Christopher N. Johnson, Ph.D.

Mississippi State University
Department of Chemistry
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Vanderbilt Center for Arrhythmia Research and Therapeutics
Vanderbilt University Medical Center
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EDUCATION & TRAINING

INSTITUTION AND LOCATION	DEGREE	END YEAR	FIELD OF STUDY
Vanderbilt Medical Center, Nashville Tennessee	Research Fellow	2016	Electrophysiology
Vanderbilt University, Nashville Tennessee	Research Fellow	2015	Structural Biology
Georgia State University, Atlanta Georgia	Ph.D.	2012	Biophysical Chemistry
Georgia State University, Atlanta Georgia	M.S.	2008	Biochemistry
State University of New York at Fredonia	B.S.	2005	Chemistry

POSITIONS

- Assistant Professor (*Tenure Track*) Mississippi State University, Department of Chemistry 2020 - current
- Adjunct Research instructor, Vanderbilt Center for Arrhythmia Research and Therapeutics 2018 - current
- Research Scientist, The Ohio State Wexner Medical Center, Davis Heart and Lung Research Institute 2018 - 2020
- Research Instructor, Vanderbilt Center for Arrhythmia Research and Therapeutics 2016 - 2018
- Postdoc Research Fellow 2015 - 2016
  Advisor: Björn Knollmann Ph.D., M.D., Clinical Pharmacology, V.U.M.C.
- Postdoc Research Fellow 2012 - 2015
  Advisor: Walter Chazin Ph.D., Center for Structural Biology, V.U.M.C.
  Co-advisor: Alfred George Jr. M.D., Genetics and Electrophysiology, V.U.M.C.
- Graduate Research Fellow 2005 - 2011
  Advisor: Markus Germann Ph.D., Biophysical
- Laboratory Instructor (Spectroscopy and analytical chemistry), George State University 2008 - 2010
- Chemistry tutor at State University of New York at Fredonia 2002 - 2004

HONORS and AWARDS

- Travel Award: Gordon Research Conference: Excitation Contraction Coupling, Lucca Italy 2019
- Research accepted at European Society of Cardiology Winter and Summer Meetings in Switzerland 2019
- Poster Award: Gordon Conference: Cardiac Regulatory Mechanism 2018
- Research accepted at European Society of Cardiology Winter and Summer Meetings in Switzerland 2018
- European Muscle Society, Young Investigator Award 2016
- Poster Award: Gordon Research Seminar Series: Cardiac Regulatory Mechanisms 2016
- Poster Award: XXII International Society for Heart Research, World Congress 2016
- 19th International Ca^{2+} Binding Protein Symposium, Emerging Scientist Award 2015
- Presentation & Travel Award: F.A.S.E.B: Ion Channel Regulation Conference, 2013
- Johnson et. al 2011, Abstract featured in Global Medical Discovery 2011
- Teaching Award: Outstanding Graduate Instruction (Georgia State University) 2009
- NCAA, all academic team athlete, X.C. and Track & Field 2003 - 2004

SCHOLARSHIPS, TRAINEESHIPS, FELLOWSHIPS and DEVELOPEMENTAL AWARDS

- Vanderbilt Institute for Clinical and Translational Research Award ($8956) 2018
- Vanderbilt University Medical Center, Junior Faculty Research Support ($60K) 2016
- NIH F32 NRSA Fellowship 5 F32 HL117612-02 2014 - 2015
- American Heart Association Fellowship 13POST14380036 2012 - 2014
- William N. Pearson Fellowship (Vanderbilt University) 2012 - 2014
- NIH T32 NRSA Training Grant Award 2011 - 2012
- Neuroscience Brains and Behavior Fellowship (Georgia State University) 2008 - 2011

SERVICE

- Accepted into the NIH Early Career Reviewer program for reviewing NIH R01applications Fall of 2020
- American Heart Association, Fellowships Basic Cell, Proteins and Crystallography, Reviewer 2019 - current
- American Heart Association, Basic Cell Science, Career Development Award, Reviewer 2018 - current
- Elected by peers: Chair of 2020 Gordon Cardiac Regulatory Mechanism Seminar Series 2018

- Discussion leader: Gordon Cardiac Regulatory Seminar Series 2018
- Accepted nomination for Early Career Committee: Cardiac Muscle Society 2017 - 2020

MEMBERSHIPS

- American Heart Association, Council on Basic Cardiovascular Sciences
- American Chemical Society, Biophysical Division
- Biophysical Society
- Cardiac Muscle Society
- European Muscle Society
- International Society for Heart Research

PEER REVIEWED PUBLICATIONS

1. Walter J. Chazin^ and **Christopher N. Johnson**^. (2020) Calmodulin Mutations Associated with Heart Arrhythmia: A Status Report. *International Journal of Molecular Sciences, Feb 12th 21,* 1418.
   ^corresponding authors

2. D. Julia Trembinski, Janina Sommer, Ariane Fischer, Chao-Chung Kuo, Ivan G. Costa, **Christopher N. Johnson**, Alexander Spring-Connell, Manuel Kaulich, Stanislas Werfel, Stefan Engelhardt, Marc N. Hirt, Kaja Yorgan, Thomas Eschenhagen, Luisa Kirchhof, Patrick Hofmann, Nazha Hamdani, Corinne Bischof, Jaya Krishnan, Riekelt H. Houtkooper, Stefanie Dimmeler, Reinier A. Boon (2020), Sarrah is an Aging-Regulated Anti-Apoptotic Long Non-Coding RNA in Cardiomyocytes Augmenting Recovery from Acute Myocardial Infarction. Nature Communications, April 27th, *(11)* 2039.

3. Josine M. de Winter, Joery P. Molenaar, Michaela Yuen, Robbert van der Pijl, Shen Shengyi, Stefan Conijn, Menne Willigenburg, Sylvia J.P. Bogaards, Esmee van Kleef, Saskia Lassche, Malin Persson, Dilson Rassier, Tamar E. Sztal, Avnika A. Ruparelia, Robert J. Bryson-Richardson, **Christopher N. Johnson**, Manuela Marabita, Bert Blaauw, Richard J. Rodenburg, Benno Küsters, Jonne Doorduin, Alan H Beggs, Henk Granzier, Ken Campbell, Weikang Ma, Thomas Irving, Edoardo Malfatti, Norma Romero, Baziel G.M. van Engelen, Nicol C. Voermans, and Coen A.C. Ottenheijm (2020). Thin filament-based impaired muscle relaxation kinetics in KBTBD13-related nemaline myopathy (NEM6). *Journal of Clinical Investigation, 130(2):* 754-767.

4. ^**Christopher N. Johnson**, Rekha Pattanayek, Franck Potet, Robyn T. Rebbeck, Daniel J. Blackwell, Roman Nikolaienko, Vasco Sequeira, Remy Le Meur, Przemysław B. Radwański, Jonathan P. Davis, Aleksey V. Zima, Razvan L. Cornea, Steven M. Damo, Sandor Györke, Alfred L. George Jr. and Bjorn C. Knollmann (2019). The CaMKII inhibitor KN93-calmodulin interaction and implications for calmodulin tuning of $Na_V1.5$ and RyR2 function. *Cell Calcium*, *82* 102063. ***^corresponding author***

5. Lisa M. Wren, Juan Jiménez-Jáimez, Zahurul A. Buihyan, Saleh Al-Ghamdi, Jumana Y. Al-Aama, Zuhair Al-Hassnan, Roger Y. Foo, Franck Potet, **Christopher N. Johnson**, Miriam C. Aziz, Gemma L. Carvill, Juan-Pablo Kaski, Lia Crotti, Francesca Perin, Lorenzo Monserrat, Paul W. Burridge, Peter J. Schwartz, Walter J. Chazin, Alfred L. George, Jr. (2019). Genetic Mosaicism in Calmodulinopathies. *Circulation: Genomic and Precision Medicine*, *12(9)* 375-385.

6. ^**Christopher N. Johnson** (2019). Calcium modulation of cardiac sodium channels. *Journal of Physiology, Feb 1,* doi.org/10.1113/JP277553. ***^corresponding author***

7. Przemysław B. Radwański, **Christopher N. Johnson**, Sándor Györke Rengasayee Veeraraghavan (2018). Cardiac Arrhythmias as Manifestations of Nanopathies: An Emerging View, *Frontiers in Physiology*, Sept 9: 1228.

8. ^**Christopher N. Johnson**, Franck Potet, Matthew K. Thompson, Brett M. Kroncke, Andrew M. Glazer, Markus W. Voehler, Bjorn C. Knollmann, Alfred L. George, Jr., and ^Walter J. Chazin (2018). A Mechanism of Calmodulin Modulation of the Human Cardiac Sodium Channel. *Structure,* Mar 28, 683-694. ***^corresponding authors***

9. Walweel K, Gomez-Hurtado N, Oo YW, Beard NA, Dos Remedios C, **Johnson CN**, Chazin WJ, van Helden DF, Knollmann BC, Laver DR (2017). Calmodulin Mutants Linked to Catecholaminergic Polymorphic Ventricular Tachycardia Fail to Inhibit Human RyR2 Channels. *J. Am. Coll. Cardiol.,* Jul 4; 70(1):115-117.

10. Pipilas DC, **Johnson CN**, Webster G, Schlaepfer J, Fellmann F, Sekarski N, Wren LM, Ogorodnik KV, Chazin DM, Chazin WJ, Crotti L, Bhuiyan ZA, George AL Jr. (2016) Novel calmodulin mutations associated with congenital long QT syndrome affect calcium current in human cardiomyocytes. *Heart Rhythm,* Oct;13(10):2012-9.

11. Gomez-Hurtado N, Boczek NJ, Kryshtal DO, **Johnson CN**, Sun J, Nitu FR, Cornea RL, Chazin WJ, Calvert ML, Tester DJ, Ackerman MJ, Knollmann BC. (2016) Novel CPVT-Associated Calmodulin Mutation in CALM3 (CALM3-A103V) Activates Arrhythmogenic Ca Waves and Sparks. *Circ. Arrhythm. Electrophysiol.* Aug;9(8)

12. Boczek NJ, Gomez-Hurtado N, Ye D, Calvert ML, Tester DJ, Kryshtal DO, Hwang HS, **Johnson CN**, Chazin WJ, Loporcaro CG, Shah M, Papez AL, Lau YR, Kanter R, Knollmann BC, Ackerman MJ. (2016) Spectrum and Prevalence of CALM1-, CALM2-, and CALM3-Encoded Calmodulin Variants in Long QT Syndrome and Functional Characterization of a Novel Long QT Syndrome-Associated Calmodulin Missense Variant, E141G. *Circ. Cardiovasc. Genet.,* Apr;9(2):136-46.

13. Makita N[*], Yagihara N[*], Crotti L[*], **Johnson CN[*]**, Beckmann BM, Roh MS, Shigemizu D, Lichtner P, Ishikawa T, Aiba T, Homfray T, Behr ER, Klug D, Denjoy I, Mastantuono E, Theisen D, Tsunoda T, Satake W, Toda T, Nakagawa H, Tsuji Y, Tsuchiya T, Yamamoto H, Miyamoto Y, Endo N, Kimura A, Ozaki K, Motomura H, Suda K, Tanaka T, Schwartz PJ, Meitinger T, Kääb S, Guicheney P, Shimizu W, Bhuiyan ZA, Watanabe H, Chazin WJ, George AL Jr. (2014) Novel calmodulin mutations associated with congenital arrhythmia susceptibility. *Circ. Cardiovasc Genet.*, Aug;7(4):466-74. ***Authors contributed equally to this work***

14. **Johnson C.N.**, Damo S.M., Chazin W.J., EF-hand Calcium Binding Proteins (2014) *Encyclopedia of Life Sciences,* DOI: 10.1002/9780470015902.a0003056.pub3

15. Hwang HS, Nitu FR, Yang Y, Walweel K, Pereira L, **Johnson CN**, Faggioni M, Chazin WJ, Laver D, George AL Jr, Cornea RL, Bers DM, Knollmann BC. (2014) Divergent regulation of ryanodine receptor 2 calcium release channels by arrhythmogenic human calmodulin missense mutants. *Circ. Res.* 2014 Mar 28; 114(7):1114-24.

16. Crotti L, **Johnson CN**, Graf E, De Ferrari GM, Cuneo BF, Ovadia M, Papagiannis J, Feldkamp MD, Rathi SG, Kunic JD, Pedrazzini M, Wieland T, Lichtner P, Beckmann BM, Clark T, Shaffer C, Benson DW, Kääb S, Meitinger T, Strom TM, Chazin WJ, Schwartz PJ, George AL Jr. (2013) Calmodulin mutations associated with recurrent cardiac arrest in infants. *Circulation*, 127 (9):1009-17.

17. **Johnson C. N**., Spring A. M., Desai S., Cunningham R. P., Germann M. W. (2011) DNA sequence context conceals alpha anomeric lesions, *J. Mol. Biol.*, *416,* 425-437.

18. [+]**Johnson C. N.,** Spring A. M., Shaw B. R., Germann M. W. (2011) Structural basis of the RNase H1 activity on stereo regular borano phosphonate DNA / RNA hybrids**,** *Biochemistry*, *50*, 3903-3912. ***[+]Abstract featured in Global Medical Discovery***

19. Germann M., **Johnson C**., Spring A. (2012) Recognition of damaged DNA: structure and dynamic markers, *Med. Res. Rev. 32,* 659-683 (available online Nov. 2010).

20. Germann M. W., **Johnson C. N**., Spring A. M. (2009) Unusual DNA structure and DNA damage recognition: structure and dynamic markers, *CHIMIA, 63*, 731-736.

21. Mazurek A., **Johnson C. N**., Germann M. W., and Fishel, R. (2009) Sequence context effect for hMSH2-hMSH6 mismatched-dependent activation, *Proc. Nat. Acad. Sci., 106*, 4177-4182.

SELECT SPEAKER INVITATIONS

1. **2019 Mississippi State University, Starkville MS, USA,** Leveraging Structural Biology to Dissect Calcium Modification of Ion Channel Function; Short stories about NaV, CaMKII and MCU."

2. **2019 University of Georgia**, **Athens GA, USA**, "Leveraging Structural Biology to Dissect Calcium Modification of Ion Channel Function"

3. **2019 Ruhr University, Bochum Germany, "**Calcium calmodulin modification of voltage gated sodium channels."

4. **2019 Gordon Research Seminar Series: Excitation Contraction Coupling, Lucca Italy**, "The Chemistry of Tuning Na_V-CaM Modulation."

5. **2019 Davis Heart and Lung Research Institute Connector Series, The Ohio State Wexner Medical Center, Columbus OH, USA,** "Calmodulin and Voltage Gated Sodium Channels (Na_Vs)."

6. **2019 Comprehensive Heart Failure Center, Würzburg Germany,** "Ca^{2+} Tuning of Cardiac Ion Channels and Potential for Disease: Short stories about Na_V, CaMKII, and MCU."

7. **2018 Center for Investigation of Membrane Excitable Disease, Washington University**, **St Louis**

MO, USA "Ca^{2+} modulation of cardiac sodium channels and potential for disease."
$200 honorarium

8. **2018 Department of Physiology, University of Bern, Bern Switzerland**. "Ca^{2+} calmodulin modulation of the cardiac sodium channel and potential for disease."

9. **2018 Temple School of Medicine, Center for Translational Medicine**. **Philadelphia PA, USA**, "Ca^{2+} Modulation of $Na_V1.5$ by Calmodulin and Potential for Arrhythmia When it Goes Wrong."

10. **2017 Gordon Research Conference: Excitation Contraction Coupling**, **Les Diablerets Switzerland,** Two minute poster flash: "Enhanced Understanding of Ca^{2+} Regulation by Calmodulin (CaM) and CaM Dependent Kinase II (CaMKII)."

11. **2016 Department of Cardiology, Academic Medical Center, Amsterdam Netherlands**. "A Mode of Ca^{2+} Regulation of the Human Cardiac Sodium Channel by Calmodulin, and Potential for Arrhythmia When it Goes Wrong."

12. **2016 European Muscle Society**, **Montpellier France**. "A Mechanism of Ca^{2+} Calmodulin Regulation of the Human Cardiac Sodium Channel."

13. **2015 19th International Symposium on Calcium-Binding Proteins and Calcium Function in Health and Disease**, **Vanderbilt University, Nashville TN, USA**. "Calmodulin Binding to the $Na_V1.5$ Inactivation Gate and Effects of Disease Associated Mutations."

14. **2013 F.A.S.E.B: Ion Channel Regulation, Nassau Bahamas**. "Physical Basis for Defects in Calmodulin: Mutations Associated with Life Threatening Heart Arrhythmias in Infants."

15. **2011 Georgia State University Brains and Behavior Neuroscience Spring Retreat, Atlanta GA, USA**, "From Macroscopic to Molecular; A Story about Modified Substrates for RNase H1."

SELECT CONFERENCE POSTER PRESENTATIONS

1. **2019 Gordon Research Conference, Excitation Contraction Coupling,** The Chemistry of Tuning Na_V CaM Modulation. ^Christopher N. Johnson, Jon P. Davis, Bjorn C. Knollmann, Przemyslaw Radwański, and Sandor Györke, Lucca, Italy. *^corresponding author*

2. **2019 Winter Heart Failure Meeting.** The CaMKII inhibitor KN93-calmodulin interaction and implications for calmodulin tuning of $Na_V1.5$ and RyR2 function. ^Christopher N. Johnson, Vasco Sequeira, Remy Le Meur, Franck Potet, Daniel J. Blackwell, Anne Neumaier, Steve Damo, Christoph Maack, and Bjorn C. Knollmann, Les Diablerets, Switzerland. *^corresponding author*

3. **2018 Gordon Research Conference**, **Cardiac Regulatory Mechanisms**: A high affinity CaM-KN93 interaction confounds interpretation of CaMKII experimental results. ^Christopher N. Johnson, Vasco Sequeira, Franck Potet, Rehka Pattanayek, Daniel J. Blackwell, Anne Neumaier, Steve Damo, Christoph Maack, and Björn C. Knollmann, New London NH.
^corresponding author

4. **2018 Biophysical Society Meeting**: A novel mode of Ca^{2+} Calmodulin regulation of the cardiac sodium channel and potential for disease. ^Christopher N. Johnson, Franck Potet, Andrew M. Glazer, Brett M. Kroncke, Björn C. Knollmann, Alfred L. George, Jr., and Walter J. Chazin, San Francisco, CA. *^corresponding authors*

5. **2018 Winter Heart Failure Meeting:** A novel mode of Ca^{2+} regulation of the cardiac sodium channel by Calmodulin. ^Christopher N. Johnson, Franck Potet, Andrew M. Glazer, Brett M. Kroncke, Björn C. Knollmann, Alfred L. George, Jr., and ^Walter J. Chazin, Les Diablerets, Switzerland. *^corresponding authors*

6. **2018 Winter Heart Failure Meeting**: Calmodulin-myosin interaction: a novel interaction regulating muscle function. ^Vasco Sequeira, Stefan Conijn, Coen Ottenheijm, Jolanda van der Velden, and ^Christopher N. Johnson, Les Diablerets, Switzerland. *^corresponding authors*

7. **2018 Winter Heart Failure Meeting**: Deconvoluting the Ca^{2+} regulatory effects of CaMKII and CaM. Daniel J. Blackwell, Franck Potet, Bjorn C. Knollmann, and ^Christopher N. Johnson, Winter Heart Failure Meeting, Les Diablerets, Switzerland. *^corresponding author*

8. **2017 International Society of Heart Research**: Sorting out Ca^{2+} Regulation by Calmodulin (CaM) and Calmodulin Dependent Kinase II (CaMKII). ^Christopher N. Johnson, Dan Blackwell, Nieves Gomez-Hurtado, and Bjorn C. Knollmann, Hamburg Germany. *^corresponding author*

9. **2017 Gordon Research Conference, Excitation Contraction Coupling**: Enhanced Understanding of Ca^{2+} Regulation by Calmodulin (CaM) and CaM Dependent Kinase II (CaMKII) ^Christopher N. Johnson, Nieves Gomez-Hurtado, Dan J. Blackwell, Rekha Pattanayek, Joshua Haynes, Steven M. Damo, Bjorn C, Knollmann, Les Diablerets Switzerland. *^corresponding author*

10. **2017 Biophysical Society Meeting:** A Mode of Ca^{2+} Regulation of Na_V Channels and Potential for Problems When it Goes Wrong. Christopher N. Johnson Franck Potet, Matthew K. Thompson, Brett M. Kroncke, Alfred L. George Jr., Björn K. Knollmann and Walter J. Chazin, New Orleans LA.

11. **2016 European Muscle Society**: A Mode of Ca^{2+} Regulation of the Human Cardiac Sodium Channel by Calmodulin. Christopher N. Johnson, Matthew K. Thompson, Markus W. Voehler, Björn K. Knollmann and Walter J. Chazin, Montpellier France.

12. **2016 Gordon Research Conference, Cardiac Regulatory Mechanisms**: Establishing Ca^{2+} Regulation of the Human Cardiac Sodium Channel by Direct Calmodulin Interaction. Christopher N. Johnson, Matthew K. Thompson, Markus W. Voehler, Björn K. Knollmann and Walter J. Chazin, , Gordon Research Seminar Series and, New London, NH.

13. **2016 International Society of Heart Research, World Congress**: A Mechanism of Calmodulation of the Human Cardiac Sodium Channel. Christopher N. Johnson, Matthew K. Thompson, Markus W. Voehler, Björn K. Knollmann and Walter J. Chazin, Buenos Aires Argentina.

14. **2016 Biophysical Society**: A Structural Rationale for Calmodulation of the Human Cardiac Sodium Channel. Christopher N. Johnson, Matthew K. Thompson, Markus W. Voehler, and Walter J. Chazin, Los Angeles CA.

15. **2015 Biophysical Society**: Ca^{2+} Regulation of the Human Cardiac Sodium Channel $Na_V1.5$: Calmodulin Interacting with the Fast Inactivation Gate and Effects of Disease Associated Mutations: Christopher N. Johnson, Markus W. Voehler, Jennifer Sun, Michelle Roh, and Walter J. Chazin, Baltimore MD.

16. **2013 F.A.S.E.B Ion Channel Regulation**: Physical Basis for Defects in Calmodulin: Mutations Associated with Life Threatening Heart Arrhythmias in Infants. Christopher N. Johnson, Michael D. Feldkamp, Subodh G. Rath, Alfred L. George Jr., and Walter J. Chazin, Nassau, Bahamas.

17. **2012 Frontiers in Bimolecular NMR**: Structural / Functional Basis of Human Cardiac Sodium Channel Fast Inactivation. Christopher N. Johnson, Michael D. Feldkamp, Alfred L. George Jr., and Walter J. Chazin, Vanderbilt University, Nashville, TN.

18. **2010 Southeastern Magnetic Resonance Conference**: NMR Studies of Improved DNA/RNA Hybrids. Christopher N. Johnson, Alexander M. Spring, Barbara Shaw and Markus W. Germann, Gainesville, FL.

19. **2009 Winship's 6th Annual Scientific Research Symposium**: Local Base Pair Dynamics Determine Mismatch Repair Efficiency. Christopher N. Johnson, Anthony Mazurek, Richard Fishel and Markus W. Germann, Emory University, Atlanta, GA.

20. **2008 Southeastern Regional American Chemical Society**: Modulation of Recognition & Repair of Mismatched DNA. Christopher N. Johnson, Anthony Mazurek, Richard Fishel and Markus W. Germann, SERMACS, Nashville, TN.

COMPLETED RESEARCH SUPPORT

Vanderbilt Institute of Clinical and Translational Research Award Johnson (PI) ($8956) 2018
The goal of this project was to investigate how disease associated mutations impact interactions between the CaM and the voltage gated cardiac sodium channel ($Na_V1.5$).

Vanderbilt University Medical Center Junior Faculty Research Support ($60,000) 2016 - 2017
This study utilized homology modeling and electrophysiology to determine how the Ca^{2+} sensing protein calmodulin alters cardiac sodium channel gating properties.

NIH F32 NRSA Fellowship 5 F32 HL117612-02 Johnson (PI) ($72,260) 2014 - 2015
"Structural / functional basis of CaM dependent modulation of $Na_V1.5$ inactivation" This study determined the atomic underpinnings of a high affinity CaM interaction with the human cardiac sodium channel inactivation gate using x-ray crystallography and small angle x-ray scattering.

American Heart Association Fellowship 13POST14380036 Johnson (PI) ($90,380) 2012 - 2014
"Structural / functional basis of CaM dependent modulation of NaV1.5 inactivation"
This study resolved conflicting reports for how the Ca^{2+} sensing protein Calmodulin interacts with the cardiac sodium channel inactivation gate using solution NMR.

NIH T32 NRSA Training Grant 2T32 NS7491-11 George (PI) 2011 - 2012
The goal of this training was to develop a production strategy for the cardiac sodium channel inactivation gate peptide and develop skills in recombinant protein expression and protein NMR spectroscopy.