Fiscal Year:	FY 2019	**Task Last Updated:**	FY 06/24/2019
PI Name:	Delp, Michael Ph.D.		
Project Title:	Effects of Spaceflight on Ocular Oxidative Stress and the Blood-Retinal Barrier		
Division Name:	Space Biology		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	SPACE BIOLOGY--Cellular and molecular biology		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	None		
Human Research Program Risks:	None		
Space Biology Element:	(1) Cell & Molecular Biology (2) Animal Biology: Vertebrate		
Space Biology Cross-Element Discipline:	(1) Developmental Biology (2) Neurobiology		
Space Biology Special Category:	(1) Translational (Countermeasure) Potential		
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Comments:	Previous affiliations were University of Florida (mid-2007-June 2014), West Virginia University (mid-2005 to mid-2007), and Texas A&M University (1995 to mid-2005).		
Project Type:	Flight	**Solicitation / Funding Source:**	2014 Space Biology Flight NNH14ZTT001N
Start Date:	02/01/2015	**End Date:**	06/04/2022
No. of Post Docs:	1	**No. of PhD Degrees:**	
No. of PhD Candidates:		**No. of Master' Degrees:**	
No. of Master's Candidates:		**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:		**Monitoring Center:**	NASA ARC
Contact Monitor:	Sato, Kevin	**Contact Phone:**	650-604-1104
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Flight Program:	ISS		
Flight Assignment:	Tissue Sharing NOTE: Extended to 6/4/2022 per F. Hernandez/ARC (Ed., 7/27/21) NOTE: Extended to 6/4/2021 per F. Hernandez/ARC and NSSC information (Ed., 6/12/19) NOTE: Extended to 7/30/2019 per F. Hernandez/ARC and NSSC information (Ed., 2/14/19) NOTE: Extended to 1/31/2019 per NSSC information (Ed., 3/12/18) NOTE: Extended to 1/31/2018 per F. Hernandez/ARC (Ed., 2/12/17)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Pecaut, Michael Ph.D. (Loma Linda University) Mao, Xiao Wen M.D. (Loma Linda University)		
Grant/Contract No.:	NNX15AE86G		
Performance Goal No.:			

Performance Goal Text:	
Task Description:	Approximately 29% of astronauts on short-term (~2 wk) space shuttle flights and 60% on long-duration (~6 mo) missions to the International Space Station (ISS) are reported to have experienced some impairment in distant or near visual acuity. These visual disturbances have been hypothesized to be related to increases in intracranial pressure (ICP) and intraocular pressure. Modeling studies have shown that a compromise in the integrity of the vascular blood-brain barrier (BBB) would serve to elevate ICP. While much attention has been directed toward the role of the cerebral vasculature in elevating ICP, little work has been done to examine conditions of the vasculature in the eye and the potential role of microgravity in altering the blood-retinal barrier (BRB), which maintains a similar function in the eye for regulating intraocular pressure as the BBB in the cranium. One condition known to compromise the BRB is oxidative stress. For example, in diabetic retinopathy, the leading cause of blindness in Western society, elevations in oxidative stress compromise the BRB and increase vascular permeability in the eye. The proposed studies through the ISS Rodent Tissue Sharing Opportunity will provide new and important information regarding the effects of spaceflight on oxidative stress in the eye and its potential deleterious effects on the BRB.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Through the collection of 300 post-flight questionnaires, it has recently been reported that approximately 29% of astronauts flying short-duration missions and 60% of astronauts on long-duration missions experience an impairment of distance and near visual acuity. Furthermore, some of these changes remain degraded for years after flight. It is hard to imagine a more severe, prevalent, and potentially intractable condition threatening human space exploration than the loss of visual acuity. In 2010, NASA Space Life Sciences at Johnson Space Center in Houston held a Visual Impairment Intracranial Pressure (VIIP) Summit of leading clinicians and scientists with expertise in ophthalmology and cerebral fluid dynamics, and it was hypothesized that the visual impairment experienced by astronauts was the result of a microgravity-induced cephalad fluid shifts and corresponding increases in ICP and intraocular pressure. The proposed studies will provide new and important information regarding the effects of spaceflight on oxidative stress in the eye, its potential deleterious effects on the blood-retinal barrier and, consequently, factors that may function to increase intraocular pressure. In addition, understanding the relation between oxidative stress in the eye and disruption of the blood-retinal barrier may provide new insight into other conditions that affect visual acuity, including diabetic retinopathy, the leading cause of blindness in Western society, where elevations in oxidative stress compromise the blood-retinal barrier and increase vascular permeability in the eye.
Task Progress:	Rodent Research-1 (RR-1) Study 1: From the RR-1 mice, the retinas were isolated from the frozen eyes under rapid thaw process. RNA/DNA were extracted from the retina. QC data showed that the samples are suitable for RNA sequencing. These studies are currently in progress. JAXA (Japan Aerospace Exploration Agency) MHU-1 Study 2: Results from this study have been published and demonstrate that spaceflight induces apoptosis in retinal vascular endothelial cells. We also identified spaceflight-induced changes in proteomic profiles and pathways in the ocular tissue. The results indicate that spaceflight induces changes in neuronal structure, cellular organization, mitochondrial function and oxidative phosphorylation and inflammation, which in turn, may lead to tissue injury and late neurodegeneration. This study is the first to investigate the role of artificial gravity provided by centrifugation during spaceflight as a countermeasure for mitigating putative effects of microgravity on ocular structure and function. Further studies will be continued on the JAXA MHU-1 eyes to estimate the effects of spaceflight with and without artificial gravity on blood-retinal barrier function. These studies will be performed in parallel with the same measures performed on eyes obtained from a JAXA MHU-2 mission. Once we have the control tissue specimen in our possession we will commence with processing and data collection. (Ed. note June 2019: compiled from PI's annual report received June 2019; covers reporting period Feb 2018-May 2019)
Bibliography Type:	Description: (Last Updated: 07/09/2025)
Articles in Peer-reviewed Journals	Mao XW, Byrum S, Nishiyama NC, Pecaut MJ, Sridharan V, Boerma M, Tackett AJ, Shiba D, Shirakawa M, Takahashi S, Delp MD. "Impact of spaceflight and artificial gravity on the mouse retina: Biochemical and proteomic analysis." Int J Mol Sci. 2018 Aug 28;19(9):E2546. https://doi.org/10.3390/ijms19092546 ; PubMed PMID: 30154332; PubMed Central PMCID: PMC6165321 , Aug-2018