrasound. Tracking of median nerve and tendons with dynamic ultrasound used clinically as a predictor of treatment response.
- Our work had been funded by NIH/NIAMS RO1AR62613, RO1AR44391, and RO1AR49823

# Marek Belohlavek, MD, PhD

## Translational Ultrasound Research Laboratory

Cardiovascular Ultrasound, Experimental and Clinical Studies

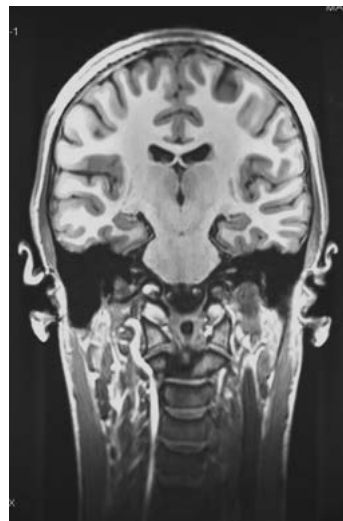
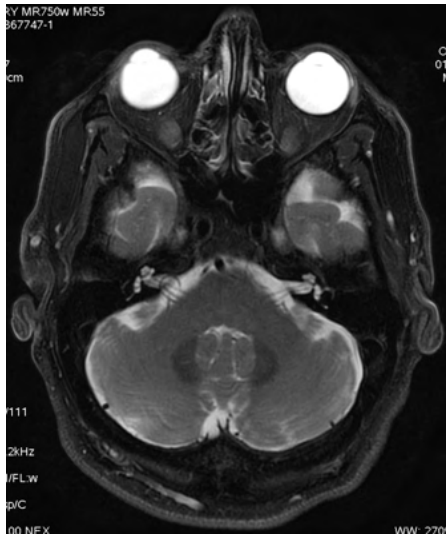


- Ultrasound imaging research in the cardiovascular system
  - Identify cardiac diseases earlier
  - Use echocardiography to study cardiac flow and pumping efficiency
  - Engineer new ultrasound-guided catheter for minimally invasive interventions
- Representative pictures from top-left, clockwise to bottom-left
  - Cardiac flow by echo particle imaging velocimetry in a mechanical heart model
  - Acoustically active catheter prototype
  - Hemodynamic data from animal surgery
  - Photo after ultrasound-navigated renal stent placement in a pig

# Matt A. Bernstein, Ph.D.

## Magnetic Resonance Imaging Physics

MRI, Novel Systems, Alzheimer's, TBI



Our lab is developing a Compact 3.0T MRI scanner:

- Lightweight, easy-to-site, low-cryogen MRI for brain and MSK applications
- Improved gradient performance compared to whole-body, 3.0T MRI systems
- Advanced brain applications including Alzheimer's disease and traumatic brain injury
- Images extremities as well as infants
- Expands global access to high-quality MRI, especially for underserved areas

We receive funding from the NIH (NIBIB and NINDS)

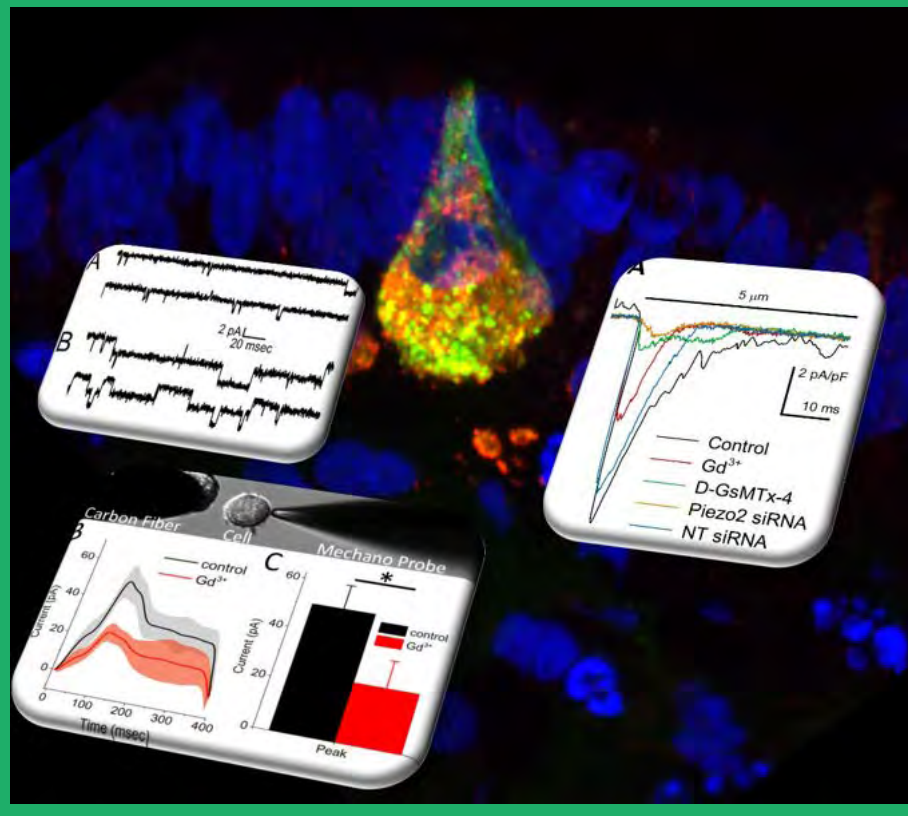
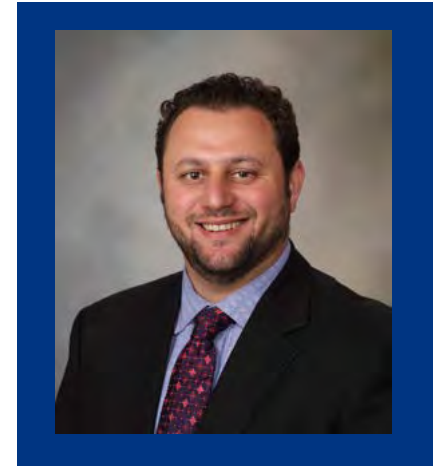


# Arthur Beyder, MD PhD

## Gastrointestinal Mechanotransduction Laboratory

(<http://www.mayo.edu/research/labs/gastrointestinal-mechanotransduction>)

enteric neuroscience, gastrointestinal motility and sensation, ion channels, mechanosensitivity, molecular mechanotransduction

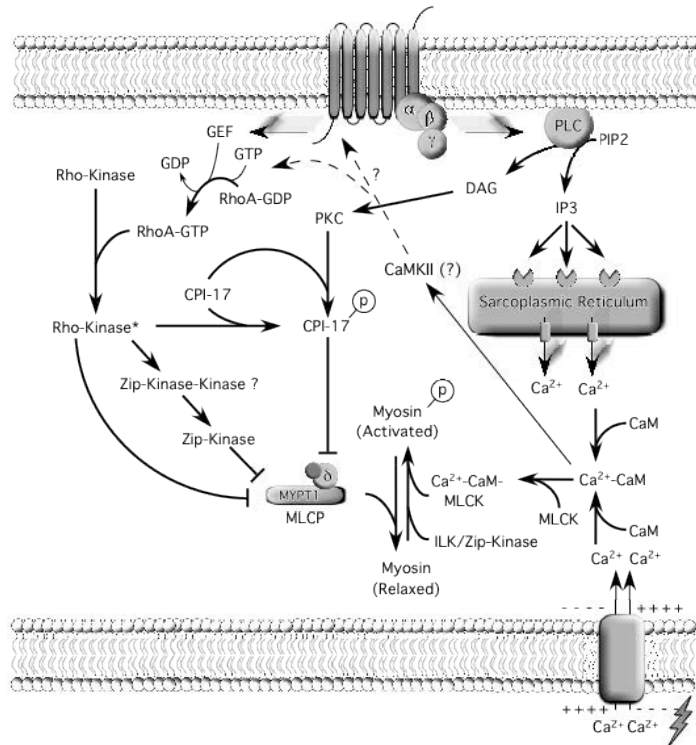
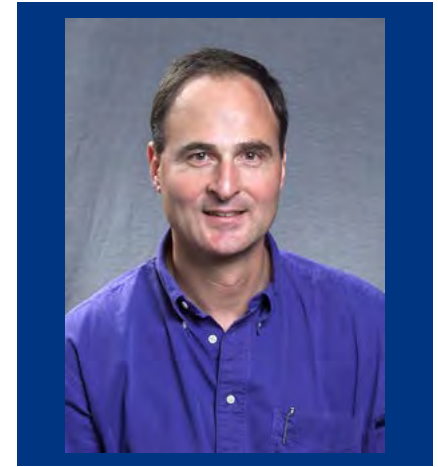


- We study gastrointestinal motility and sensation in health and disease. We focus on:
  - molecular mechanisms of mechanotransduction
  - mechanosensitive ion channels
  - mechano-electrical coupling in cells, tissues, organs and organisms
- We use a range of techniques:
  - Functional: electrophysiology/optogenetics and mechanical stimulation (single molecule/cell, tissue *in-vitro* and *in-vivo*)
  - Structural: Epifluorescence, confocal and super-resolution imaging, next-generation sequencing
- Our work is supported by NIH, American Gastroenterological Society (AGA) and Mayo Clinic

# Frank Brozovich, M.D., Ph.D.

## Contractility of Smooth Muscle

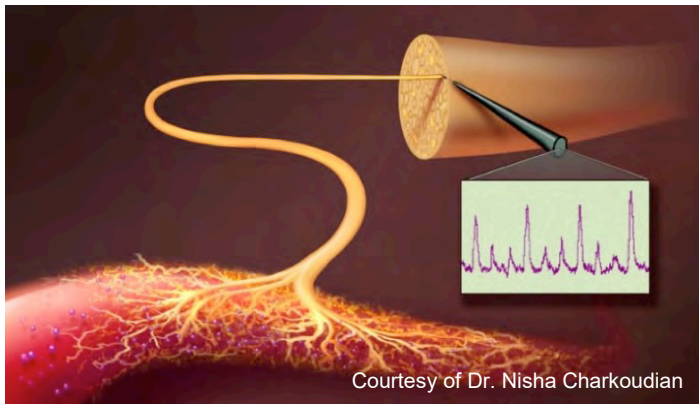
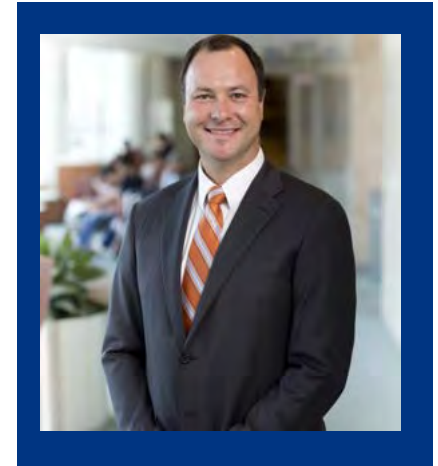
Nitric Oxide Signaling, Phosphatase, G-protein Coupled Receptors



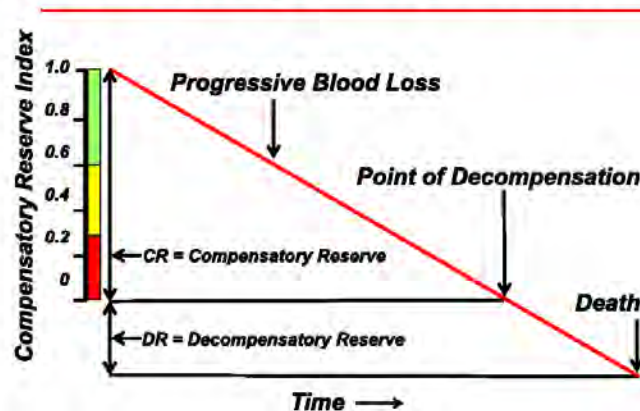
- Nitric Oxide Signaling
  - Myosin light chain phosphatase
  - Protein kinase G
  - Protein Structure Function
- G-protein Coupled Receptors
  - Smooth Muscle Contractility
  - Rho kinase/PKC
- Disease Models
  - Heart Failure
  - Pulmonary Hypertension
  - Nitrate Tolerance

# Timothy B. Curry, MD, PhD

## Integrative Human Physiology Laboratory



### Compensatory Reserve Index (CRI)



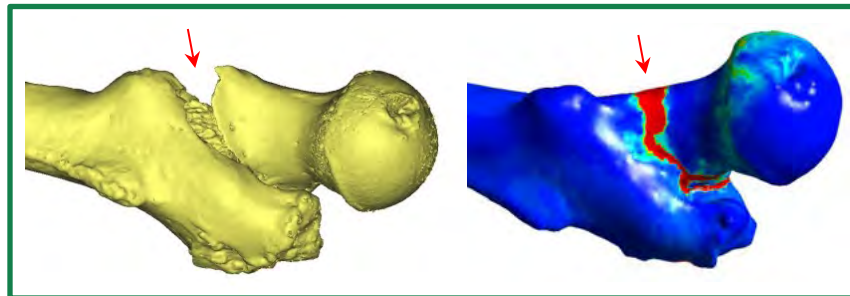
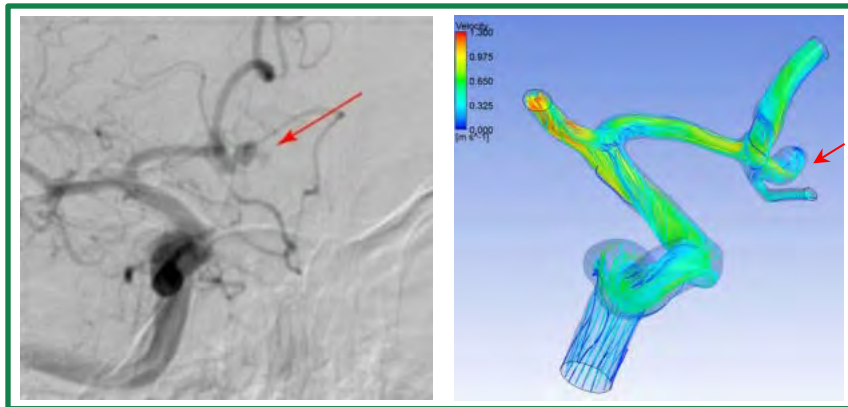
J Trauma Acute Care Surg. 2013 Dec;75(6):1053-9

- We are interested in the neurovascular control of blood pressure and blood flow, including during exercise. We are also developing predictive models of hypovolemia and hypoxia.
- Key techniques we use are pharmacological studies, simulated hemorrhage with lower body negative pressure, and measurement of muscle sympathetic activity using microneurography
- We have recently received funding from the Department of Defense, Mayo Clinic, and industry.

# Dan Dragomir-Daescu, Ph.D.

## Computational Biomedical Engineering

Computational Fluid and Biofluid Dynamics,  
Finite Element Analysis of Tissue,  
Cardiovascular Implant Design



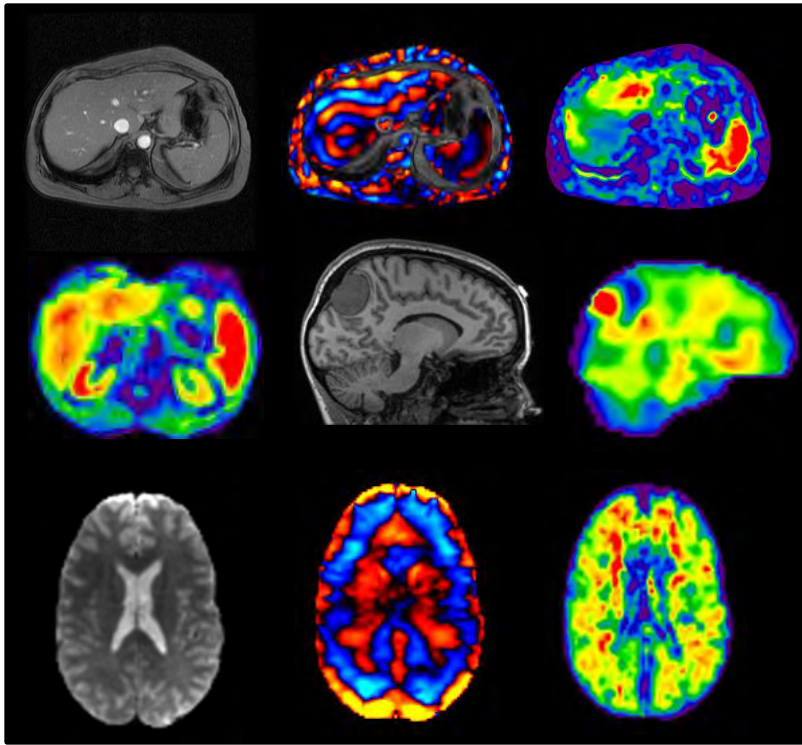
- We are interested in computational modeling of blood flow, hard and soft tissue, and design and fabrication of cardiovascular devices including
  - Computational Hemodynamics
  - Bone Fracture Mechanics
  - Stents and Grafts
  - Blood Flow Diverters
- Top: Angiography of ruptured aneurysm (left) and 3D model of computed hemodynamics (right)
- Bottom: Computed tomography (CT) reconstruction of femur fracture (left) and 3D model of simulated fracture using finite element analysis (right)
- We recently received funding to study a) metastatic spine fracture strength and b) optimal stent design for treatment of atherosclerosis



# Richard L. Ehman, M.D.

## Magnetic Resonance Imaging Research

MRI, MR Elastography, Medical Imaging Technology



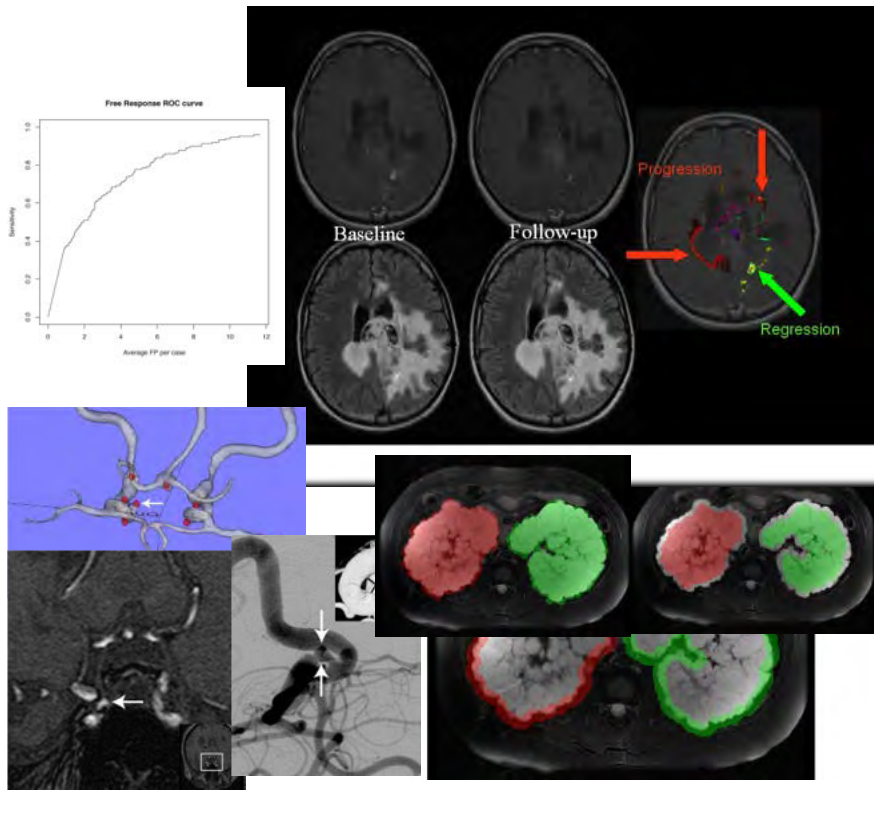
- We apply advanced physics and engineering to invent new imaging technologies to address key challenges in patient care
- Our team focuses on MRI-based techniques for imaging the mechanical properties of tissue and explores diagnostic applications in many areas:
  - Detecting and characterizing cancers of breast, prostate, liver, thyroid, and brain
  - Assessing fibrotic diseases of the liver, lung, pancreas, kidneys, and connective tissues
  - Studying degenerative and post-traumatic disorders of the brain
- Our technologies are tested clinically and used to enhance patient care at the Mayo Clinic



# Bradley Erickson, MD PhD

## Imaging Informatics

Change Detection, Machine Learning

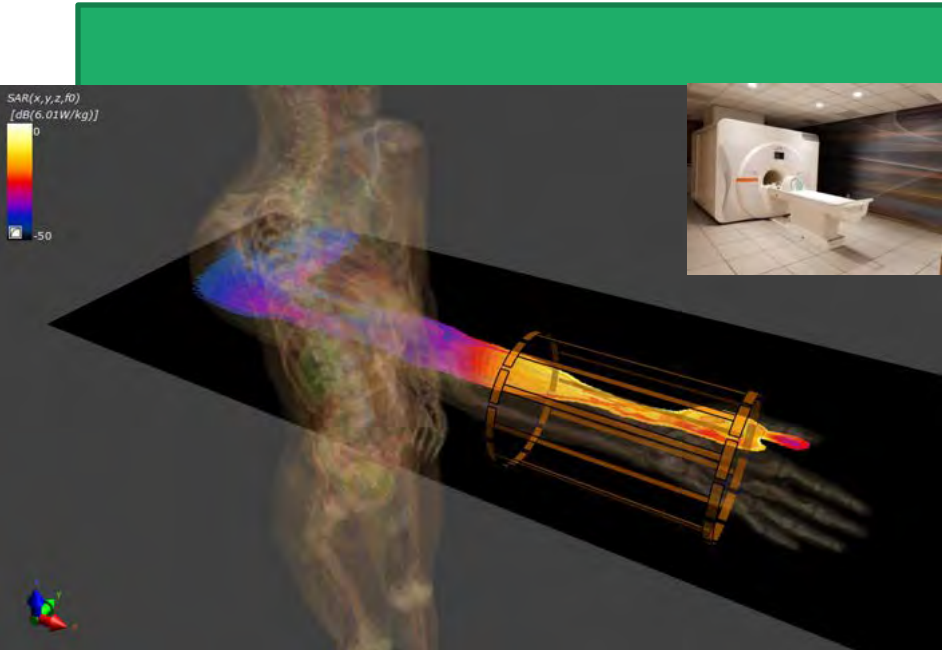


- We focus on using computers to extract and evaluate information present in medical images
- New imaging devices are creating images at speeds that exceed the ability of humans to appreciate. Computer technology can help address 'information overload' and let humans focus on the practice of medicine that computers cannot do well

# Andrew J Fagan, PhD

## Fagan Lab

7T MRI, Technology Development, Clinical Translation



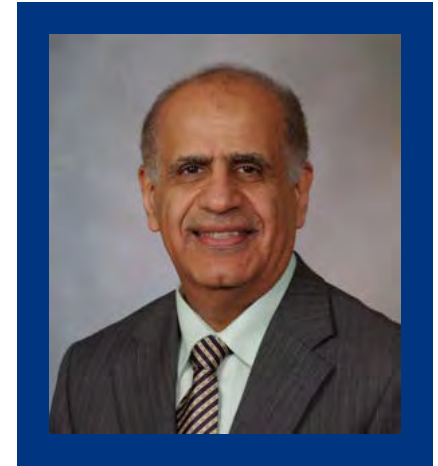
electromagnetic simulation showing the energy deposition in the forearm of a virtual human within a newly-developed radiofrequency wrist coil  
(insert: the 7 Tesla MRI scanner)

- Technology development for 7 Tesla MRI
  - radiofrequency (RF) coils
  - solutions to improve  $B_0$  shimming
  - parallel transmit development
- Electromagnetic simulations of new RF coil
  - used for coil development
  - also used for implant safety studies
- Clinical translation of 7 T MRI technology
  - optimization of 7 T images for use in pre-surgical planning
  - image quality improvements

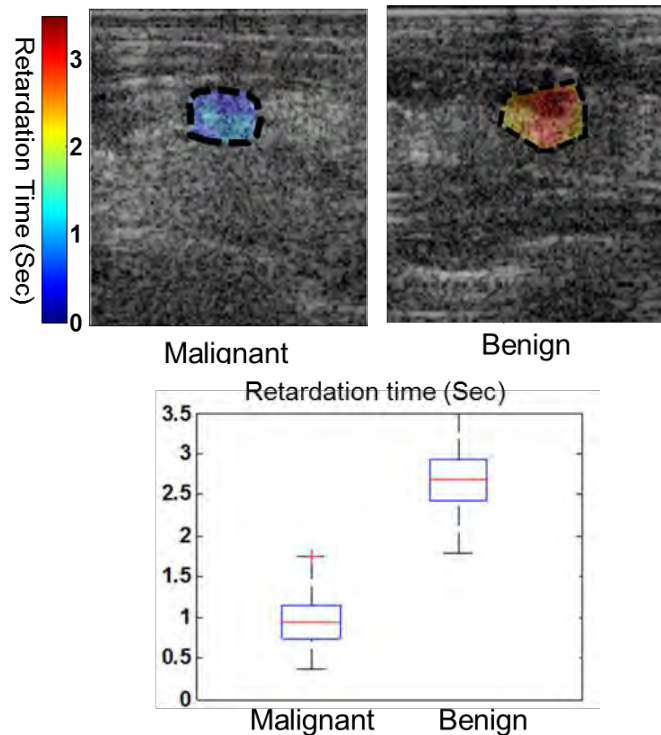
# Mostafa Fatemi, PhD

## Diagnostic Ultrasound Technologies

Tissue viscoelasticity, nonlinear elasticity, imaging



Differentiation of breast masses by SAVE  
(Retardation time) method



### **Research Focus:**

- Novel diagnostic ultrasound technologies
- Tissue viscosity & elasticity mapping, nonlinear elasticity

### **Funded Research:**

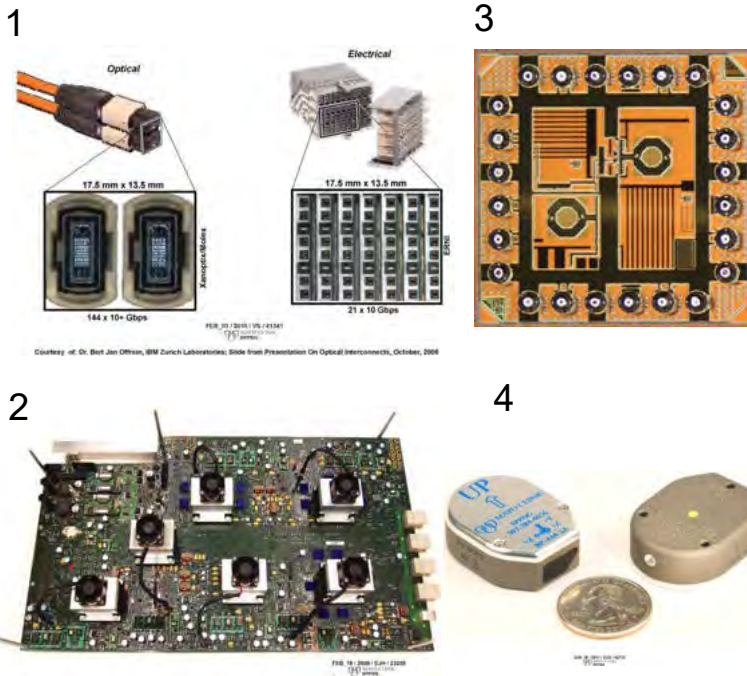
- Breast cancer
- Thyroid cancer
- Bladder compliance
- Prostate imaging
- Active catheter
- Vibro-acoustography



# Barry Gilbert PhD

## Special Purpose Processor Development Group (SPPDG)

Circuit Design, Miniature Packaging, High Speed Test



- We develop high performance electronics across a range of applications
  - High Performance Computing (HPC)
  - High Speed Networks
  - Miniaturized Digital / Wireless Systems
  - Biomedical applications of the above
- Example topics include the following
  1. Optical Interconnects for HPCs
  2. High speed (40→1000 Gbps) network components
  3. Chip scale atomic clock (CSAC)
  4. Miniaturized physiological monitor

# Leigh G. Griffiths, MRCVS, PhD.

## Cardiovascular Research Laboratory

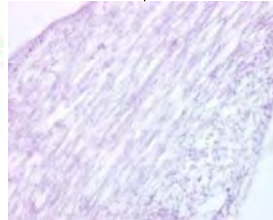
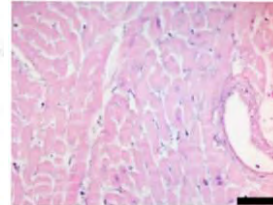
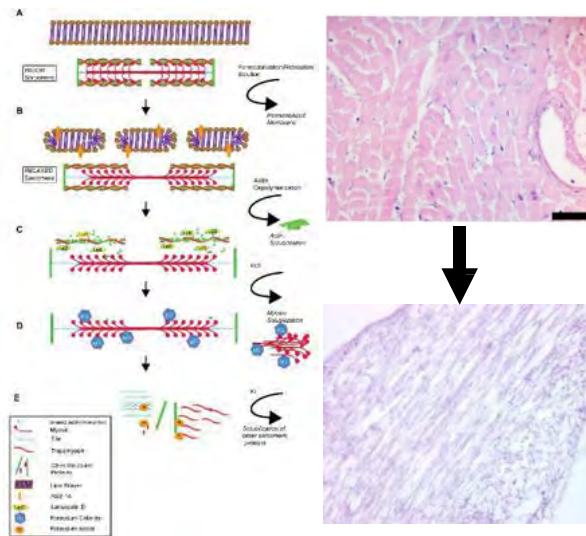
Transplant Immunology, ECM Scaffolds, Cardiovascular Tissue Engineering



### Antigen Identification



### Heart Muscle ECM Scaffold



### • Transplant Immunology

- Immunoproteomic identification of the barriers to allotransplantation and xenotransplantation
- Epitope mapping for individual antigens

### • Extracellular Matrix Scaffold Production

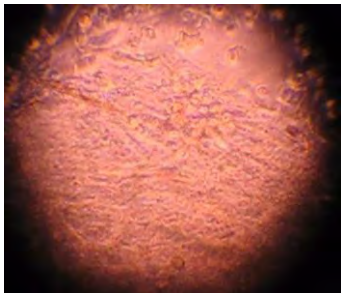
- Leverage antigen identification towards development of xenogeneic ECM scaffolds which avoid recipient graft-specific immune responses
- Maintain ECM scaffold structure-function relationships and recellularization capacity.

### • Cardiovascular Tissue Engineering

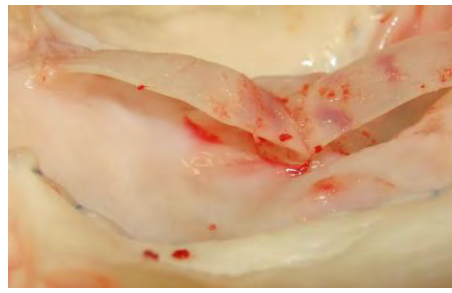
- Identify critical cell-matrix interactions responsible for migration, differentiation, proliferation and function.
- Develop tissues and organs with chronic *in vivo* functionality

- We have received funding from NIH, AHA, CIRM

### Tissue Engineered Cardiac Muscle



### Heart Valve *in Vivo*



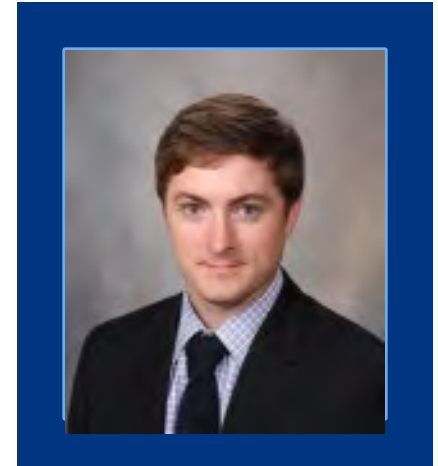
MGS Biomedical Engineering & Physiology Faculty

# Clifton Haider, PhD

## SPPDG

Accelerated Medical Device Development,  
Autonomous Physiologic Monitoring, Quantitative  
Predictive Physiologic Biomarkers

MOUNT EVEREST EXPEDITION MEMBERS WEARING MAYO/SPPDG DEVELOPED  
BIOMEDICAL PLATFORM ACTIVITY MONITOR WITH ELECTROCARDIOGRAM (ECG)  
CAPABILITY (BP-AM-3A) – APRIL/MAY 2012



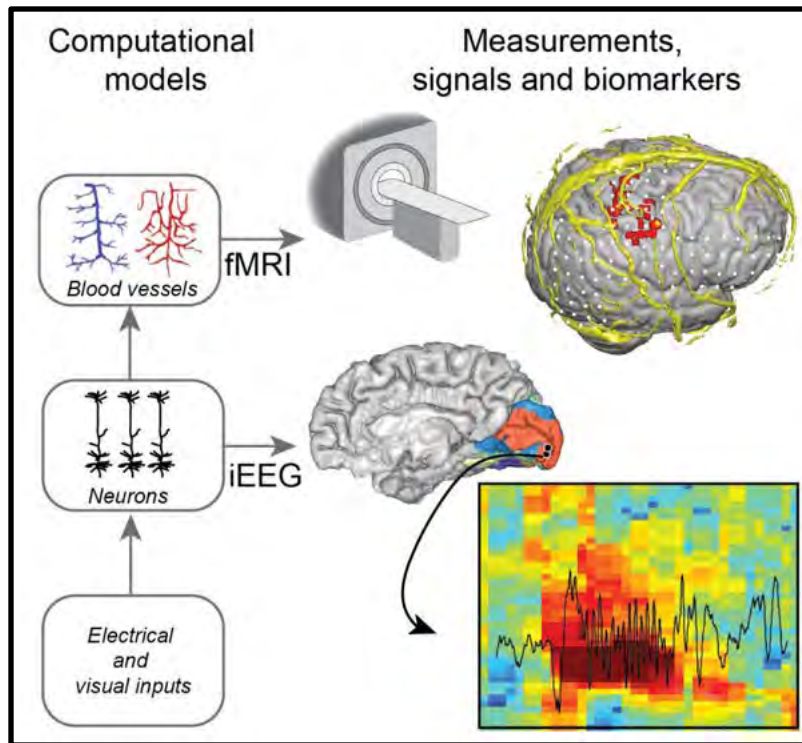
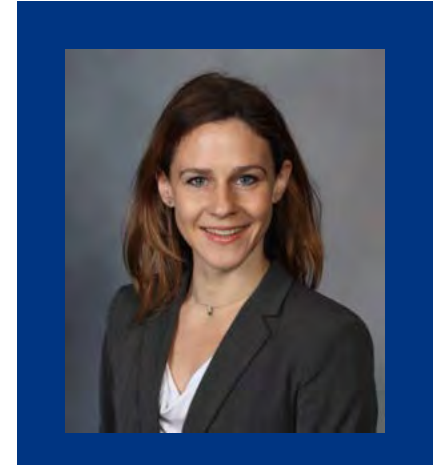
- My research interests address accelerated medical device development.
- We explore mathematical, algorithmic, software, and laboratory discovery platforms for novel physiologic sensing.
- The discovery platform incorporates statistical modeling, design, and demonstration of physiologic sensor limits to ensure that the first medical device prototype captures the pathophysiology of interest.
- The numerical design phase is immediately followed by integration of the new sensor into a scalable Mayo Clinic-developed miniature physiologic monitor that permits on-body validation.



# Dora Hermes, PhD

## Multimodal Neuroimaging Lab

Magnetic resonance imaging (MRI), neurophysiology, brain stimulation, vision, computational modeling

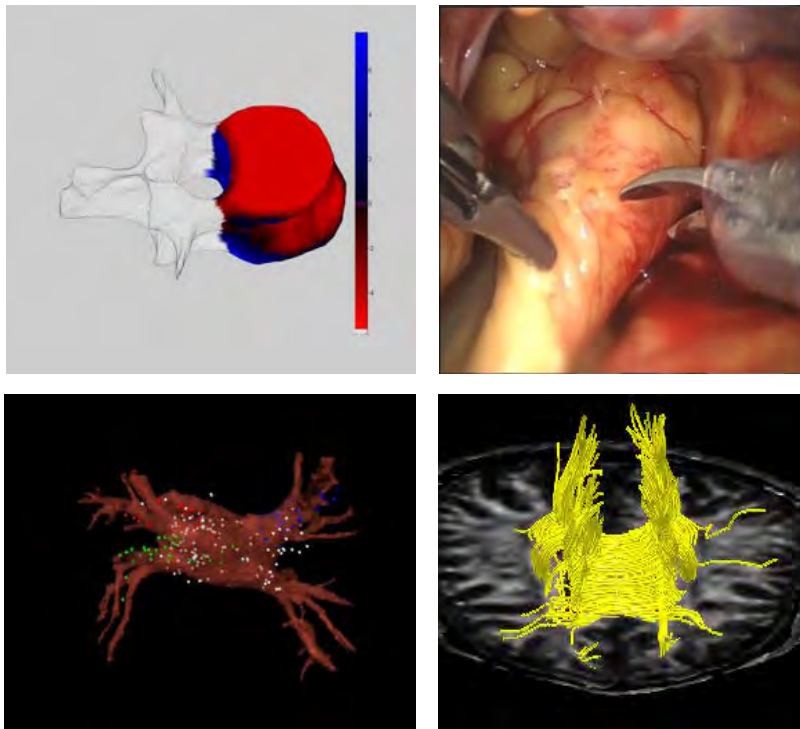


- We are interested in understanding the signals measured in the living human brain in order to identify biomarkers of neurological and neuropsychiatric diseases and develop neuroprosthetics to interface with the brain.
- We use intracranial EEG (iEEG) data and advanced MRI imaging techniques (e.g. 3T&7T fMRI, DTI).
  - We study the effect of electrical and visual input on brain signals.
  - Computational models of neuronal populations are developed to predict typical and atypical signals.
- Funded by NIH.

# David Holmes III, PhD

## Biomedical Imaging

Image-Guided Interventions, Robotics, Image Analysis

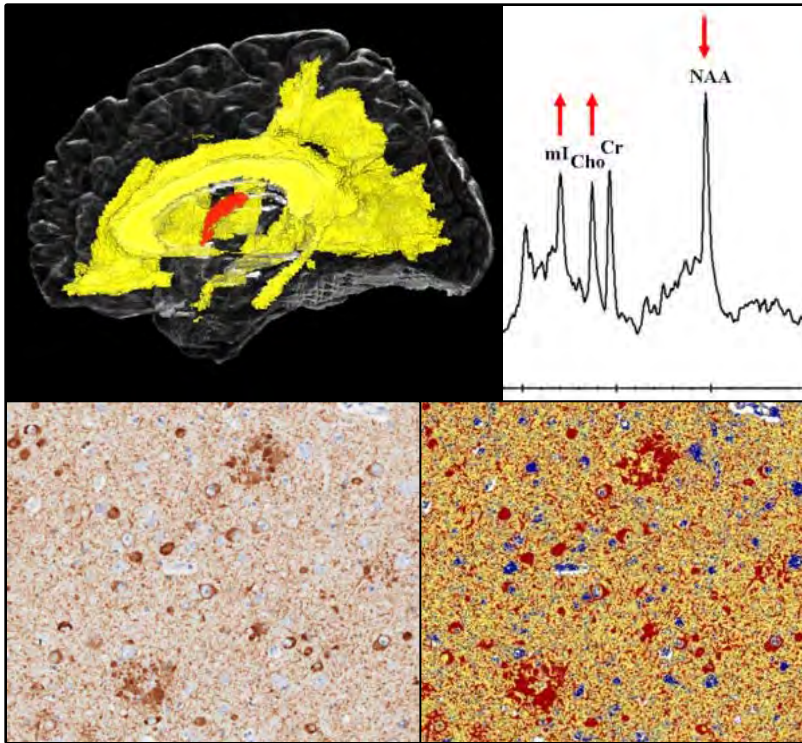


- Our lab leverages high-resolution medical images to drive research and clinical practice.
  - Image-guidance provides unparalleled feedback during interventions
  - Robotic surgery can be augmented with real-time imaging processing
  - Quantitative image analysis can lead to new discoveries
- Quantitative analysis and visualization drive our research. Some examples include:
  - Analysis of vertebral shape (Upper Left)
  - Robotic surgery visualization (Upper Right)
  - Image-guided cardiac models (Lower Left)
  - DTI-derived fiber tracks (Lower Right)

# Kejal Kantarci MD, MS

## Pathologic Basis of Neuroimaging Biomarkers

Neuroimaging, Dementia with Lewy Bodies, MRS, DTI, Women's Health, Sex differences



We study pathologic correlates of neuroimaging biomarkers in aging and dementia

We work with advanced imaging techniques such as magnetic resonance spectroscopy (MRS) and diffusion tensor imaging (DTI)

The sample images are from

- Antemortem DTI and MRS studies
- Pathologic analysis using digital microscopy from postmortem tissue

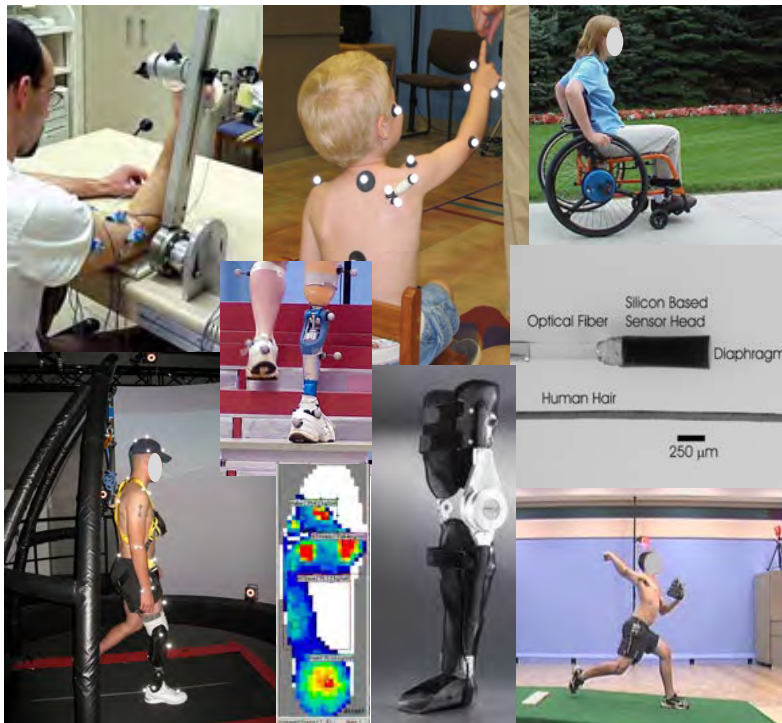
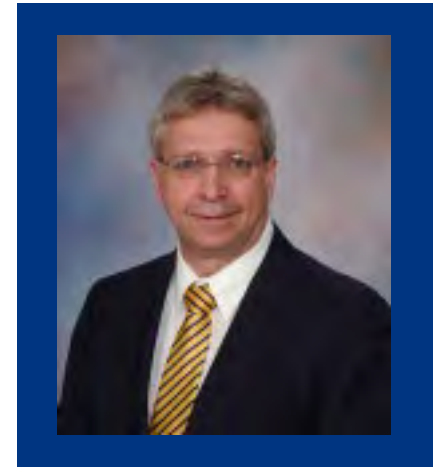
Our work is funded by the NIH/NIA and MN partnership grants



# Kenton R. Kaufman, Ph.D., P.E.

## Biomechanics/Motion Analysis Laboratory

Human movement, orthotics & prosthetics, muscle, rehab

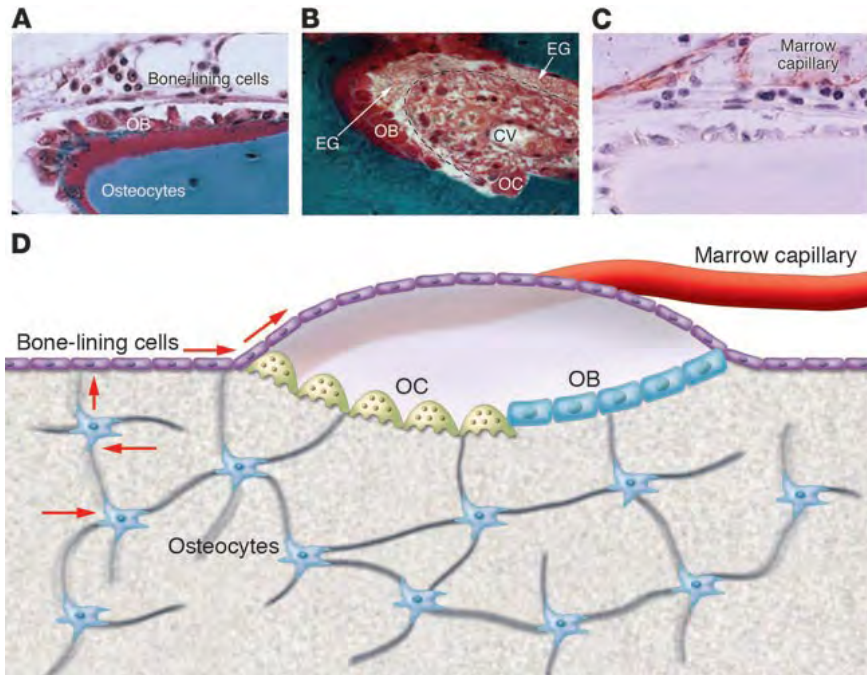
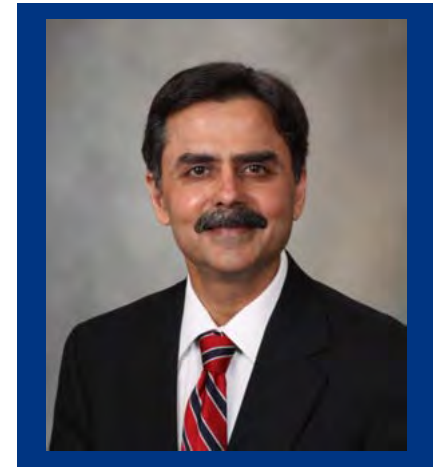


- Our research is focused on human locomotion
  - Rehabilitation of Wounded Warriors
  - Improving human mobility
  - Measurement of muscle force in-vivo
- We also provide clinical patient assessments
  - Quantify neuromusculoskeletal function
  - Recommendations for clinical treatment
  - Objective outcome evaluations
- Funding
  - NIH
  - DOD
  - Industry

# Sundeep Khosla, M.D.

## Osteoporosis and Age-Related Bone Loss

Epidemiology, clinical-investigation,  
and basic bone biology



### Age-related changes in bone quality

- Novel imaging approaches (e.g., high-resolution peripheral quantitative computed tomography)
- *In vivo* microindentation in humans

### Pathogenesis of age-related bone loss in humans

- New approaches to isolate osteoblasts, osteocytes, and osteoclasts from human samples

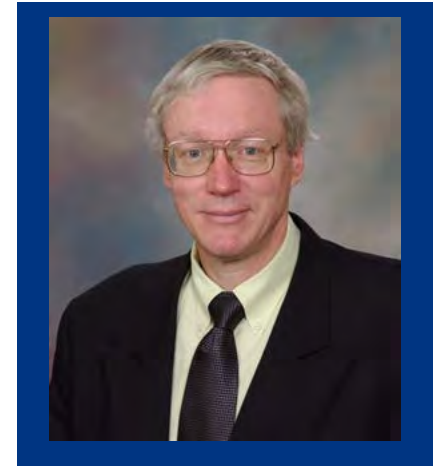
### Mouse models to study estrogen action in bone

- Cell- and time-specific deletion of estrogen receptors in bone

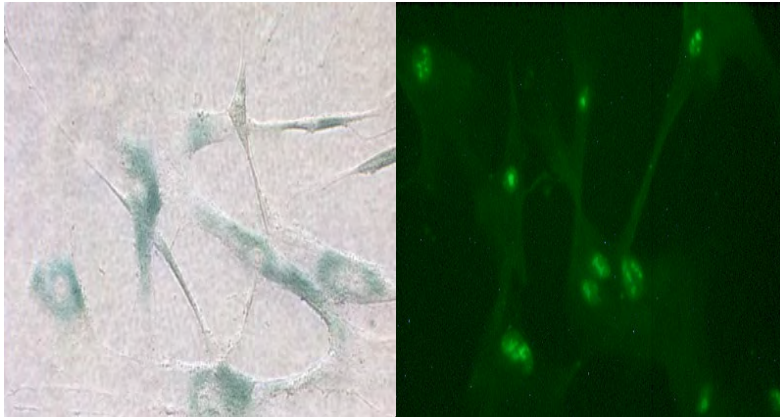
# James Kirkland, M.D., Ph.D.

## Molecular and Cellular Mechanisms of Aging

Cellular Senescence, aging and stem cells,  
fat cell progenitors and aging, treatments for frailty



### Senescent fat cell progenitors



Senescence-associated  $\beta$ -galactosidase

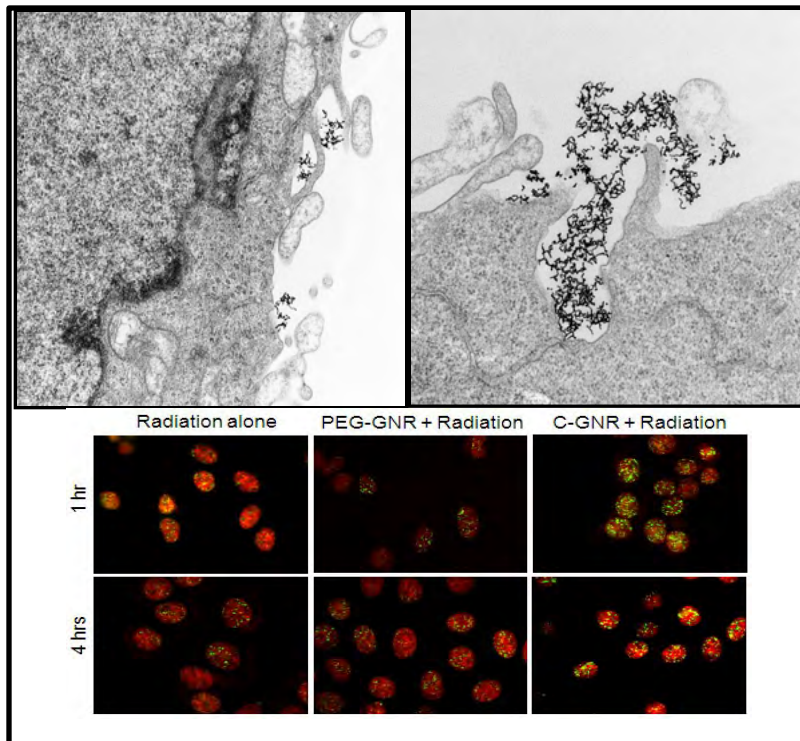
$\gamma$ -Histone 2-AX  
DNA repair foci

- We are interested in:
  - Mechanisms through which cellular senescence induces inflammation, metabolic dysfunction, resistance to stem cell engraftment, and frailty in animal models and humans
  - Based on this, translational studies of drugs that enhance lifespan and healthspan and decrease frailty
- We found that senescent preadipocytes accumulate in fat tissue with aging. They secrete cytokines and other factors that cause inflammation, lipotoxicity, and metabolic dysfunction. Removal of these cells or interfering with their senescent secretory phenotype appear to restore function in old age.
- We have funding from the NIH and foundations

# Sunil Krishnan, MD

## Nanotechnology & radiation biology lab

Nanoparticles, radiosensitizers, immune effects, cancer



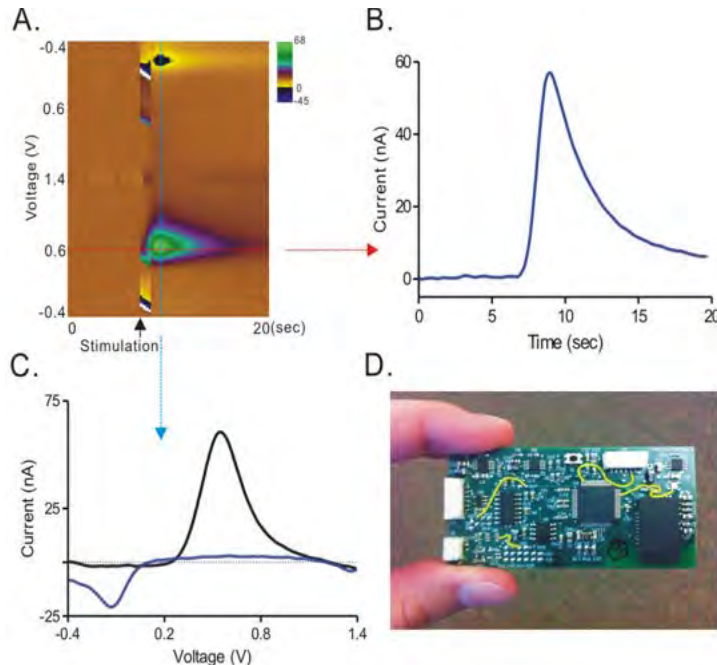
- We study ways to sensitize tumors to radiation using:
  - Nanoparticles that home to tumors
  - Nanoparticles that respond to external and internal stimuli (focused ultrasound, pH, proteases, etc)
  - Immune modulation by charged particle radiation
  - Chemotherapy and targeted therapy
- We enjoy working with chemists, biologists, and engineers to make novel nano-formulations and study novel biology
  - To the left are some conjugated gold nanorods binding to cell surface receptors and getting internalized
  - And below that are images of cells with DNA damage (green spots) as a result of the nanorods amplifying radiation dose
- We have recently received funding from the NIH to study nanoparticles targeting the immune system (in head and neck cancer) and to study combination therapy with chemotherapy and biologic agents (in pancreatic cancer)



# Kendall H. Lee, M.D., Ph.D.

## Neural Engineering Laboratory

Deep Brain Stimulation, Neuromodulation, WINCS, Electrochemistry

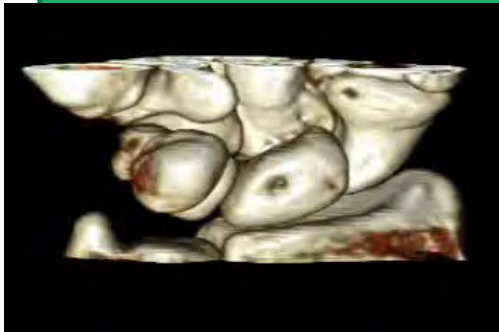
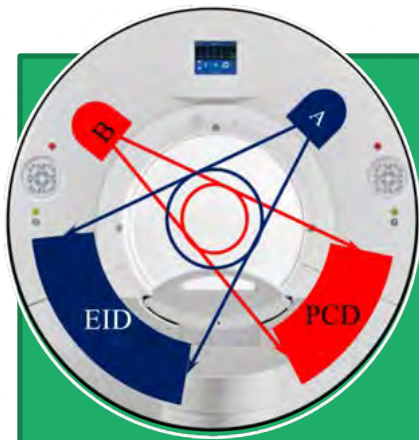


- Elucidating the mechanism of action of DBS
  - Fast Scan Cyclic Voltammetry
  - fMRI during DBS
  - Patch clamping
- We have made WINCS
  - A is color plot of dopamine voltammetry
  - B is peak current versus time plot
  - C is cyclic voltammagram of dopamine
  - D is photograph of WINCS device
- We have recently received funding from NIH to study the mechanism of DBS

# Shuai Leng, PhD

## Computed Tomography (CT)

Spectral CT, Image Reconstruction, CBCT, 3D printing



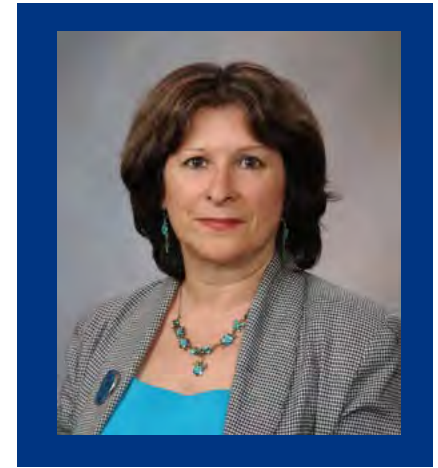
We are interested in the imaging techniques and clinical applications of X-ray CT in diagnosis and image guided therapy. Current focus areas include:

- Dual Energy CT and Photon Counting Detector Based Spectral CT
- Dynamic (4D) CT imaging
- Image Reconstruction
- Radiation dosimetry and dose reduction
- Image quality assessment
- 3D printing in medical applications

# Lilach O. Lerman, MD, PhD

## Renovascular Research Laboratory

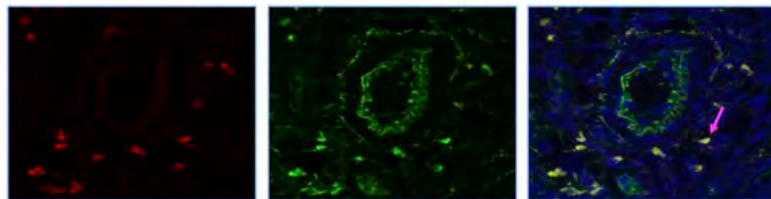
Nephrology and Hypertension, Imaging,  
Regenerative Medicine



**MRI**

**Co-registered**

**CT**



**Dil-labeled EPC**

**CD31**

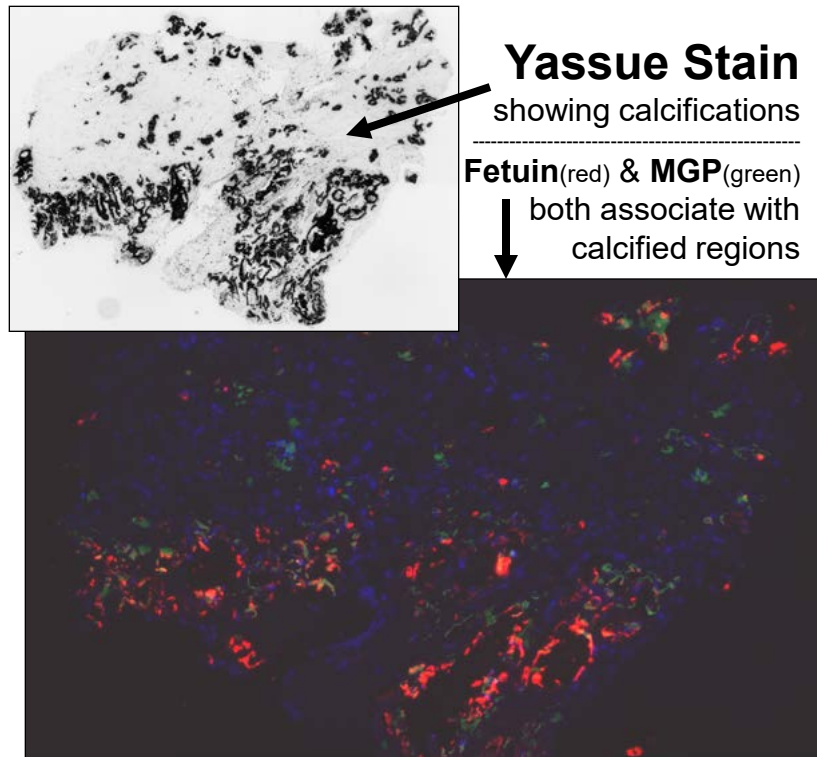
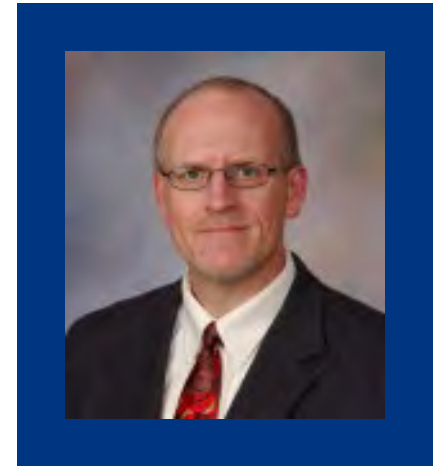
**Merged**

- Areas of interest
  - Renovascular Disease/Hypertension
  - Renal and cardiac imaging
  - Regenerative medicine
  - Cardiovascular risk factors
- Representative Figures:
  - TOP: Kidney MRI (left) and MDCT (right) images co-registered (center) based on anatomical landmarks.
  - BOTTOM: Engrafted endothelial progenitor cells (EPC) labeled in red Dil (left) co-localize (yellow, right) with CD31+ endothelial cells (green, center) in stenotic kidney micro-vessels (magenta arrow, right) from a pig with atherosclerotic renovascular disease.
- Funding: Primarily NIH (NHLBI and NIDDK), as well as Foundations (AHA) and Industry.

# John C. Lieske, M.D.

## Nephrolithiasis

Cell biology, urinary biomarkers, genetics



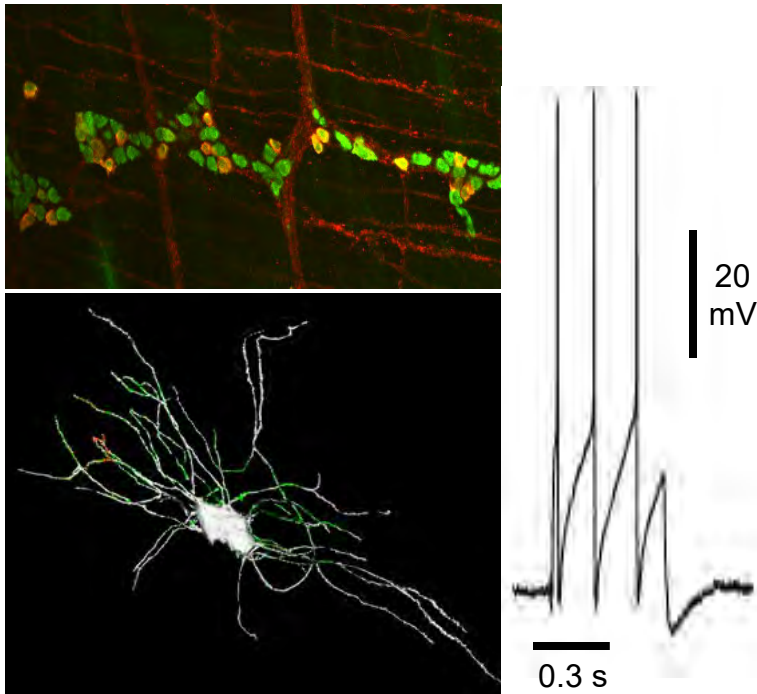
- Our lab studies the pathogenesis of kidney stone formation
  - Cell biology of renal crystallization
  - Identification of urinary biomarkers of ongoing stone formation
  - Genetics of stone formation
- A biopsy from a stone former's kidney demonstrates microscopic calcification and increased expression of 2 proteins associated with pathologic biomineralization
  - Fetuin (red)
  - Matrix Gla Protein (Green)
- Our research is funded by the NIH through the O'Brien Urology Research Center, the Rare Kidney Stone Consortium, and an R01 grant



# David R. Linden, Ph.D.

## Gastrointestinal Physiology

Autonomic Neuroscience, Inflammation, Neuroplasticity

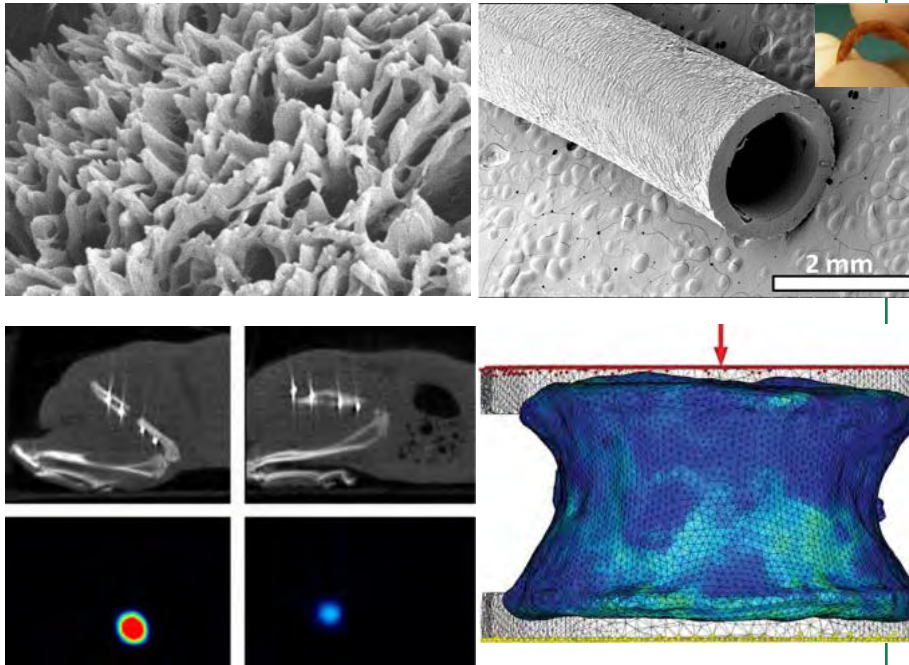


- Understand the mechanisms by which **inflammation** alters the structure and function of the **nervous system**
  - Electrophysiology
  - Cell Morphology / Immunohistochemistry
  - Cellular Expression Analyses
- Use human biospecimens and animal models of Inflammatory Bowel Disease and Functional Bowel Disorders
- Funded by the National Institute of Diabetes Digestive and Kidney Diseases

# Lichun Lu, PhD

## Biomaterials, Regenerative Medicine

Polymer Synthesis, 3-D Scaffolds, Drug Delivery

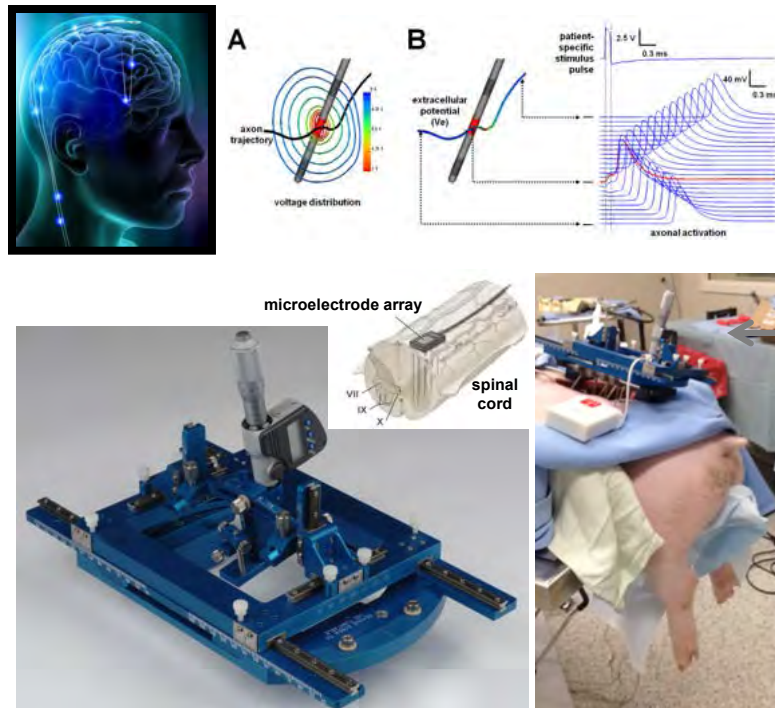


- Synthetic biodegradable polymers as biomaterials platform
- Advanced 3-D scaffold fabrication
- Controlled delivery of therapeutics
- Noninvasive prediction of spine fracture using QCT/FEA
- Preformed and injectable bone scaffolds
- Functionalized nerve guidance tubes

# J. Luis Lujan, Ph.D.

## Neural Engineering Laboratory

Neuromodulation, Neuroprosthetics, Artificial Intelligence,  
Brain Machine Interfaces



Our research focus is:

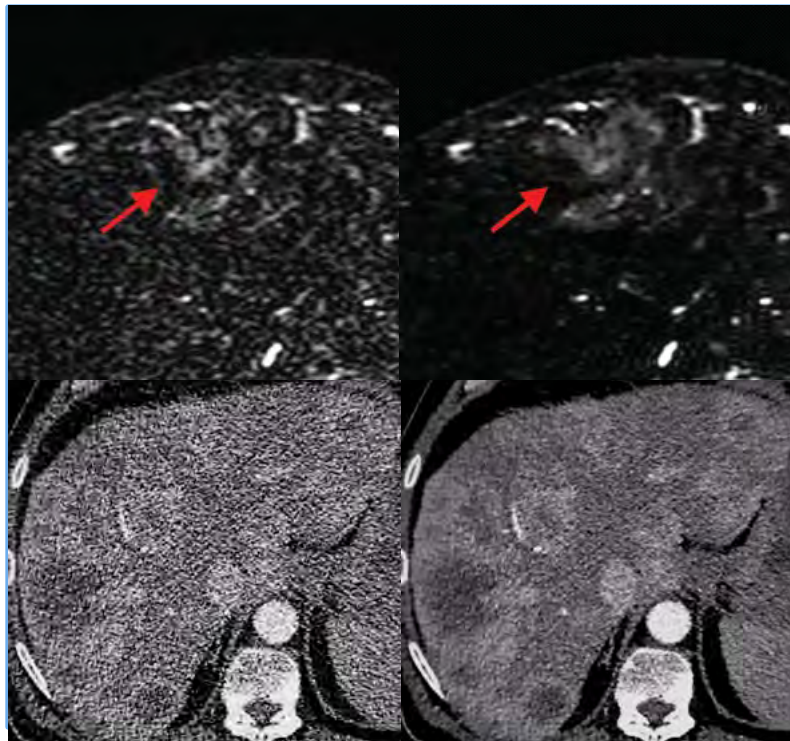
- Neuroprosthetics and neuromodulation techniques for restoring neurologic and motor function following neural injury and disease.
- Computational modeling of neurologic/psychiatric disease and mechanisms of action of deep brain stimulation (DBS).
- Diffusion tensor imaging (DTI) for analysis and reconstruction of neural pathways.
- Brain machine interfaces (BMI) and closed-loop neural control algorithms.

Current funding provided by NIH.

# Armando Manduca, Ph.D.

## Mathematical Methods in Medical Imaging

Image Processing and Analysis, Image Reconstruction



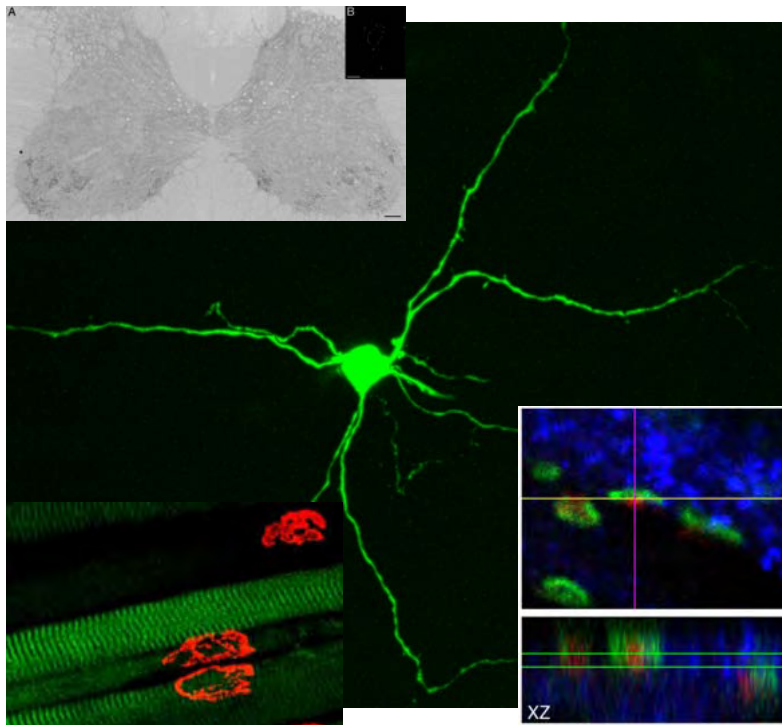
- We're interested in mathematical aspects of medical imaging, including
  - Analysis and inversion of MR and ultrasound elastography data
  - Undersampled image reconstruction for improved spatial and temporal resolution
  - Advanced image processing algorithms for medical imaging applications
- Top: standard (L) and our (R) reconstruction of highly undersampled MR angiography data
- Bottom: CT data before (L) and after (R) non-local means denoising



# Carlos Mantilla, MD, PhD

## Regenerative Physiology

Control of Breathing, Respiratory Neurobiology & Neuroplasticity, Spinal Cord Injury, Neuromuscular Diseases

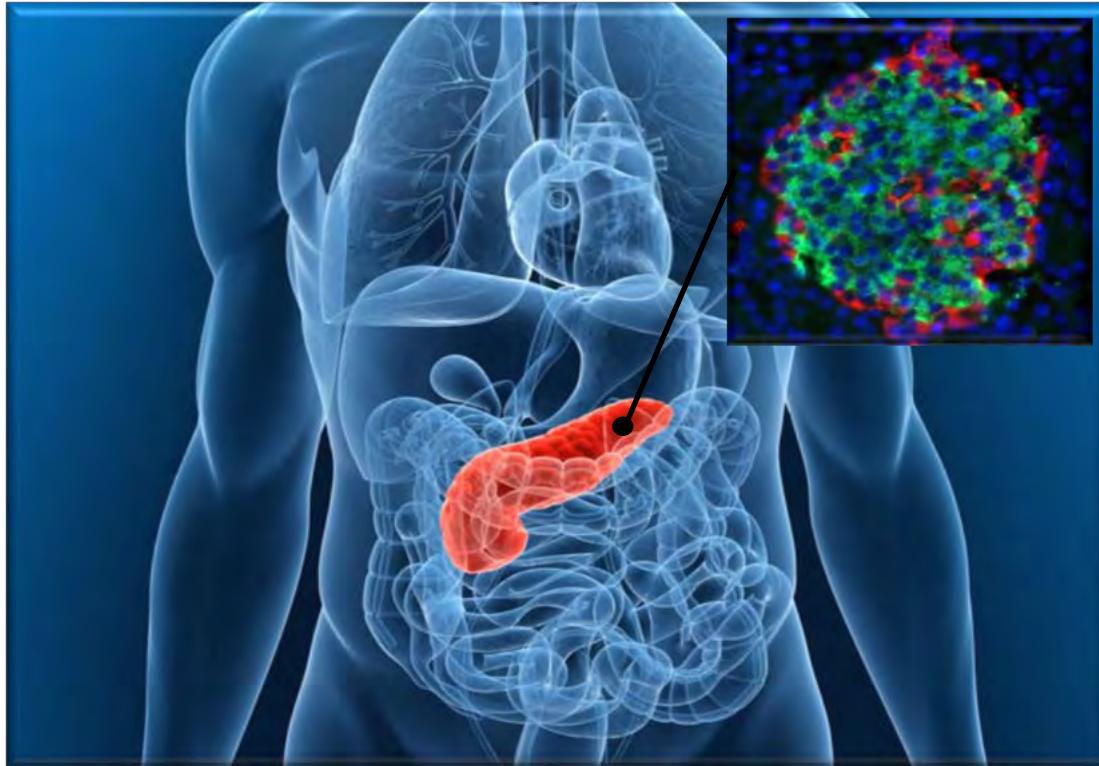


- My research interests address the restoration of respiratory function following injuries or disease (e.g., spinal cord injury, critical illness and neuromuscular disorders).
- We explore the role of trophic factors in enhancing neuroplasticity at the spinal cord, motoneuron, neuromuscular junction and muscle levels.
- Two main trophic factor families are actively investigated in the laboratory: neurotrophins and neuregulins.
- We receive funding from NHLBI, NIA and the Mayo Clinic

# Aleksey Matveyenko Ph.D

## Islet Regeneration Laboratory

Diabetes, Metabolic Syndrome, Circadian Rhythms



**Molecular mechanisms  
underlying pathogenesis  
of diabetes mellitus**

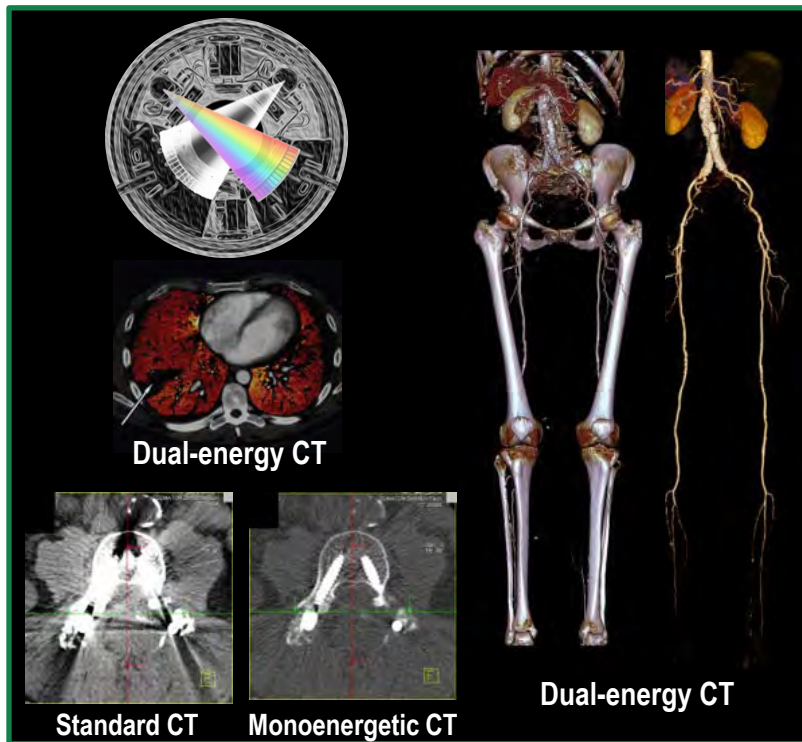
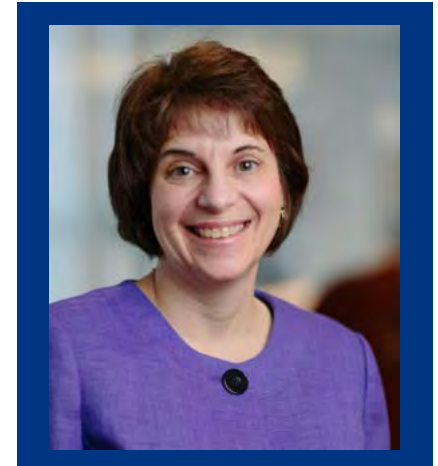
**Regenerative approaches  
for treatment of diabetes  
mellitus**

**Role of circadian rhythms  
in regulation of cellular  
metabolism**

# Cynthia H. McCollough, PhD

## CT Clinical Innovation Center

X-ray computed tomography (CT), radiation dose reduction

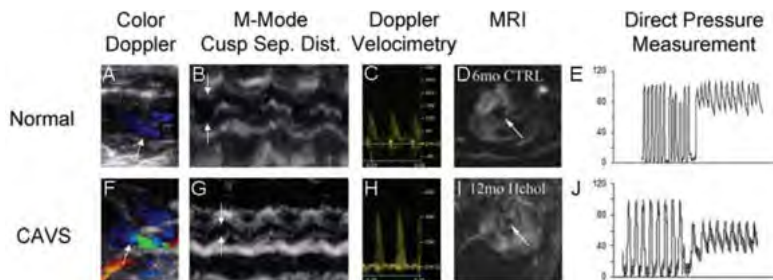
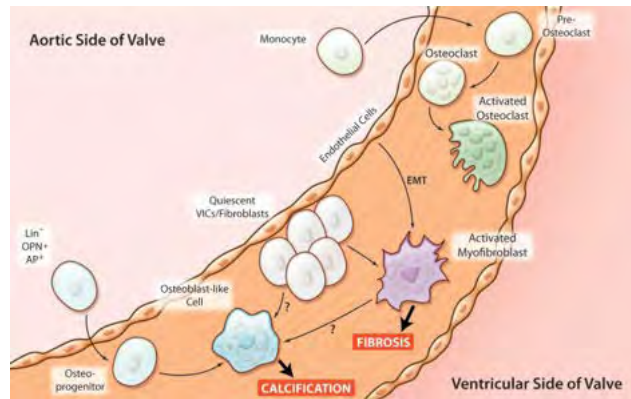


- Our basic and translational research team investigates and develops new CT scanning technology and clinical applications.
- Active projects are in the areas of:
  - Dual- and multi-energy CT
  - Use of photon-counting detectors in CT
  - Radiation dose reduction and management
  - Use of model observers for scan protocol optimization
  - Non-invasive characterization of urinary stone disease
- We receive funding from the NIBIB (3 R01 level awards), NIDDK (1 R01 level award) and industry (Siemens Healthcare)

# Jordan D. Miller, PhD

## Cardiovascular Biology

Heart Valve Disease, Vascular Biology, Age-Related Disease



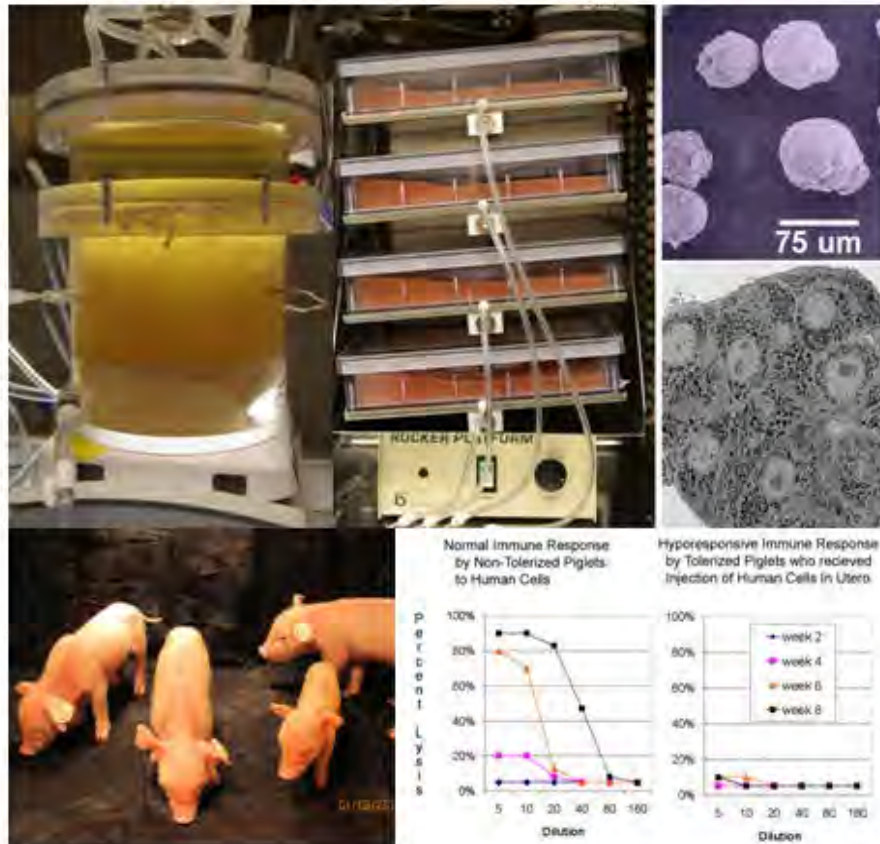
- Our primary research interests are driven by unmet clinical needs
  - Calcific aortic valve disease
  - Atherosclerosis
  - Myxomatous mitral valve degeneration
- Our research program uses cutting-edge approaches to identify novel mechanisms and therapeutic targets
  - High-throughput molecular screening
  - Effects of tissue specific gene deletion/overexpression or drug treatment on valve function in mice
  - High-resolution echocardiography, MRI, and direct catheterization techniques in mice
- Our program is highly translational and is conducting FDA-regulated, NIH-funded clinical trials
  - Re-activation of nitric oxide signaling in the progression of heart valve calcification in humans with mild/moderate aortic valve stenosis



# Scott L. Nyberg, MD, PhD.

## Bioartificial Liver

liver failure, hepatocyte transplantation,  
tissue engineering

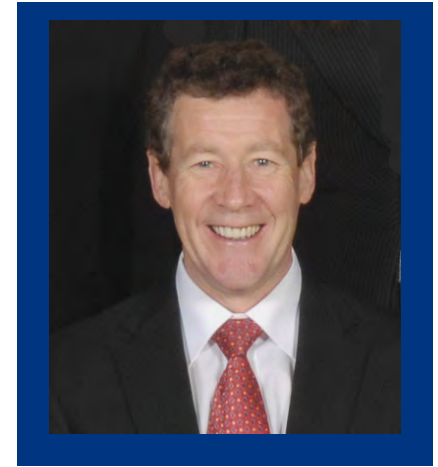


- Developing a liver support device
  - Bridge to liver transplantation
  - Mass production of human hepatocytes
  - Spheroid Reservoir Bioartificial Liver
- Genetically Engineered Pig
  - Fah-Deficient Pigs
  - Tolerization of pigs to human cells
- We have recently received funding to develop a Humanized Bioartificial Liver from the Coulter Foundation and Marriott Foundation

# Michael O'Connor, Ph.D.

## Molecular Imaging in Breast Cancer

Molecular Breast Imaging, Positron Emission Mammography, functional imaging of the breast



- We work on the development of molecular imaging technologies that can be used for the early detection of breast cancer and for monitoring breast function and response to therapies. Our work focuses on:
  - Radiation Dose reduction in MBI
  - Development of new technologies for combined anatomical/functional imaging of the breast
  - Evaluation of new radiotracers
- MBI techniques are capable of finding cancers occult on conventional imaging modalities
  - Upper left image shows a mammogram, interpreted as normal.
  - Corresponding MBI image shows a small 7 mm invasive ductal carcinoma (arrow).

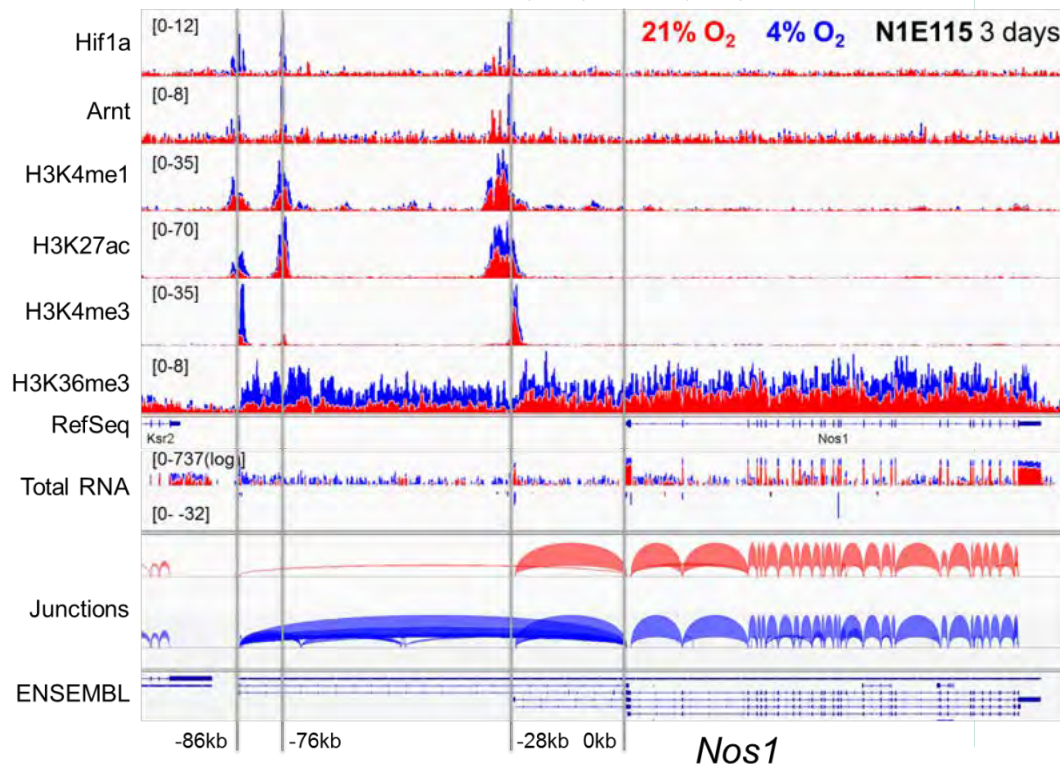
# Tamas Ordog, MD

## Metabolic Control of Transcriptional Memory and Cell Fates

Adult stem cells, Enteric neurons, Pacemaker cells,  
Epigenomics, Diabetes, Aging, Caloric deficit, Sarcoma



chr5:117,759,112-117,965,850



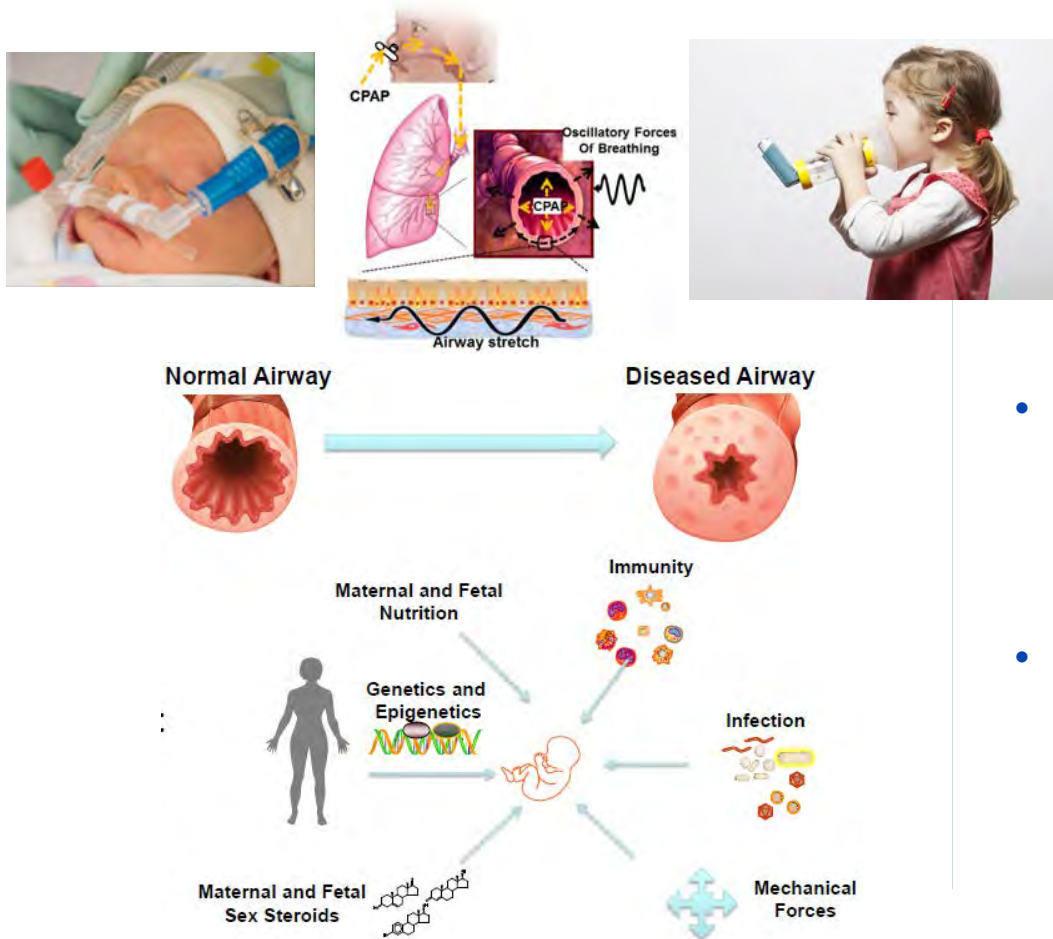
- We study heritable/long-term changes in cellular phenotypes in
  - enteric neurons and
  - pacemaker/neuromodulator cells
- We focus on cell fate changes in
  - development/aging
  - diabetes and
  - cancer
- We investigate the role of epigenetic regulation of gene transcription and its metabolic regulation via
  - hypoxia
  - glucose and
  - tricarboxylic acid cycle metabolites
- Figure: hypoxia-induced upregulation of neuronal nitric oxide synthase expression via Hif1a binding to enhancers and promoters



# Christina M. Pabelick, MD

## Pediatric Airway Diseases

Wheezing and Asthma in Neonates and Children



- **Interests:**

- Premature birth and lung growth
- Perinatal airway inflammation
- Pediatric airway diseases

- **Funding:**

- Mayo Clinic Children's Research Center
- Center for Biomedical Discovery



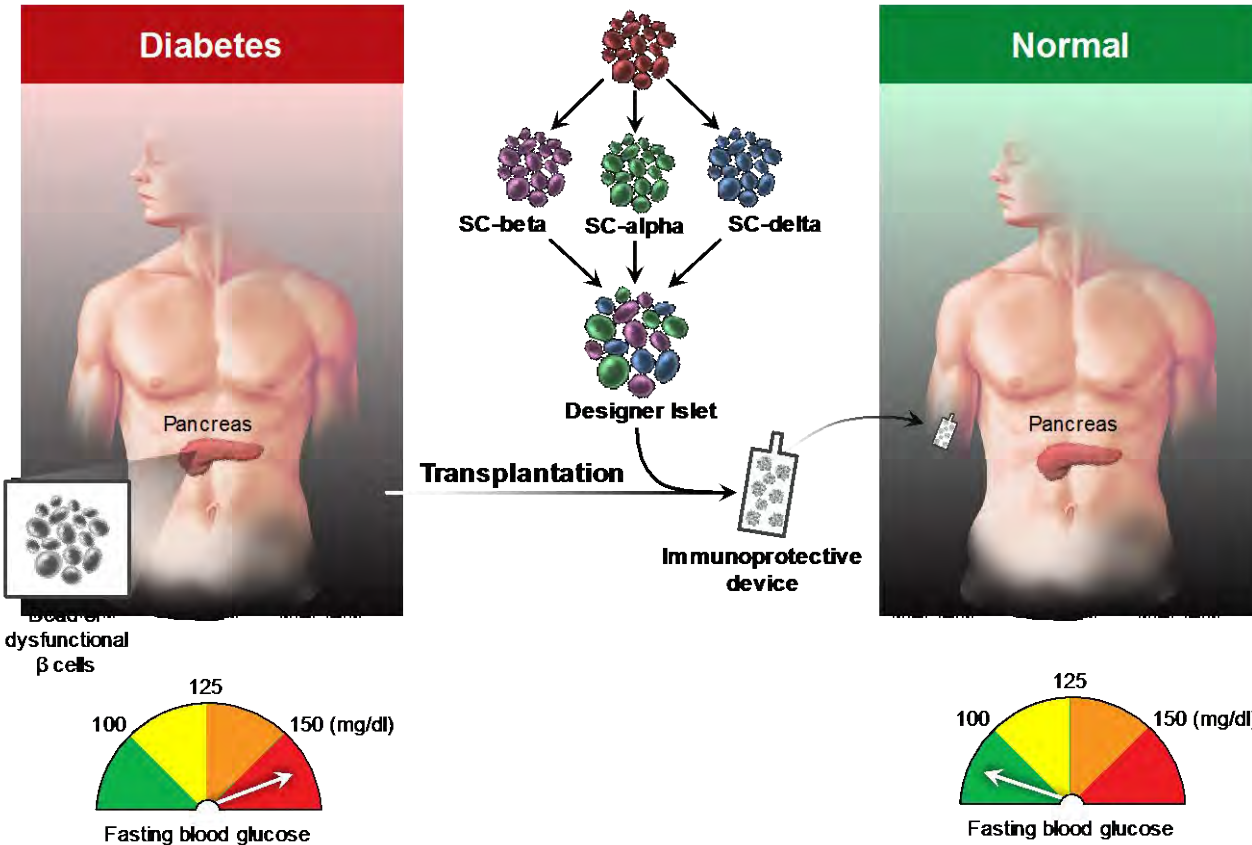
# Quinn P. Peterson, Ph.D.

## Diabetes Cell Replacement Therapy

Diabetes, Stem Cell Biology, Tissue Engineering



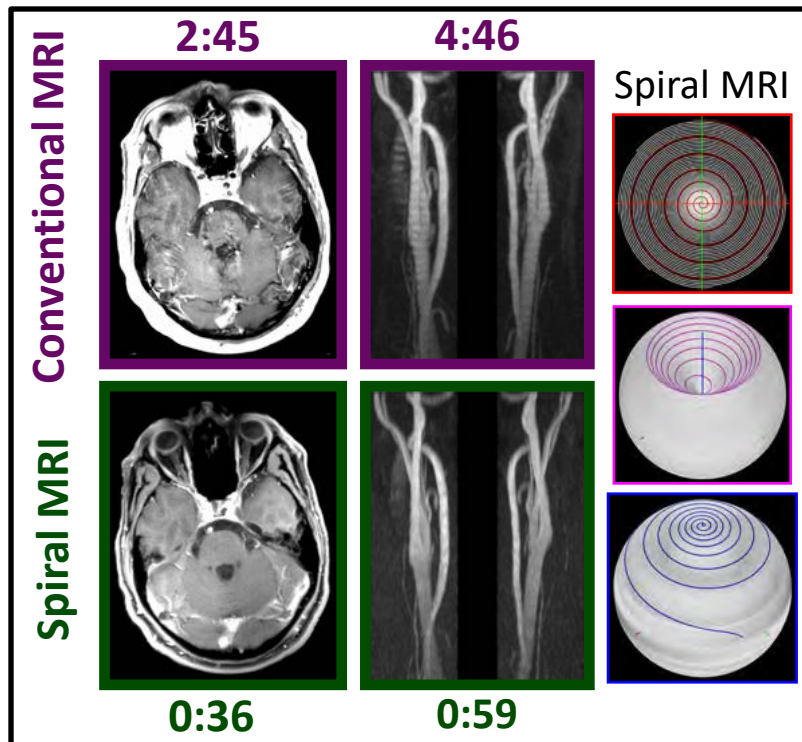
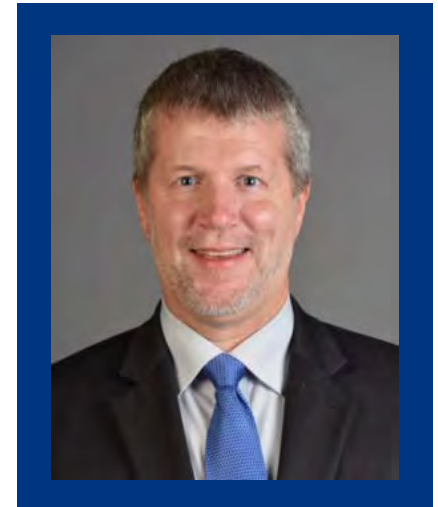
- Develop cell replacement strategies to treat type 1 diabetes
- Directed differentiation of stem cells to endocrine cell fates
- Bottom-up islet engineering to study islet structure and function



# James Pipe, PhD

## Magnetic Resonance Technology & Use Design Group

MRI methods, Rapid Imaging, Signal Processing,  
Algorithm and Software Design, Clinical Impact



- We develop many methods to improve clinical MRI, with a focus on rapid imaging
- Spiral MRI methods (*left*), a focus of our work, will speed up MRI scans by factors up to 4X to 8X while improving image quality
- We are also redesigning how MR scanners are used to positively impact patient care and reduce healthcare costs
- We work closely with MR vendors to translate our work from our lab and into clinical practice worldwide.

# Y.S. Prakash, MD, PhD

(Chair, Department of Physiology and BME)

## Lung Diseases

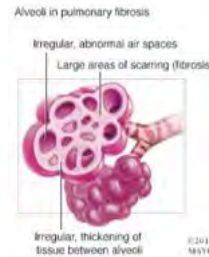
### Asthma



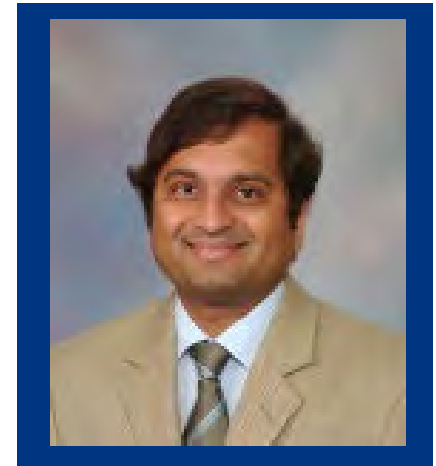
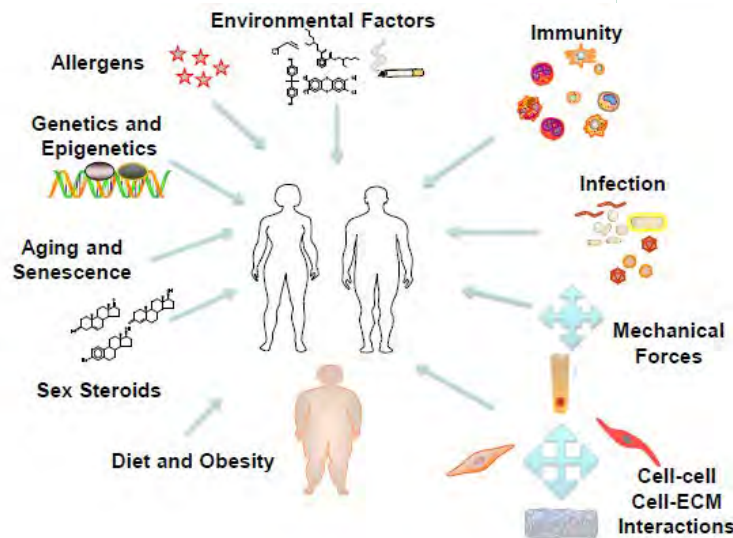
### COPD



### Fibrosis



### Growth and Aging



#### • Our Interests

- What factors contribute to lung diseases?
- How can we study lung diseases using human tissues and animal models?
- What are some novel treatment approaches?

#### • Funding

- NIH

#### • Lab Make-up

- Postdoctoral fellows
- Research associates
- Senior and junior technicians

#### • Lab Webpage

<http://www.mayo.edu/research/labs/pulmonary-cell-biology/overview>

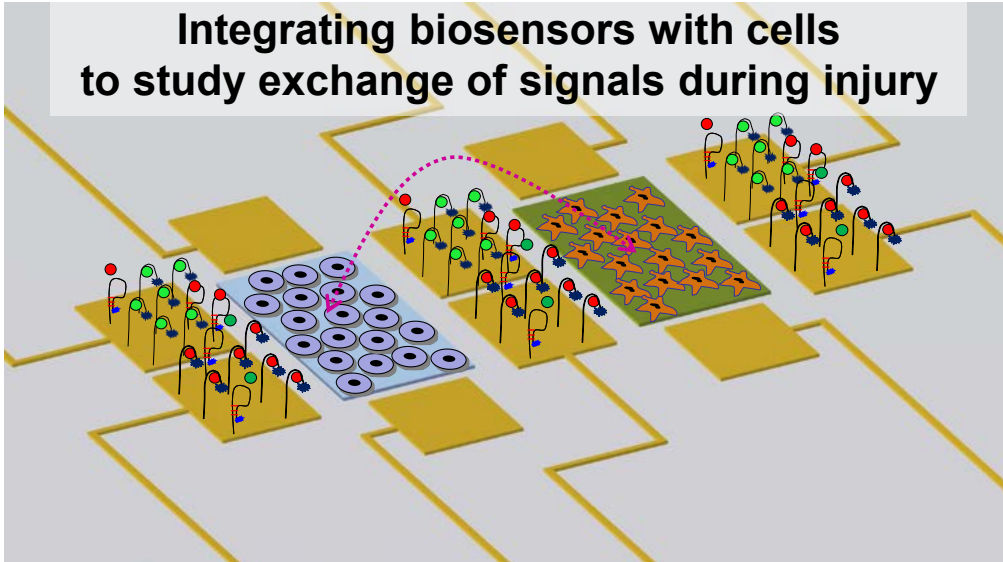
# Alexander Revzin, PhD

## Microsystems for cell cultivation and analysis

Microfluidics, micropatterned surfaces, biosensors, injury models, stem cells, personalized medicine



**Integrating biosensors with cells  
to study exchange of signals during injury**



### Grad student statistics:

10 PhD and 3MS students graduated in the past 12 yrs.  
~4.5 yrs to graduate; ~6 papers/per student.

Career paths: academia, industry, medical school.

### Example of projects in the lab:

- 1) Designing stem cell niche for differentiation of liver cells
- 2) Microfluidic devices with integrated biosensors for modeling tissue injury.
- 3) Microsystems for cancer cell cultivation and drug screening.
- 4) Miniature immunoassays for cytokine profiling and blood analysis.

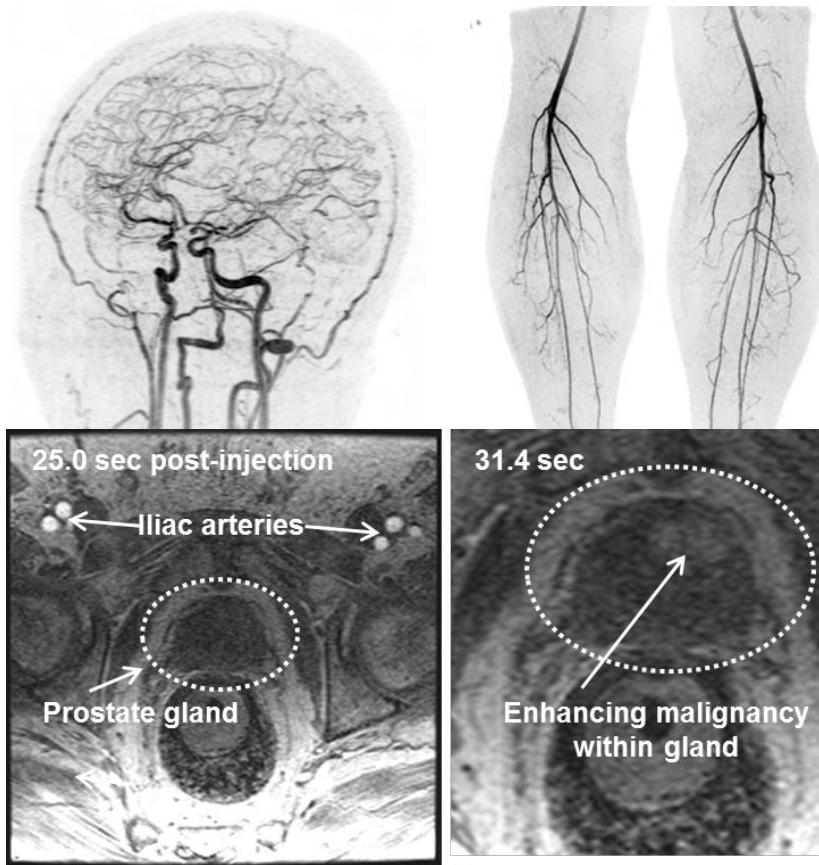
MGS Biomedical Engineering & Physiology Faculty



# Stephen J. Riederer, Ph.D.

## Magnetic Resonance Imaging Physics

MRI, fast scan MRI, MR angiography, MRI of cancer

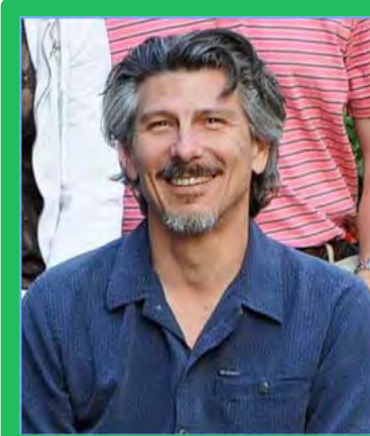


- We develop new physics-based techniques for forming MR images
  - Images with unprecedented detail
  - Short (1-10 sec) acquisition times
  - Images of blood vessels and of enhancing cancers
- Our studies range from analysis of image formation to experimental technology development to *in vivo* studies in patients
  - Shown are vessel images of the brain and lower legs, and fast selective enhancement of a prostate malignancy
- We have projects funded by NIH and the Department of Defense.

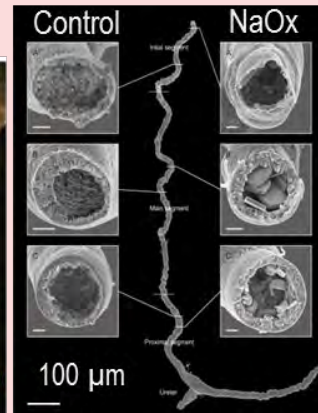
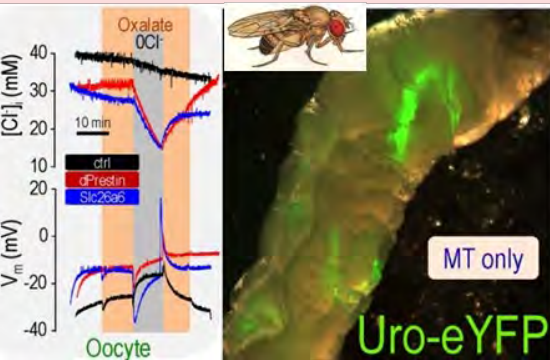
# Michael F. Romero, PhD (Professor, Cons)

## Transporter biology & pHysiology laboratory

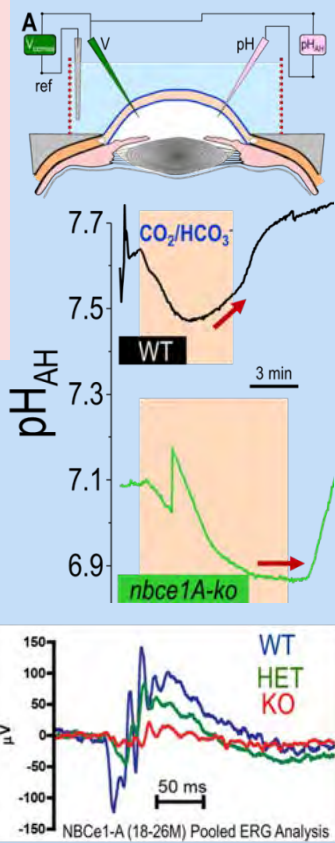
ion/solute transport, physiology, kidney, eye, gut, animal models, electrophysiology, disease molecular mechanisms, sensor development



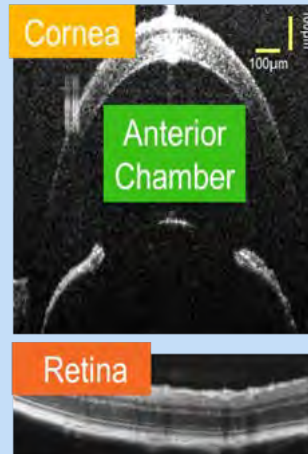
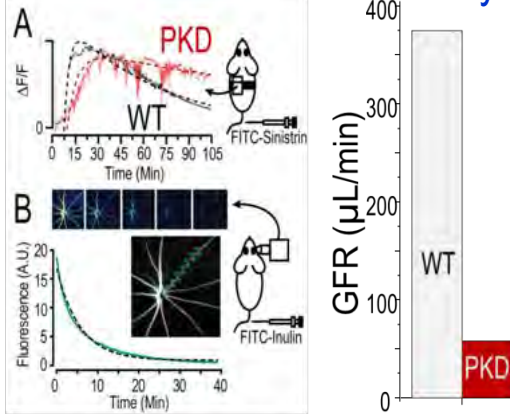
### *Drosophila* kidney stones



### Ocular Physiology



### Renal function – GFR via Eye



### Current Lab Projects:

#### 1. *Drosophila* - Kidney stones

- a. genes- fly, dog, human
- b. prevention therapeutics

#### 2. Renal function / phenotyping

- a. Glomerular filtration rate, GFR
- b. PKD models
- c. NBCe1 knockout mice

#### 3. Ocular Physiology

- a. Glaucoma – OCT, ERG
- b. NBCe1 knockouts & Aging

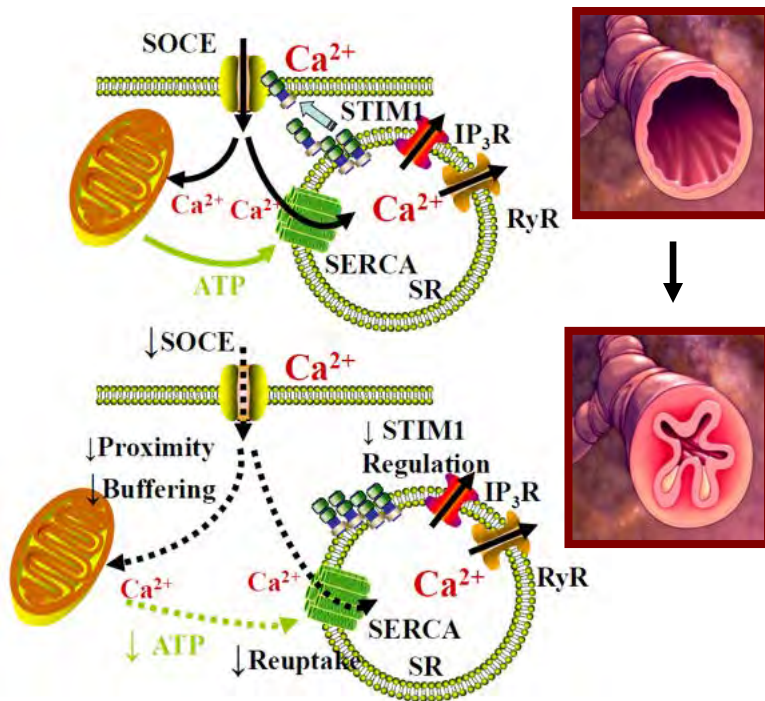
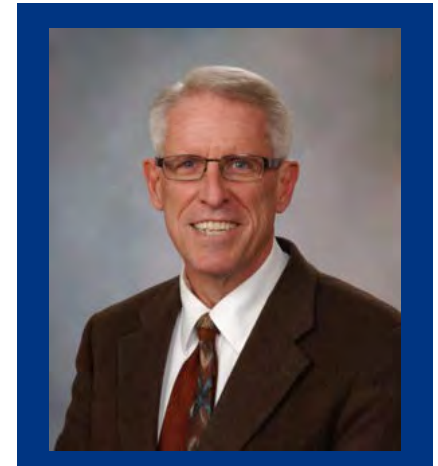
#### 4. New Sensors

- a. pHerry, pHire
- b. voltage

# Gary C. Sieck, Ph.D.

Physiology, Biomedical Imaging, Biomechanics

Neural Control of Respiration, Neuromuscular Control,  
Confocal Microscopy, Muscle Mechanics



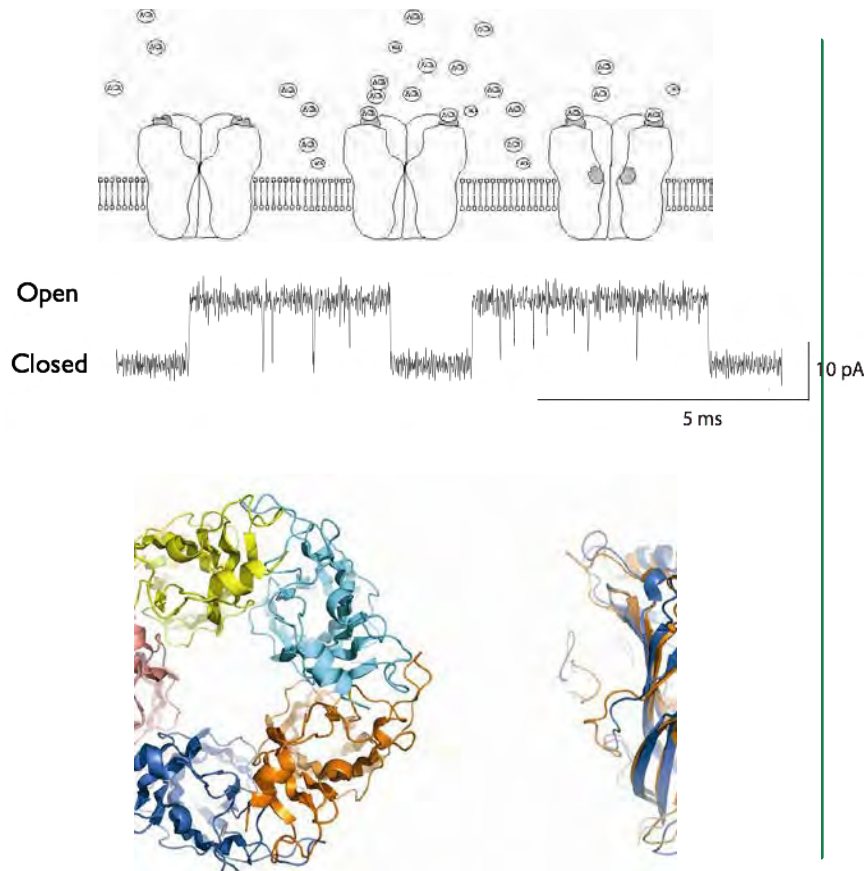
- Our research focus is:
  - Neuromotor Control of Diaphragm muscle
  - Contractile Protein expression & muscle fiber mechanics
  - **Pathways in Calcium Regulation**
    - **Smooth, Cardiac & Skeletal Muscle**
  - **Anesthetic effect on cardiac & smooth muscle**



# Steven M. Sine, Ph.D.

## Physiology and Biophysics

Nicotinic Acetylcholine Receptors, Drug Discovery



## Muscle & Neuronal AChRs

- Single molecule recording
- Disease mechanisms
- Reaction mechanisms
- Receptor structure
- Receptor pharmacology

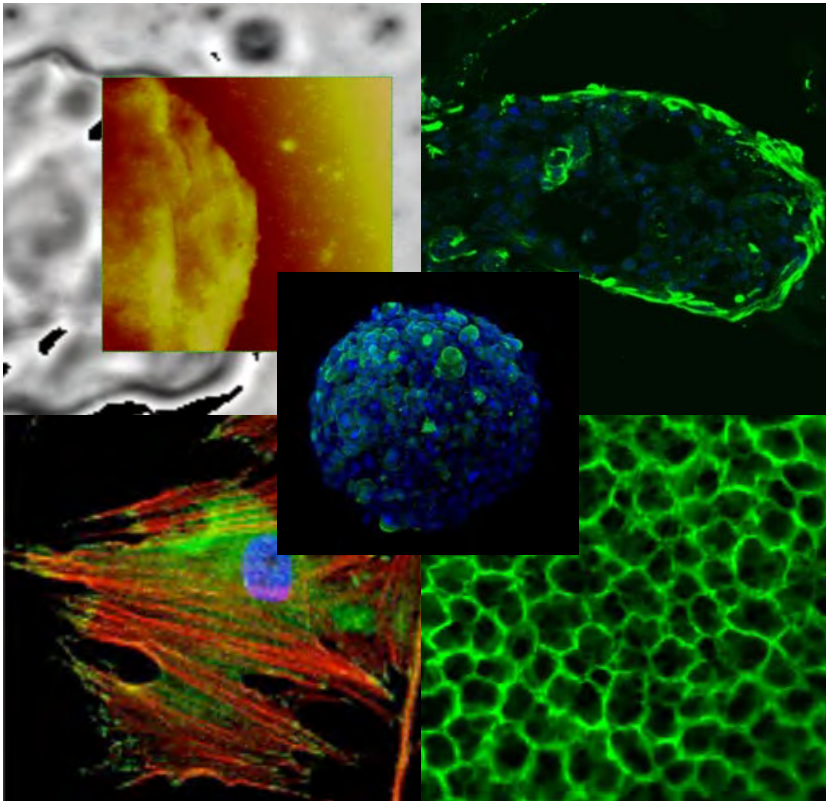


# Daniel J. Tschumperlin, PhD

## Tissue Repair and Mechanobiology

Matrix & Cell Biology, Regenerative Medicine

Microphysiological Disease Modeling

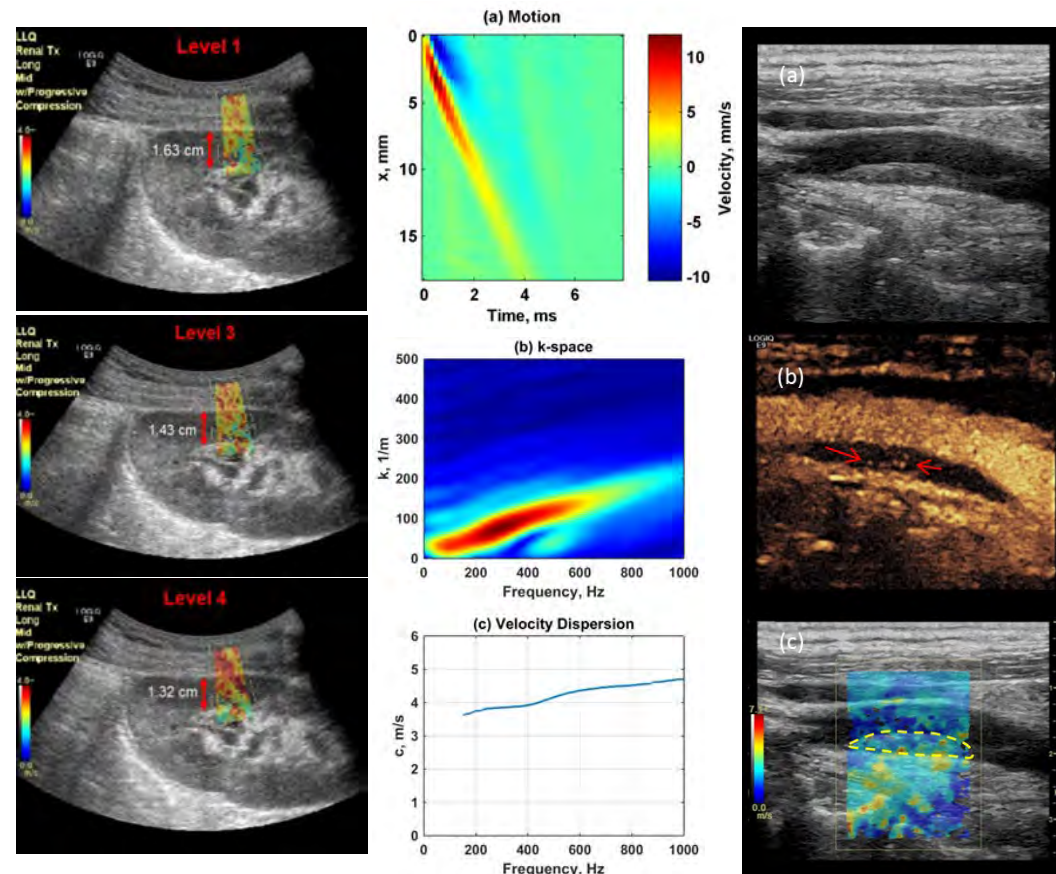


- We are building a deeper understanding of cell-cell and cell-matrix interactions that underlie human disease processes, using:
  - Mechanobiological systems to study cell-matrix-mechanical interactions
  - Microfluidic and scaffold-free multicellular models to study tissue level pathophysiology
  - 3D self-assembly approaches to study tissue organization and regeneration
- Our goal is to develop novel therapies and approaches for:
  - Pulmonary Fibrosis
  - Lung Regeneration

# Matthew W. Urban, Ph.D.

## Ultrasound Research

Shear Waves, Ultrasound Imaging,  
Viscoelastic, Anisotropic, and Nonlinear Tissue Properties



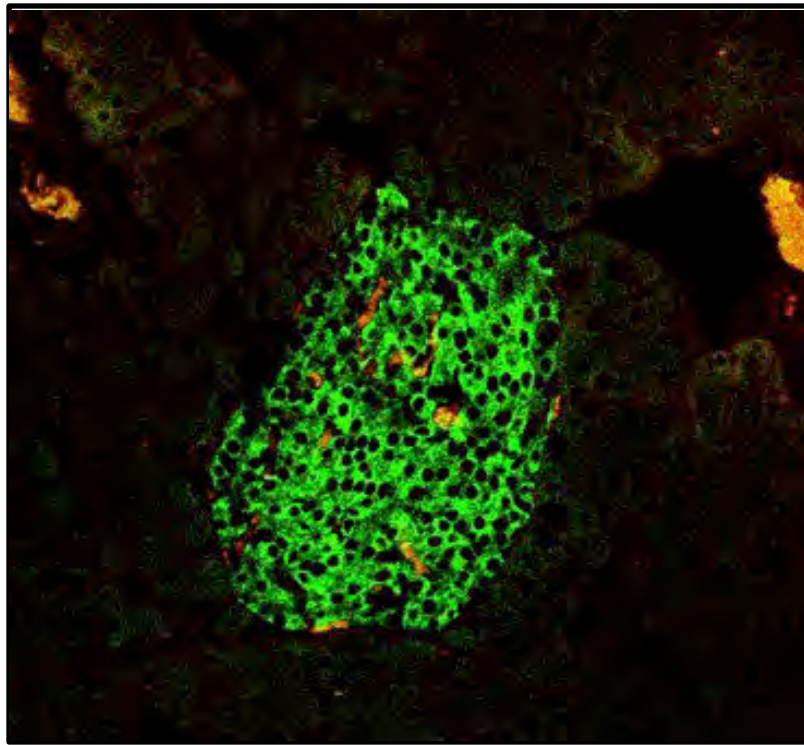
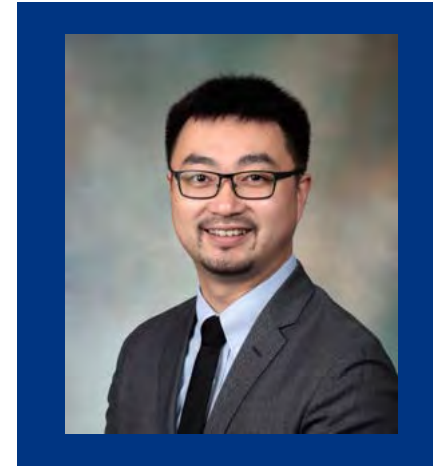
- We are interested in using ultrasound to study mechanical properties of tissue including
  - Unique methods for shear wave generation
  - Novel techniques for shear wave detection
  - Advanced methods of measuring tissue viscoelasticity, anisotropy, and nonlinearity
- Representative results from our work are shown
  - Left column: Shear wave velocity changes in renal allografts when subjected to compression. This is used to measure shear nonlinearity.
  - Middle column: (a) Wave propagation in human carotid artery, (b) Fourier representation of motion, (c) Wave velocity dispersion.
  - Right column: (a) Ultrasound imaging in patient with carotid plaque, (b) Contrast-enhanced ultrasound with red arrows pointing to microbubbles, (c) Shear wave velocity map of plaque.
- We have funding from NIH to study renal viscoelastic properties in renal transplants and patients with chronic kidney disease (R01DK092255) and internal funds to explore vascular elastography.

# Zong Wei, Ph.D.

## Assistant Professor

### Laboratory of Epigenomics and Metabolism

Focus: diabetes, epigenetics and genomics, immunometabolism



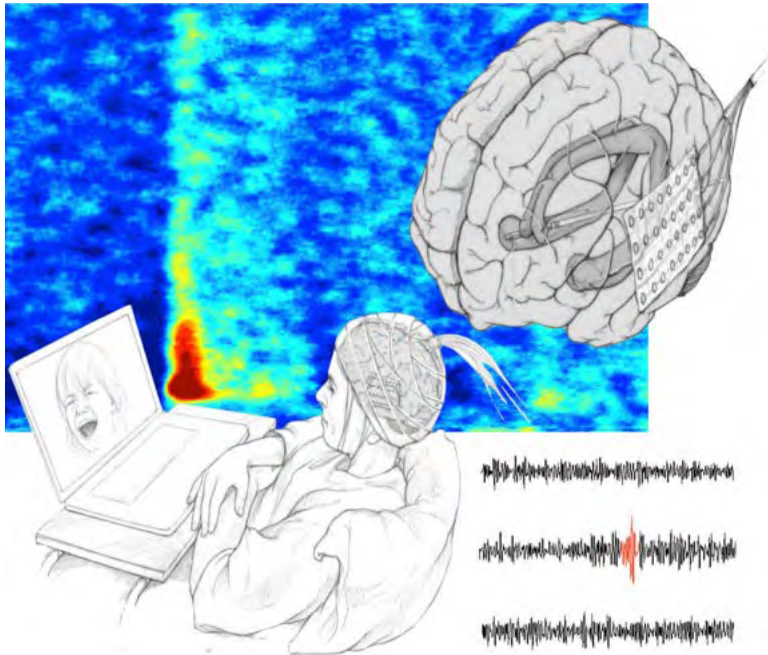
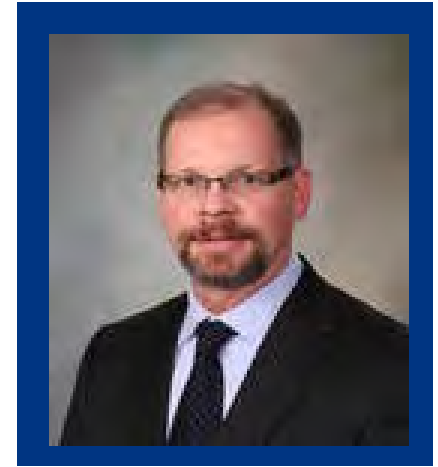
- Our lab focuses on basic and translational research in metabolic diseases, including:
  - Signal-dependent epigenomic dynamics in diabetes.
  - Novel epigenetic regulators in metabolic diseases and chronic inflammation.
  - Cross-talk between pancreatic islets and the immune microenvironment.
- Our research is funded by K01 Career Development Award from NIDDK



# Greg A. Worrell, MD., Ph.D.

Mayo Systems Electrophysiology Laboratory  
Departments of Neurology & Biomedical Engineering  
and Physiology

Epilepsy, Cognition, Neurophysiology, Brain Stimulation



Kucewicz et al. Brain 2014

- Our research focus is:
  - **Neurophysiology of normal and pathological brain**
    - Epileptogenesis & Ictogenesis (the process by which epilepsy & seizures develop)
    - Cognition, Sleep & Movement
    - Data-mining & machine learning in large-scale neurophysiology data
  - **Brain stimulation**
    - Mapping normal & pathological brain
    - Therapeutic stimulation for neurological disorders

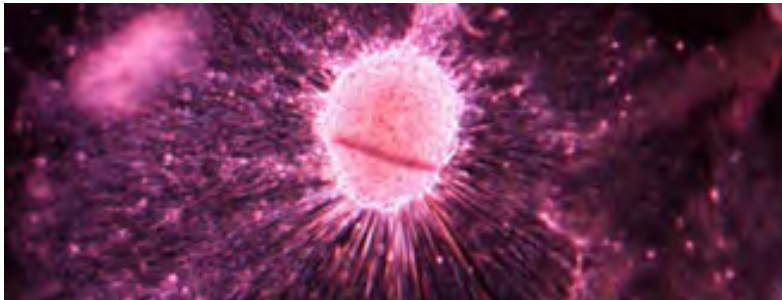
**Funded by NIH, DARPA & Mayo Clinic**



# Michael J. Yaszemski, MD, PhD

Professor of Biomedical Engineering  
and Orthopedics

Tissue Engineering and Biomaterials; Bone  
Histomorphometry



Dorsal root ganglion explant (containing neurons, Schwann cells and supporting cells) dissected from rat embryos cultured on positively charged OPF hydrogel. (Mahrokh Dadsetan, Ph.D., Andrew Knight, Ph.D.)

- Synthesis and characterization of novel degradable polymers for use in bone regeneration
- Nervous tissue regeneration
- Controlled delivery of chemotherapeutic agents to muscular tumors

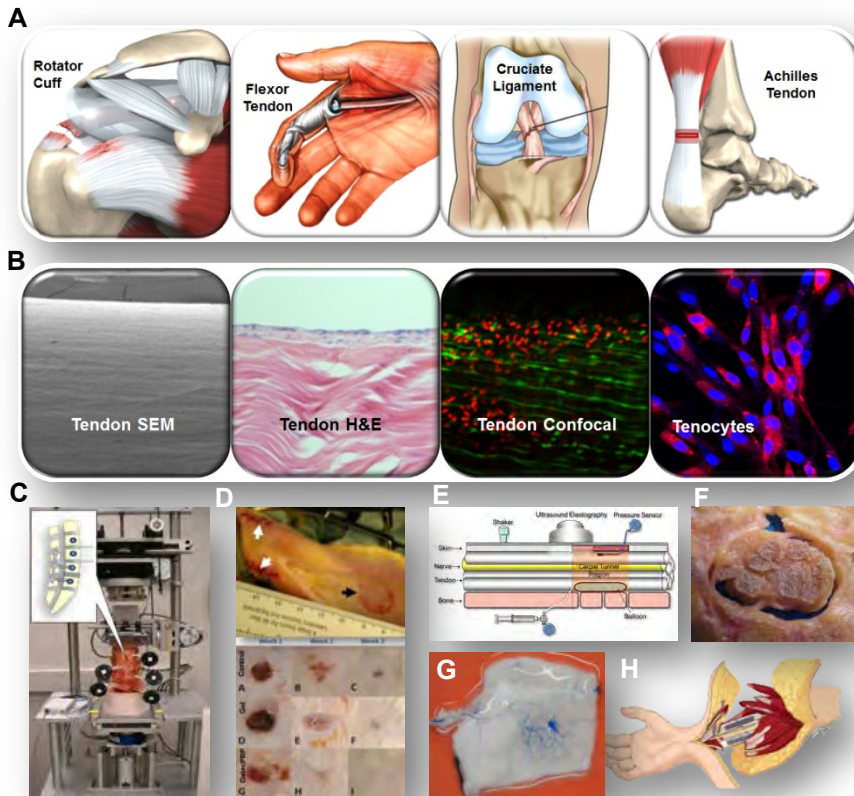
# Chunfeng Zhao, M.D.

## Biomechanics and Tendon/Soft Tissue Biology Laboratory

Musculoskeletal biomechanics

Tendon and soft tissue engineering and regenerative medicine

Musculoskeletal organ/tissue transplantation

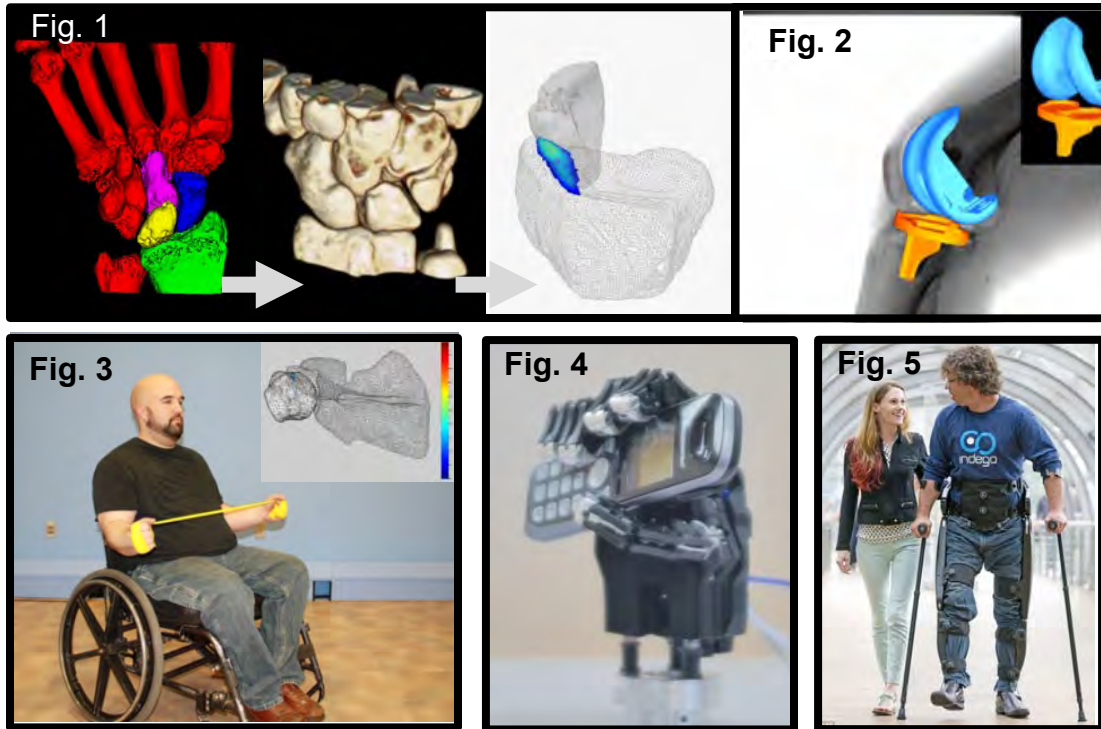


- My research focuses on clinical translational research in musculoskeletal, skin and composite tissues injury, repair, and regeneration, especially tendon and ligament (Fig A)
- Stem cell based therapy, tissue engineering and regenerative medicine in musculoskeletal system (Fig B).
- Musculoskeletal biomechanics, especially in spine and upper extremity areas (Fig C).
- Regenerative medicine for wound healing (Fig D)
- Medical imaging research, especially using ultrasound elastography for musculoskeletal disorders (Fig E)
- Carpal tunnel syndrome research (Fig F)
- Composite tissue (Fig G), hand and digit transplantation (Fig H)

# Kristin Zhao, Ph.D.

## Assistive and Restorative Technology Laboratory

biomechanics, assistive technology, imaging methods, rehabilitation interventions



Dr. Zhao's team uses innovative technologies, including biomechanics and imaging, to enable earlier diagnoses, effective intervention and outcome assessment, and the development of novel assistive devices for individuals with injuries and disabilities. Some current projects include:

- Assessment of wrist joint and thumb joint instability using dynamic CT imaging (Fig. 1)
- Knee joint implant tracking using fluoroscopy shape matching techniques (Fig. 2)
- Computer modeling and exercise interventions for individuals with spinal cord injury to reduce shoulder pain (Fig. 3)
- Development of a novel myoelectric prosthesis (Fig. 4)
- Exoskeleton use in chronic spinal cord injury (Fig. 5)

Funding includes NIH, DOD, and Mayo-ASU Team Science Award.



# Wuqiang Zhu, M.D., Ph.D.

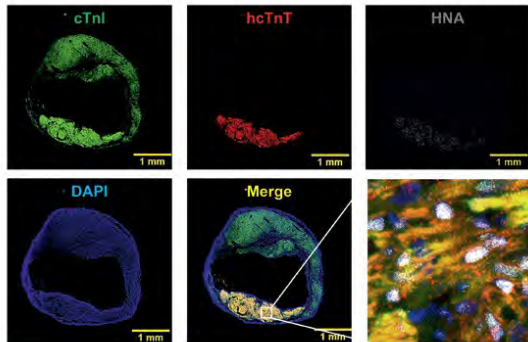
## Associate Professor

Cardiomyocyte proliferation, Cell cycle, Stem cell therapy, Chemotherapy, Cardiotoxicity, Optogenetics, Nanoparticle



- This is the science that we are interested in
  - Myocardial regeneration in neonatal porcine hearts
  - Stem cells-based therapy for myocardial repair
  - Chemotherapy-induced cardiotoxicity
- We have been know to make pretty pictures
  - Here is a pretty picture of remuscularization of injured left ventricle by human induced pluripotent stem cells-derived cardiomyocytes six months after cell implantation
- We have recently received funding to study this stem cell based therapy for ischemic heart diseases in pigs

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MOLECULAR AND  
CELLULAR CARDIOLOGY



ISHR  
International Society for Heart Research