## BIOGRAPHICAL SKETCH

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NAME: Christopher Michael Francis

eRA COMMONS USER NAME (credential, e.g., agency login): CMFRANCIS

POSITION TITLE: Assistant Professor

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

| INSTITUTION AND LOCATION | DEGREE *(if applicable)* | Completion Date MM/YYYY | FIELD OF STUDY |
|---|---|---|---|
| Auburn University, Auburn, AL | BSc | 2006 | Physics |
| University of South Alabama, Mobile, AL | PhD | 2013 | Physiology |
| University of South Alabama, Mobile, AL | Postdoctoral Research | 2017 | Physiology and Cell Biology |

### A. Personal Statement

My primary research focuses are computational biology and image analysis, with the general aim of deciphering signaling within the vasculature in physiology and disease. Through my undergraduate and graduate training in physics and computational physiology, I have developed a skillset in several quantitative areas including mathematical modeling, biostatistics, image processing, and software design. I have taken courses in mathematical modeling with Mathematica (Wolfram Research) and developed a computational model of cell calcium signaling in Matlab (Mathworks) as the primary topic of my doctoral dissertation under my advisor, Dr. Mark Taylor. Since pursuing physiological research in signal transduction, I have learned advanced biostatistics and statistical processing with R as a means of analyzing the complex and diverse patterning of tissue-wide calcium signaling. Along with my work in confocal microscopy, this has led to my research in image processing and analysis, specifically in the design and implementation of image processing algorithms as they relate to measurement of intracellular signaling events. These research interests were realized during my graduate work with the design of LC_Pro, a java-based application for ImageJ (NIH) to perform automated, high-throughput analysis of intracellular signals, which is currently used by over fourteen labs in the United States, United Kingdom, Japan, and the Netherlands. Recently, I completed development of a next-generation signal processing software solution written in python and implemented through google cloud platform cloud computing. This work has led directly to the development of thermographic analysis software for active dynamic thermography methods using forward looking infrared for the purposes of diagnosing partial thickness burn wounds. As this analytics technique is targeted to assessment of tissue viability, I have recently pursued the implementation of this approach in burn wounds and pressure injuries by constructing a simple handheld infrared device with onboard software

In parallel to my quantitative training, I have had both graduate and postdoctoral education with my postdoctoral mentor, Dr. Troy Stevens, in vascular physiology and animal studies. During this time, I mastered the technique of dissecting and opening vascular segments for the measurement of intracellular calcium signals in intact endothelial and smooth muscle layers. As a postdoctoral researcher with mentorship from Dr. Stevens, I have extended these techniques into the field of lung biology, where I have investigated the role of vascular calcium dynamics in the pathology of pulmonary arterial hypertension (PAH). More recently, I have learned the technique of live lung imaging using agarose and gelatin installations to enable the imaging of thin slices of lung segments. Since my graduate studies, I have also maintained active collaboration with Dr. Taylor. Recently, our interest in measuring endothelial shear stress has coincided, and our collaboration has culminated with the design of a perfused opened artery imaging chamber to perform studies on physiological shear stress as a driver of vascular remodeling. Taken together, my expertise in vascular biology, computational techniques, and biomedical engineering qualifies me for the work outlined in the submitted project proposal.

## B. Positions and Honors

2007-2013: Graduate Student, Department of Physiology, University of South Alabama College of Medicine, Mobile, AL. (Mark S. Taylor, Dissertation Advisor)

2013-2017: Postdoctoral Fellow, Department of Physiology and Cell Biology and Center for Lung Biology, University of South Alabama College of Medicine, Mobile, AL. (Troy Stevens, Mentor)

2017-present: Assistant Professor, Department of Physiology and Cell Biology, and Center for Lung Biology, University of South Alabama College of Medicine, Mobile, Al.

## C. Contributions to Science

Analysis technology
During my training, I have made three significant contributions to the scientific community in the areas of biological image processing and vascular physiology: 1. Development of an automated, high-throughput software solution to biological second messenger signal analysis, 2. Use of this technology to decipher vascular endothelial calcium signaling patterns, and 3. Investigation of the functional impact of signaling patterns on vascular tissue

Intracellular calcium signals have long been measured using fluorescent indicators and microscopy, but these signals have only been recently resolved in subcellular locales and high temporal resolution. Such technological advances in microscopy have led to the discovery of vastly complex and heterogeneous calcium activity in vascular tissue, but there are significant limitations to the effective analysis of such measured data. As part of my dissertation work, I developed and coded an algorithmic approach to the rapid and unbiased analysis of these data sets with my advisor, Dr. Mark Taylor. This work, implemented as a plugin for NIH ImageJ, is widely in use within the vascular signaling community, and has been vetted in the following publications:

- **Francis M**, Qian X, Charbel C, Ledoux J, Parker JC, Taylor MS. "Automated region of interest analysis of dynamic $Ca^{2+}$ signals in image sequences". *Am J Physiol Cell Physiol.* 2012; 303(3):C236-43. PMCID: PMC3423022

- **Francis M**, Waldrup J, Qian X, Taylor MS. "Automated analysis of dynamic $Ca^{2+}$ signals in image sequences". *J Vis Exp.* 2014; 88. PMCID: PMC4195352

As previously described, advancements in imaging and signal analysis have led to the identification of numerous spatially and temporally distinct calcium signals in endothelial and smooth muscle cell layers of the vasculature. Although our advanced analysis approaches have been utilized to characterize these modalities, there has been a lack of relevant metrics of functional outcomes of these signaling signatures, and they have yet to be integrated into physiological theory. To this end, I have conducted original research and co-authored the following publications on the topic of deciphering calcium signal patterning. Finally, I have contributed to the physiological community by performing research aimed at elucidating the functional role of complex signal patterns in physiology and disease. In this area, our research group has provided major experimentally substantiated contributions to physiological theory, particularly in the field of vascular physiology:

- **Francis M**, Waldrup J, Qian X, Meriwether J, Solodushko V, Taylor M. "Functional tuning of intrinsic $Ca^{2+}$ dynamics in swine coronary arteries. *Circ Res.* 2016 1;118(7):1078-90. PMCID: PMC4818197

- **Francis M**, Xu N, Zhou C, Stevens T. "TRPC4 encodes high frequency calcium events in severe pulmonary arterial hypertension". *Am J Path.* 2016;186(6):1701-1709. PMCID: PMC4901130

## D. Additional Information: Research Support

**Ongoing Research Support**

K25 HL136869 (Francis) 07/01/2017-06/30/2022
NIH/NHLBI

NIH Mentored Quantitative Research Development Award (K25)
“TRPC4-mediated Calcium Signals Accelerate Vascular Remodeling in Pulmonary Arterial Hypertension”
The major goal of this project is to determine the role of interaction between TRPC4-dependent calcium signals and shear stress in driving vascular remodeling in pulmonary arterial hypertension.
Role: Principal Investigator (Mentor: Troy Stevens, PhD)

**Completed Research Support**

COM Intramural Grant (Fonseca) 01/01/2019-12/31/2019
University of South Alabama
“Image Analysis to Quantify Metastatic Risk in Pancreatic Intraductal Papillary Mucinous Neoplasms.”
Role: Co-Investigator