Fiscal Year:	FY 2021	**Task Last Updated:**	FY 11/26/2021
PI Name:	Bowles, Dawn Ph.D.		
Project Title:	Proteomic Signatures of Space Radiation Induced Cardiovascular Degeneration		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Radiation health		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **SR**:Space Radiation		
Human Research Program Risks:	(1) **Cardiovascular**:Risk of Cardiovascular Adaptations Contributing to Adverse Mission Performance and Health Outcomes		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
PI Email:	dawn.bowles@duke.edu	**Fax:**	FY
PI Organization Type:	UNIVERSITY	**Phone:**	919-668-1947
Organization Name:	Duke University		
PI Address 1:	Department of Surgery		
PI Address 2:	Msrb1 Room 401B, DUMC 2642		
PI Web Page:			
City:	Durham	**State:**	NC
Zip Code:	27710-0001	**Congressional District:**	4
Comments:			
Project Type:	Ground	**Solicitation / Funding Source:**	2014-15 HERO NNJ14ZSA001N-RADIATION. Appendix D: Ground-Based Studies in Space Radiobiology
Start Date:	05/12/2016	**End Date:**	05/11/2022
No. of Post Docs:	1	**No. of PhD Degrees:**	
No. of PhD Candidates:	1	**No. of Master' Degrees:**	
No. of Master's Candidates:		**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:		**Monitoring Center:**	NASA JSC
Contact Monitor:	Zawaski, Janice	**Contact Phone:**	
Contact Email:	janice.zawaski@nasa.gov		
Flight Program:			
Flight Assignment:	NOTE: End date changed to 5/11/2022 per L. Barnes-Moten/JSC and NSSC information (Ed., 5/10/21) NOTE: End date changed to 5/11/2021 per NSSC information (Ed., 8/12/20)		
Key Personnel Changes/Previous PI:	November 2021 report: Dr. Mark Dewhirst retired and is no longer CoInvestigator on the project.		
COI Name (Institution):	Abraham, Dennis M.D. (Duke University) Kidane, Yared Ph.D. (Wyle Laboratories, Inc.) Mao, Lan M.D. (Duke University) Moseley, Martin Ph.D. (Duke University)		
Grant/Contract No.:	NNX16AK20G		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Radiation damage and the cell's attempt to repair it triggers a myriad of signal transduction pathways which alter gene, and ultimately, protein expression. Space radiation may affect biomolecules, cellular processes, and ultimately the cellular protein content (the proteome) differently than radiation present on Earth. Epidemiological analysis of terrestrial radiation exposure indicates that single high- or multiple low-dose radiation exposure can culminate in a wide array of cardiac injury and malfunction over time. Based on terrestrial data, it is believed that cardiovascular disorders may develop in astronauts from exposure to the space radiation environment. Indeed, a recent study by Yan et al. (2014), found that a single full body exposure to a low dose of proton or iron particle radiation, which somewhat mimics the space radiation environment, was sufficient to induce a significant, long term, negative effect on murine cardiovascular function. In this proposal, we take advantage of our expertise with bioinformatics analysis of cardiovascular proteomic data sets and murine cardiovascular physiology to evaluate the consequences of low dose, chronic space radiation, or mixed field space radiation on the dynamics of the cardiac proteome and to understand how the radiation induced changes relate to cardiovascular function. In doing so, we will extend Yan et al.'s work by identifying a proteomic signature that predicts the development of permanent cardiovascular degeneration from a single low dose space radiation exposure. Further, we seek to evaluate whether the proteomic signatures differ when mice experience repeated exposures of space-like radiation or mixed field space radiation. This information will lead to a mechanistic understanding of the altered cellular and molecular processes contributing to the development of cardiovascular dysfunction at the organ and organismal level in scenarios better mimicking the space radiation environment. This information is needed to predict, monitor, and prevent cardiac damage during long term space flight. Reference: Yan, X., et al., Cardiovascular risks associated with low dose ionizing particle radiation. PLoS One, 2014. 9(10): p. e110269.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Limited information is known regarding the impact of chronic low level radiation on cardiovascular molecular biology and function both terrestrially and during extended space exploration. Our research is expected to provide information in regards to terrestrial and astronaut heath. Innovative technologies that may arise from our studies may include novel biomarkers predictive of cardiovascular susceptibility to chronic low level radiation as well as countermeasures that may be employed both on Earth as well as during space exploration.
Task Progress:	Radiation and follow up -- Approximately 920 C57b/6 male mice have been irradiated and undergone a thorough cardiovascular assessment (some over an 18-month period post radiation). Cardiac function -- Functionally, in contrast to other forms of radiation, a single exposure to 5 ion Galactic Cosmic Ray Simulation (GCRSim) appears to have significant effects on clinically relevant parameters of cardiac function. Tissue repository-- a large tissue repository covering a range of organs has been established. Tissues have been shared with other investigators as well as used in our proteomics studies. Proteomics-- Bioinformatics analyses reveals both commonly as well as uniquely affected biological pathways across radiation types and doses. Notably, GCR exhibits highly perturbed cornification and keratinization pathways as well as mitochondrial pathways modulated by phosphorylation. In agreement with numerous other studies, perturbation of mitochondrial processes and cellular components was affected across most of the radiation conditions evaluated. We are currently working on four papers based on our findings. The first paper is an evaluation of cardiac function focusing on GCR mice. This paper is in revision at iscience. The second paper is focusing on our GCR proteomics findings. This paper is still in draft format but relevant findings are noted in this report. The third paper is an evaluation of cardiac function looking across all doses of gamma, oxygen, and iron. The 4th paper focuses on proteomics findings across gamma, oxygen, and iron.
Bibliography Type:	Description: (Last Updated: 03/11/2025)
Abstracts for Journals and Proceedings	Bowles DE, Kidane Y, Lee F, Bishawi M, Thompson JW, Moseley MA, Foster MW, Abraham DA, Glass C, Blocker S, Wang C, Johnson A, Rockman H, Mao L, Slaba T, Dewhirts MW. "Proteomics Signatures of Space Radiation Induced Cardiovascular Degeneration." 2021 NASA Human Research Program Investigators' Workshop, Virtual, February 1-4, 2021. Abstracts. 2021 NASA Human Research Program Investigators' Workshop, Virtual, February 1-4, 2021. , Feb-2021
Articles in Peer-reviewed Journals	Davis CM, Allen AR, Bowles DE. "Consequences of space radiation on the brain and cardiovascular system." J Environ Sci Health C Toxicol Carcinog. 2021 Apr 27;39(2):180-218. https://doi.org/10.1080/26896583.2021.1891825 ; PMID: 33902387 , Apr-2021