BIOGRAPHICAL SKETCH

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NAME: Brenda G. Hogue

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

POSITION TITLE: 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
Mississippi State University, Starkville, MS	B.S.	08/1971	Microbiology
Duke University, Durham, NC	M.Ed.	09/1976	Secondary Science Education
University of Tennessee, Knoxville, TN	Ph.D.	02/1986	Molecular Virology
University of California Los Angeles Medical School, Los Angeles, CA	Postdoctoral	08/1991	Molecular Virology

A. Personal Statement

I am extensively involved in graduate education at ASU. I have been the PI/Director for the NIH funded Postbaccalaureate Education Program (PREP) since 2004. I served as the Director of the Microbiology Graduate Program for the past five years, but recently stepped down because of significant commitments to my research and PREP. I serve on the advisory committee for NIH funded ASU IMSD Program. I served for a number of years on the Executive Committee for the Molecular Cellular Biology (MCB) Graduate Program. I received an Outstanding Achievement and Contribution Award from the ASU Commission on the Status of Women in 2013. Over the course of my career I have trained/mentored 9 Ph.D. and 6 MS graduate students, 7 postdoctoral fellows undergraduate honor thesis and provided research experiences for 18 undergraduates, 4 Barrett Honors College undergraduate theses. About a third of my graduate students have been/are underrepresented students. I serve on the ASU Faculty Women's Association Executive Board. I teach upper level undergraduate and graduate students molecular virology.

I have significant expertise and experience in the field of RNA viruses and molecular/cellular biology. A major focus of my research is directed toward understanding the molecular details of assembly and release of enveloped RNA viruses, using coronaviruses (CoV) as our models. Our work focuses to a large extent on structure-function studies. CoVs acquire their envelope at the endoplasmic reticulum Golgi intermediate compartment (ERGIC) and are released through interplay with the cellular secretory pathway. Interactions between viral and cellular proteins are explored, the use of vesicular trafficking and assembly at ERGIC membranes are studied. A combination of genetic, biochemical, structural and imaging approaches is used to understand functions of the viral structural proteins. Our studies make use of state-of-the-art confocal microscopy of fixed and live cells, electron microscopy (EM), cryoEM, correlative light electron microscopy (CLEM), free electron lasers (XFELS), ion channel analysis, proteomics, reverse genetic manipulation of infectious genomic clones to study the viral proteins, their subcellular localization, transport within cells during assembly of wild-type and genetically altered VLPs and viruses and structural studies of both viruses and proteins. I have significant experience in leading NIH and NSF funded grants as PI and co-investigator. I have broadened our work to include development of a vaccine platform against SARS-CoV and have established number of cross-disciplinary collaborations. We collaborate with engineers to study ion channel activity of CoV proteins that are important for virus assembly. I am co-PI on a NSF-funded project to analyze the structure of virus particles and viral proteins. Single particle analysis and structural studies with nanocrystals are being done at the XFEL facility, Linac Coherent Light Source, (LCLS), at Stanford University and the European XFEL

that recently opened in Germany. XFELs produces ultrafast pulses of X-rays millions of times brighter than even the most powerful synchrotron sources. We are helping develop the technology for three-dimensional structure at atomic resolution of viruses and viral proteins, as well as future planning for time-resolved studies with these. My laboratory is also working on determining the structures of several coronavirus envelope proteins using the relatively new technology, crystallization in lipid cubic phase (LCP). My expertise and broad experience with viruses and viral proteins, including significant involvement in structural studies and XFEL technology application for virus studies, including use of microfluidic devices, strongly supports my role as a multi-PI role on this project.

1. Venkatagopalan, P., Daskalova, S.M., Lopez, L.A., Dolezal, K.A. and **Hogue, B.G.** 2015. Coronavirus envelope (E) protein remains at the site of assembly. Virology 478:75-85.
2. Lawrence, R.M.a, Conrad, C.E., Grant, T.D., Zatsepin, N.A., Liu, H., James, D., Garrett Nelson, Subramanian, G., Aquila, A., Hunter, M.S., Liang, M., Boutet, S., Coe, J., Spence, J.C.H., Weierstall, U., Liu, W., Fromme, P., Cherezov, V., **Hogue, B.G.** 2015. Serial femtosecond X-ray diffraction of enveloped virus microcrystals. Struct. Dyn. 2, 041720; doi: 10.1063/1.4929410
3. Arndt, A.L., Larson, B.J. and Hogue, B.G. 2010. A conserved domain in the coronavirus membrane protein tail is important for virus assembly. J. Virol. 84: 1518-1428.
4. Ding, J., Lawrence, R.M., Jones, P.V., Hogue, B.G., Hayes, M.A. 2016. Concentration of Sindbis virus with optimized gradient insulator-based dielectrophoresis. Analyst. 141(6):1997-3008. PMID:26878279

B. Positions and Honors

Positions and Employment

1971 - 1972	Teacher - General Biology, Pearl McLaurin High School, Jackson, MS
1972 - 1973	Teacher - General Biology, Southern Council Academy, Durham, NC
1973 - 1978	Teacher - Advanced Placement Biology, South Granville High School, Creedmor, NC
1978 - 1980	Veterinary Medicine Assistant, Oak Ridge, TN; Post-bacc Student, University of Tennessee
1980 - 1986	Predoctoral Trainee, Department of Microbiology, Cell, Molecular and Developmental Biology Program, University of Tennessee, Knoxville, TN
1986 - 1990	Postdoctoral Fellow, Department of Microbiology & Immunology, UCLA School of Medicine, UCLA
1990 - 1991	Assistant Research Virologist, Department of Microbiology & Immunology, UCLA School of Medicine
1991 - 1999	Assistant Professor, Department of Microbiology & Immunology, Baylor College of Medicine, Houston, TX; Joint Appointment - Division of Molecular Virology
2000 - 2002	Assistant Professor, Department of Molecular Virology & Microbiology, Baylor College of Medicine
2002 - 2016	Associate Professor (tenured 2007), School of Life Sciences; Center for Infectious Diseases & Vaccinology, Biodesign Institute, Arizona State University, Tempe, AZ
2016 - Present	Professor, School of Life Sciences; Biodesign Center for Immunotherapy, Vaccines, and Virotherapy, Biodesign Institute, Arizona State University, Tempe, AZ

Other Experience and Professional Memberships

1982 -	Member, American Society for Virology (ASV) (includes progress from student to full member)
1987 -	Member, American Society for Microbiology (ASM)
2007 – 2019	Editorial Board, Journal of Virology
2013-2020	Editorial Board, Virology
2010-2016	Selected Review Panels – NIH ZAI1 BB-M S2 (Chair) (6/2010), ZAI1 JTS-I (S1) (7/2011), ZAI1 RGK-M (J1) (9/2011), ZAI1 GSM-M (J1) (11/2011), ZAI1 UKS-M (M2) (03/2012); MPRC-B – NIGMS (7/2012), NIAID ZAI-RWM-M-M1; NIH BAA-NIAID-DMID-NIH AI2012149 (3/2013), ZRG1 F13-C (20)L F13 Infectious Diseases & Microbiology Fellowships (3/24-25/2016)
2013 - 2016	American Society for Virology Program Committee

Honors

1984 - 1986	Predoctoral Fellow, Tennessee Centers of Excellence Program - Livestock Diseases and Human Health, University of Tennessee College of Veterinary Medicine
1987 - 1989	NIH NRSA Postdoctoral Fellowship F32 GM11788
2013	ASU Commission on the Statue of Women Outstanding Achievement and Contribution Award
2013	ASU Committee for Campus Inclusion "Excellence in Diversity" Award Nominee
2014	ASU Devils' Advocate Apple Polisher Faculty Recognition – (commitment & dedication to student development)

C. Contribution to Science

1. The molecular biology of coronaviruses (CoVs) has been the central focus of my research throughout my career. CoVs are enveloped, positive stranded RNA viruses that cause significant respiratory and enteric infections in humans and a broad range of animals. The significance of human CoVs increased significantly in 2003 when a new virus with high mortality rate emerged. The SARS outbreak resulted in significant economic and social disruption. More recently new CoVs that infect humans and animals have been identified, the latest being the Middle East respiratory syndrome (MERS) virus that appeared in 2012 and continues to circulate. Like SARS-CoV, the MERS CoV exhibits a high mortality rate. Basic research in my laboratory focuses on the mechanism of CoV assembly at intracellular membranes. My work and publications across my career have contributed to understanding of the functional and mechanistic roles of the viral proteins. These continue to provide insight for antiviral therapeutic and vaccine development. My lab has contributed to our understanding of CoV envelope (E) proteins that are involved in virus assembly and virulence. E proteins are viroporins, a class of proteins that exhibit ion channel activity. Viroporins are found in many medically important RNA and DNA viruses and are potential targets for antiviral therapy. Studies in my lab have helped advance understanding of the structure and function of the E proteins and their roles in virus assembly. We have also provided insight about the CoV membrane (M) protein that forms the basic lattice of the viral envelope. We have showed that certain domains and specific residues within the carboxy tail are critical for virus assembly. The work and publication collectively provides insight about the role of this important domain in the assembly process at intracellular membranes. My lab has also helped promote the understanding of CoV nucleocapsid (N) proteins that encapsidate the viral genomic RNA. The importance of residues within the protein and significance of post-translational phosphorylation contributes to understanding the roles of this multifunctional protein. We were one of the first labs to show that a CoV N protein can function as an interferon antagonist. This is important because the initial host response against virus infection is mediated by the innate immune system through interferon signaling. I served as the primary PI on all of these studies in my laboratory.
    a. Ye, Y. and Hogue, B.G. 2007. Role of the mouse hepatitis coronavirus E viroporin protein transmembrane domain in virus assembly. Epub Jan 17. J. Virol. 81(7):3597–3607.
    b. Lopez, L.A., Riffle, A.J., Pike, S.L., Gardner, D. and Hogue, B.G. 2008. Importance of conserved cysteine residues in the coronavirus envelope protein. 2008. J. Virol. 82:3000-10. [Editors' Spotlight Paper].
    c. Arndt, A.L., Larson, B.J. and Hogue, B.G. 2010. A conserved domain in the coronavirus membrane protein tail is important for virus assembly. J. Virol. 84: 1518-1428.
    d. Venkatagopalan, P., Daskalova, S.M.; Lopez, L.A., Dolezal, K.A. and Hogue, B.G. 2015. Coronavirus envelope (E) protein remains at the site of assembly. Virology 478:75-85.

2. In addition to the studies described above, my lab is working on an exciting new technology, X-ray Free Electron Lasers (XFELs), for determining 3-D atomic resolution structures of viruses and proteins. XFELs produce high intensity X-ray pulses (~120/sec) at an extremely short rate of ~10 femtoseconds (1 fs = 10^{-15}s). We are using the Linac Coherent Light Source (LCLS https://slacportal.slac.stanford.edu/sites/lcls_public/Pages/Default.aspx) commissioned in 2009 at the Stanford Linear Accelerator Center (SLAC) and also the European XFEL that opened recently in Germany (http://www.xfel.eu/). XFELs are currently the world's most powerful X-ray laser that can capture high-resolution single shot images of atoms and molecules. Diffraction patterns theoretically can be read at each pulse. The great potential of XFELs is the ability to capture images of biological processes in real time and thus provide unique and exciting opportunities to explore biological mechanisms in real time at room temperature. It has already been shown that XFELs are a powerful,

cutting-edge technology for structural studies using protein nanocrystals. My lab is one of the international team virology leads that is exploring the limits of the technology for single particles studies. I am a co-investigator on a NSF funded National Science and Technology Center (STC) project, called BioXFEL since late 2013. BioXFEL includes scientists from 8 US research universities who are addressing fundamental biology questions at the molecular level by capturing "snapshots" of biomolecules. STCs are funded to address significant problems that require highly interdisciplinary, collaborative teams. As a co-investigator for the project I lead the single virus particle and virus crystal analysis effort.

a. Hosseinizadeh, A. Mashayekhi, G., Copperman, J. Schwander, P., Dashti, A., Sepehr, R., Fung. R., Schmidt, M., Yoon, C.H., Hogue, B.G., Williams, G.J., Aquila, A., Ourmazd, A. 2017. Conformational landscape of a virus by single-particle X-ray scattering. Nat Methods Sep;14(9):877-881. doi: 10.1038/nmeth.4395. Epub 2017 Aug 14. PMID: 28805793.
b. Li X., Chiu C.Y., Wang H.J., Kassemeyer S., Botha S., Shoeman R.L., Lawrence R.M., Kupitz C., Kirian R., James D., Wang D., Nelson G., Messerschmidt M., Boutet S., Williams G.J., Hartmann E., Jafarpour A., Foucar L.M., Barty A., Chapman H., Liang M., Menzel A., Wang F., Basu S., Fromme R., Doak R.B., Fromme P., Weierstall U., Huang M.H., Spence J.C., Schlichting I., **Hogue B.G.**, Liu H. 2017. Diffraction data of core-shell nanoparticles from an X-ray free electron laser. Nature Sci. Data 4:170048. PMID: 28398334.
c. Lawrence, R.M., Zook, J.D., **Hogue, B.G.** 2016. Full inactivation of alphaviruses in single particle and crystallized forms. 2016. J. Virol. Methods 236: 237-244.
d. Lawrence, R.M., Conrad, C.E., Grant, T.D., Zatsepin, N.A., Liu, H., James, D., Garrett Nelson, Subramanian, G., Aquila, A., Hunter, M.S., Liang, M., Boutet, S., Coe, J., Spence, J.C.H., Weierstall, U., Liu, W., Fromme, P., Cherezov, V., **Hogue, B.G.** 2015. Serial femtosecond X-ray diffraction of enveloped virus microcrystals. Struct. Dyn. 2, 041720; doi: 10.1063/1.4929410

3. A major focus of my research is on enveloped viruses and their constituent membrane proteins. I am part of an interdisciplinary collaboration that formed the basis for establishment of the ASU Center for Membrane Proteins in Infectious Diseases (MPID) (http://mpid.asu.edu/) that was funded by NIH until 2016 when NIH decided to no longer support the Protein Structure Initiative (PSI). MPID focused on determining structures of viral, bacterial and human membrane proteins that are involved in pathogenesis. As a Center Co-PI, my lab focused on a number of membrane proteins that we study in my virology laboratory for structural study. I provided the lead for structural studies on all of the viral protein targets and also key leadership across the Center. Even though MPID is no longer funded, my lab continues to devote a significant amount of effort toward structural work that we align with our functional studies. Membrane proteins constitute >60% of all the drug targets for infectious diseases, yet structures for <300 are known. Thus, our work is highly significant in that it provides input for structure-based rational design of antivirals drugs and vaccines.

a. Deb A, Johnson WA, Kline AP, Scott BJ, Meador LR, Srinivas D, Martin-Garcia JM, Dörner K, Borges CR, Misra R, **Hogue BG**, Fromme P, Mor TS. 2017. Bacterial expression, correct membrane targeting and functional folding of the HIV-1membrane protein Vpu using a periplasmic signal peptide. PLoS One 12(2):e0172529. doi: 10.1371/journal.pone.0172529. PMID: 28225803.
b. Kessans, S.A., Linhart, M., Meador, L.R., Kilbourne, J. **Hogue, B.G.,** Fromme, P., Matoba, N., Mor, T.S. 2016. Immunological characterization of plant-based HIV-1 Gag/Dgp41 virus-like particles. PLOS One. 17;11(3):e0151842. doi: 10.1371/journal.pone.0151842. eCollection 2016. PMID:26986483
c. Venkatagopalan, P., Daskalova, S.M.; Lopez, L.A., Dolezal, K.A. and Hogue, B.G. 2015. Coronavirus envelope (E) protein remains at the site of assembly. Virology 478:75-85.
d. Gong, Z.; Martin-Garcia, J.M.; Daskalova, S.M.; Craciunescu, F.M.; Song, L.; Dörner, K.; Hansen, D.T.; Yang, J.H.; LaBaer, J.; Hogue, B.G.; Mor, T.S.; Fromme, P. 2015. Biophysical Characterization of a Vaccine Candidate against HIV-1: the Transmembrane and Membrane Proximal Domains of HIV-1 gp41 as a Maltose Binding Protein Fusion. PLOS One. 10(8):e0136507; doi:10.1371/journal.pone.013650

Complete List of Published Work in MyBibliography:
http://www.ncbi.nlm.nih.gov/sites/myncbi/brenda.hogue.1/bibliography/46172399/public/?sort=date&direction=

descending

D. Research Support

Ongoing Research Support

2R25GM071798-06A1 Hogue (PI) 09/25/2004 - 07/31/2018
HHS-NIH-NIGMS (No Cost Extension to 7/31/18)
ASU Post-Baccalaureate Research Education Program (PREP)
The overall goal is to provide 1-2 years of preparation beyond the undergraduate level to prepare underrepresented minority graduates to smoothly transition into highly competitive graduate programs, to successfully complete those programs and go onto pursue careers as strong investigators who address important current and future biomedical problems, including health issues and disparities in minority populations.
Role: PI

R876181 Spence (PI) 08/01/2013 - 12/29/2018
NSF-STC (renewal to 2023 TBA soon)
Biology with X-ray Lasers
The goal of the Hogue Lab's part of this NSF Science Technology Center funding is to study and help develop the use of X-ray free electron lasers like the Linac Coherent Light Source, (LCLS), at SLAC/Stanford University to determine the three-dimensional structure at atomic resolution of viruses that are difficult or impossible to crystallize and also structures of viral proteins and viruses from small nanocrystals. http://www.bioxfel.org
Role: Co-Investigator

1531991 Spence (PI) 09/01/2015 - 08/31/2018
NSF-BIO-DBI (Renewal for 2018-23 pending)
MRI: Acquisition of Cryo-EM for Southwest Regional Center
The award funds acquisition of an electron microscope for the biological sciences for use by scientist in the southwestern region of the US.
Role: Co-PI

Completed Research Support (selected)

1S10OD021816-01 Spence (PI) 04/01/2016 - 03/31/2017
HHS-NIH
3D Nanoprinter
The proposed work will lead to the development of new methods and breakthroughs in determining the structure and dynamics of biomolecules of significant biomedical relevance. Especially in the areas of drug design (e.g., GPCRs), this has been achieved recently using the recently-invented X-ray laser to image protein structures and their dynamics.
Role: Co-Investigator

1U54GM094599 Fromme (PI) 10/01/2010 – 06/30/2016
NIH NIGMS
Center for Membrane Proteins in Infectious Diseases (*Protein Structure Initiative (PSI) Center*)
The goal of this project/center is to determine the three dimensional structure of membrane proteins of bacterial and viral pathogens, including coronavirus envelope proteins that are viroporins that form ion channels and also viroporins of other RNA viruses.
Role: Co-PI

ASU Biodesign Seed Funding Hogue (PI) 07/01/2015 - 06/30/2016
Solving Structures of Viroporins - Targets for Antiviral Therapeutic Development.
Funding for furthering preliminary results for development of proposals for high-end funding.
Role: PI

1120997 Weierstall (PI) 07/01/2009-07/31/2014
Femtosecond Virus Structure
The project focused on use of X-ray free electron lasers (XFELs) for virus structural studies. Role: Co-PI