**BIOGRAPHICAL SKETCH**

Provide the following information for the Senior/key personnel and other significant contributors.
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NAME: Kenneth S. Campbell

eRA COMMONS USER NAME: ken.campbell

POSITION TITLE: Associate Professor of Physiology and Cardiovascular Medicine

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 |
|---|---|---|---|
| University of Oxford, Oxford, UK | BA (Hons) | 09/90-06/93 | Physics |
| University of Birmingham, Birmingham, UK | PhD | 09/93-04/98 | Muscle physiology |
| University of Wisconsin-Madison, WI, USA | Postdoc | 04/98-01/03 | Muscle physiology |

No variances from ordinary career progression

**A. PERSONAL STATEMENT**

I have broad training and ~20 years of experience in biophysics, physiology, and scientific computing. My research focuses on heart failure (http://www.campbellmusclelab.org) and bridges the scientific gaps between molecular, cellular, and organ-level function. I also collaborate extensively with cardiothoracic surgeons and cardiologists. Many of our experiments use tissue samples isolated from patients undergoing heart transplants and other cardiac surgeries. I have also gained leadership experience by directing an institution-wide biobanking program for the University of Kentucky Center for Clinical and Translational Science. This program currently collects discarded clincal samples from ~20,000 patients.

My research lab is currently focusing on three main goals.

1) Identify the molecular changes that have the biggest impact on the heart's ability to pump blood. These can be targeted with new therapies to rescue function.
2) Understand the relationship between torsion (twisting of the heart) and transmural variation (changes in cellular properties across the ventricular wall).
3) Integrate cardiac imaging and computer modeling to predict how therapies will affect function. This will help clinicians to develop patient-specific treatment plans.

Representative manuscripts include:


1) Campbell, S. G., Haynes, P., Kelsey Snapp, W., Nava, K. E. & **CAMPBELL, K. S.** (2013). Altered ventricular torsion and transmural patterns of myocyte relaxation precede heart failure in aging F344 rats. *AJP Heart.* 305, H676-686. PMC 3761331.
2) Haynes, P., Nava, K. E., Lawson, B. A., Chung, C. S., Mitov, M. I., Campbell, S. G., Stromberg, A. J., Sadayappan, S., Bonnell, M. R., Hoopes, C. W. & **CAMPBELL, K. S.** (2014). Transmural heterogeneity of cellular level power output is reduced in human heart failure. *J Mol Cell Cardiol.* 72, 1-8. PMC 4037376.
3) **CAMPBELL, K. S.** (2014). Dynamic coupling of regulated binding sites and cycling myosin heads in striated muscle. *J Gen. Physiol.* 143, 387-399. PMC 3933939.
4) **CAMPBELL, K. S.** (2016). Compliance accelerates relaxation in muscle by allowing myosin heads to move relative to actin. *Biophys. J.* 110, 661-668. PMCID not available. PMID 26840730.

## B. POSITIONS AND HONORS

### Positions and Employment

| | |
|---|---|
| 2003 – 2004 | Assistant Scientist, Department of Physiology, University of Madison-Wisconsin |
| 2004 – 2009 | Assistant Professor (Tenure-track), Department of Physiology, University of Kentucky |
| 2009 – present | Associate Professor (Tenured), Department of Physiology, University of Kentucky |
| 2015 – present | Associate Professor (Joint Appointment), Division of Cardiovascular Medicine, University of Kentucky |

### Other Experience

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|---|---|
| 2006 - 2012 | Biophysical Society Early Careers Committee |
| 2007 | Symposium Chair, Experimental Biology, American Physiological Society Annual Meeting |
| 2008, 2010 | Biophysical Society Annual Meeting Career Workshop Coordinator |
| 2009 | Invited Speaker, The 2009 Workshop on Multi-scale Muscle Mechanics, Woods Hole, MA |
| 2009 - present | Executive Committee Member, Center for Muscle Biology, University of Kentucky |
| 2009 - 2014 | Co-Director, Single Fiber Function, Center for Muscle Biology, University of Kentucky |
| 2010 | Symposium Chair, 6$^{th}$ World Congress on Biomechanics, Singapore |
| 2011 | Co-Chair, Muscle Mechanics and Ultrastructure, Biophysical Society Annual Meeting |
| 2011 | Director, Modeling workshop for trainees in muscle biology, University of Kentucky |
| 2011 - 2013 | Key Function Leader, Translational Technologies and Resources, Kentucky Center for Clinical and Translational Sciences |
| 2013 | Invited speaker, Workshop on Multiscale Physics of Muscle, University of Washington |
| 2013 - present | Core Director, Biospecimens, Kentucky Center for Clinical and Translational Sciences |
| 2013 - present | Chair, Executive Steering and Operations Committees, University of Kentucky Global Consent Biobanking Project |
| 2014 | Symposium Speaker, Biophysical Society Annual Meeting |
| 2015 - present | Co-founder and Chief Technology Officer, MyoAnalytics, LLC |
| 2016 - present | Director of Graduate Studies, Department of Physiology, University of Kentucky |

### Grant Reviewing

| | |
|---|---|
| 2007 - 2009 | American Heart Association, National Peer Review Committee Member |
| 2007 | Ad hoc Reviewer for National Science Foundation |
| 2010 | Ad hoc Reviewer for Swiss National Science Foundation |
| 2010 | Ad hoc Reviewer for Prinses Beatrix Fonds (The Netherlands) |
| 2011 - 2012 | Co-Chair, American Heart Association, Cardiac Biology and Regulation 1 |
| 2012 - 2014 | Ad hoc, NIH ZHL1 CSR-P (01)1 – Mentored Career Transition Scientist |
| 2012, 2014 | National Science Foundation (Foundation policy prevents identifying the review panels) |
| 2013 – 2014 | Chair, American Heart Association, Cardiac Biology and Regulation 1 |
| 2013 - present | University of Kentucky CTSA Pilot Review Standing Committee |
| 2013 | NIH NHLBI PPG Invited reviewer |
| 2014 - 2019 | Charter member, NIH CSR MTI Review Panel |
| 2015 | American Heart Association Established Investigator Award review panel |

### Editorial Board

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|---|---|
| 2010 - present | Frontiers in Cardiac Muscle Physiology |
| 2014 - present | VAD – the Ventricular Assist Device Journal |

### Manuscript Reviewing

Approximately 1 article every 3 weeks for journals including: Archives of Biochemistry and Biophysics, American Journal of Physiology: Endocrinology and Metabolism, American Journal of Physiology: Heart and Circulatory Physiology, Biophysical Journal, Circulation, Circulation Research, European Journal of Applied Physiology, Journal of Applied Physiology, Journal of Experimental Biology, Journal of General Physiology, Journal of Molecular and Cellular Cardiology, Journal of Physiology, Journal of Theoretical Biology, Mathematical Biosciences, Pflügers Archiv, PLoS Computational Biology, PLoS One

**Honors**

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|---|---|
| 1993 - 1998 | Wellcome Trust Prize Studentship |
| 1999 - 2002 | American Heart Association Postdoctoral Fellowship |
| 2006, 2010, 2014 | Holsinger Award for Excellence in Teaching (University of Kentucky, Physiology) |
| 2007, 2014 | Abraham Flexner Master Educator Award (University of Kentucky, Medicine) |
| 2012 - present | Fellow of the American Heart Association |
| 2014 | University of Kentucky CTSA Mentor Recognition Award |

**Professional Memberships**

| | |
|---|---|
| 1993 - 2010 | Physiological Society |
| 1998 - present | Biophysical Society |
| 2001 - present | American Heart Association |
| 2004 - present | American Physiological Society |

## C. CONTRIBUTION TO SCIENCE

Complete list of published work in NCBI My Bibliography (50 publications, h-index is 22, i10-index is 32). http://www.ncbi.nlm.nih.gov/sites/myncbi/kenneth.campbell.1/bibliography/41161730/public/?sort=date&direction=descending

### Contribution 1: Transmural variation in myocardium

Dr. Campbell's laboratory has demonstrated that rodent and human hearts exhibit transmural variation in contractile function and that disease changes the normal patterns. These results are important because they may explain changes in cardiac torsion and regional shortening that predict clinical outcomes.

5) Campbell, S. G., Haynes, P., Kelsey Snapp, W., Nava, K. E. & **CAMPBELL, K. S.** (2013). Altered ventricular torsion and transmural patterns of myocyte relaxation precede heart failure in aging F344 rats. *AJP Heart.* 305, H676-686. PMC 3761331.

6) Chung, C. S. & **CAMPBELL, K. S.** (2013). Temperature and transmural region influence functional measurements in unloaded left ventricular cardiomyocytes. *Physiological Reports.* 1, e00158. PMC 3871472.

7) Haynes, P., Nava, K. E., Lawson, B. A., Chung, C. S., Mitov, M. I., Campbell, S. G., Stromberg, A. J., Sadayappan, S., Bonnell, M. R., Hoopes, C. W. & **CAMPBELL, K. S.** (2014). Transmural heterogeneity of cellular level power output is reduced in human heart failure. *J Mol Cell Cardiol.* 72, 1-8. PMC 4037376.

8) Zhang, X., Haynes, P., **CAMPBELL, K. S.**, & Wenk, J. (2015). Numerical evaluation of myofiber orientation and transmural contractile strength on left ventricular function. *J. Biomech. Eng.* 137:044502. PMCID not available. PMID 25367232.

### Contribution 2: Quantitative understanding of muscle biophysics

Dr. Campbell has published 24 manuscripts that include experimental data quantifying the mechanical properties of skeletal and cardiac muscles. Important insights from these publications include: (a) bound cross-bridges contribute to diastolic myocardial stiffness, (b) cooperativity modulates the rate at which muscles develop force, and (c) heterogeneity of half-sarcomere responses contributes to residual force enhancement.

9) **CAMPBELL, K. S.**, Patel, J. R. & Moss, R. L. (2003). Cycling cross-bridges increase myocardial stiffness at submaximal levels of $Ca^{2+}$ activation. *Biophys. J.* 84, 3807-3815. PMC 1302962.

10) **CAMPBELL, K. S.** (2006). Tension recovery in permeabilized rat soleus muscle fibers after rapid shortening and restretch. *Biophys. J.* 90, 1288-1294. PMC 1367280.

11) **CAMPBELL, K. S.** & Holbrook, A. M. (2007). The rate of tension recovery in cardiac muscle correlates with the relative residual tension prevailing after restretch. *AJP: Heart.* 292, H2020-2022. PMC 2001153.

12) Campbell, S. G. & **CAMPBELL, K. S.** (2011). Mechanisms Of Residual Force Enhancement In Skeletal Muscle: Insights From Experiments And Mathematical Models. *Biophysical Reviews.* 3, 199-207. PMC 237401.

**Contribution 3: Mathematical modeling of striated muscle**

Dr. Campbell has published 12 manuscripts that integrate mathematical modeling of skeletal and cardiac muscles with experimental data. The earliest manuscripts focused on the short-range mechanical properties of skeletal muscle and have influenced the field of sensorimotor control. Three manuscripts from 2009 to 2011 showed that interactions between half-sarcomeres could explain residual force enhancement and apparent activation-dependent stiffening of muscle fibers. These papers introduced the concept of emergent properties in muscle. The most recent manuscripts have focused on MyoSim, the sarcomere-level modeling framework that will be used in this project.

13) **CAMPBELL, K. S.** & Lakie, M. (1998). A cross-bridge mechanism can explain the thixotropic short-range elastic component of relaxed frog skeletal muscle. *J. Physiol.* 510, 941-962. PMC 2231083.

14) **CAMPBELL, K. S.** & Moss, R. L. (2000). A thixotropic effect in contracting rabbit psoas muscle: prior movement reduces the initial tension response to stretch. *J. Physiol.* 525, 531-548. PMC 2269955.

15) **CAMPBELL, K. S.** (2009). Interactions between connected half-sarcomeres produce emergent mechanical behavior in a mathematical model of muscle. *PLoS Comput Biol.* 5, e1000560. PMC PMC2770126.

16) Campbell, S. G., Hatfield, P. C. & **CAMPBELL, K. S.** (2011). A mathematical model of muscle containing heterogeneous half-sarcomeres exhibits residual force enhancement. *PLoS Computational Biology.* 7, e1002156. PMC 3182863.

**Contribution 4: Biobanking**

Dr. Campbell's experience with biobanking started in 2008 when he initiated a collaboration with a cardiothoracic surgeon in order to collect samples of human myocardium. The project continues and Dr. Campbell's lab has now obtained ~3 kg of human myocardium from >250 people who have heart failure or who were organ donors without a history of cardiovascular disease. This collection supports collaborations with ~10 groups in 3 countries.

Because of his experience, Dr. Campbell was chosen to lead an institution-wide biobanking program for the University of Kentucky CTSA-supported Center for Clinical and Translational Sciences. This program has enrolled ~20,000 patients to date and gives the institution permission to bank any sample that is procured as part of normal clinical care and that would otherwise be discarded. Dr. Campbell is the Director of this program and devotes 15% of his academic effort to the research.

17) Blair, C. A., Haynes, P., Campbell, S. G., Chung, C., Mitov, M. I., Dennis, D., Bonnell, M. R., Hoopes, C. W., Guglin, M. & **CAMPBELL, K. S.** (2016). A protocol for collecting human cardiac tissue for research. *The VAD Journal.* 2, Article 12. http://uknowledge.uky.edu/vad/vol12/iss11/12. PMC not available. PMID Not available.

**Contribution 5: Open source software for scientific research**

Dr. Campbell has a 15 year track record of creating scientific software and making it freely available to the research community. SLControl (http://www.slcontrol.org) is a package for acquiring and analyzing data relating to muscle mechanics. GelBandFitter (http://www.gelbandfitter.org) is a tool for analyzing closely-running bands on gels and immunoblots. MyoSim (http://www.myosim.org) is software for simulating the mechanical properties of half-sarcomeres. Dr. Campbell wrote all of the code for these applications and continues to provide support and maintain the documentation.

18) **CAMPBELL, K. S.** & Moss, R. L. (2003). SLControl: PC-based data acquisition and analysis for muscle mechanics. *AJP: Heart.* 285, H2857-2864. PMC not available. PMID 12907419.

19) Mitov, M. I., Greaser, M. L. & **CAMPBELL, K. S.** (2009). GelBandFitter--a computer program for analysis of closely spaced electrophoretic and immunoblotted bands. *Electrophoresis.* 30, 848-851. PMC 2742644.

20) **CAMPBELL, K. S.** (2014). Dynamic coupling of regulated binding sites and cycling myosin heads in striated muscle. *J Gen. Physiol.* 143, 387-399. PMC 3933939.

## D. FUNDING

### Ongoing

AHA 15GRNT25460003 Kenneth S. Campbell, PhD 07/01/15 – 06/30/17
American Heart Association
Transmural variation in cellular level contraction
This project combines experiments and multiscale mathematical modeling to determine whether (a) collagen is associated with disease and region-specific changes in the contractile function of human myocardium, (b) mechanical unloading can improve tissue-level function, and (c) losing transmural variation reduces the heart's mechanical efficiency and adds to the burden of organ failure.

NIH 1R01HD090642 Ting (Overall PI), Campbell (Sub-contract PI) 09/16/16 – 05/31/21
Eunice Kennedy Shriver National Institute of Child Health and Human Development
CRCNS: Multiscale models of proprioceptive encoding for sensorimotor control
This project focuses on muscle spindle sensory encoding. Dr. Campbell leads a sub-contract from Emory University that measures the short-range stiffness of single muscle fibers and develops MyoSim-based simulations of history-dependent spindle properties.

NSF 1538754 Wenk / Campbell (Co-PIs) 09/01/15 – 08/31/18
National Science Foundation
Multiscale modeling of left and right ventricular function
The goal of this project is to use novel multi-scale techniques to integrate cellular level measurements into a geometrically accurate bi-ventricular model of the heart.

NIH 1UL1TR01998-01 Phillip Kern, MD 08/15/16 - 05/31/2020
Kentucky Center for Clinical and Translational Sciences
Role: Co-Investigator, Core Director for Biobanking
This is an NIH CTSA award and provides infrastructure, services, and programs to support clinical and translational investigators. Dr. Campbell directs the institutional-wide biobanking program that has enrolled ~20,000 patients since November, 2013.

### Completed Research Support (within the last 3 years)

NIH P30GM110787 Louis B. Hersh, PhD 09/01/14 – 04/30/16
National Institute of General Medical Sciences
COBRE for the Center for Molecular Medicine
Role: PI on pilot project, "Molecular mechanisms of cardiac dysfunction"
This pilot project used F344 rats as an animal model of aging-associated heart failure and integrated cardiac imaging, cell-level functional measurements, and finite element computer modeling to test whether targeting sarcomeric proteins can modulate and improve myocardial strain patterns.

AHA 14BGIA18850020 Jonathan F. Wenk, PhD 01/01/14 – 12/31/15
American Heart Association
Computer assisted optimization of therapies for heart failure
Role: Co-Investigator
The major goal of this project was to develop a fully time-dependent multi-scale finite element model of the left ventricle.