Fiscal Year:	FY 2024	**Task Last Updated:**	FY 04/11/2024
PI Name:	Nickerson, Cheryl A Ph.D.		
Project Title:	Contributions of the Microbiome in Astronaut Health: a New Dimension in Modeling Crew Infectious Disease Risks		
Division Name:	Space Biology		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	None		
Human Research Program Risks:	None		
Space Biology Element:	(1) Cell & Molecular Biology (2) Microbiology		
Space Biology Cross-Element Discipline:	(1) Immunology		
Space Biology Special Category:	(1) Cell Culture (2) Translational (Countermeasure) Potential		
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Zip Code:	85287-5401	**Congressional District:**	9
Comments:	NOTE PI moved from Tulane University to Arizona State University in 2006.		
Project Type:	GROUND	**Solicitation / Funding Source:**	2016-17 Space Biology (ROSBio) NNH16ZTT001N-MS, PS, AB. App D,E,F: Research Using Microgravity Simulation Devices, Parabolic and Suborbital Flights, and Antarctic Balloons
Start Date:	10/01/2018	**End Date:**	09/30/2023
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	0	**No. of Master' Degrees:**	0
No. of Master's Candidates:	0	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NASA KSC
Contact Monitor:	Freeland, Denise	**Contact Phone:**	321-867-5878
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Flight Program:			
Flight Assignment:	NOTE: End date changed to 9/30/2023 per NSSC information (Ed., 10/12/22) NOTE: End date changed to 9/30/2022 per NSSC information (Ed., 9/23/21)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Bean, Heather Ph.D. (Arizona State University) Barrila, Jennifer Ph.D. (Arizona State University) Ott, C. Mark Ph.D. (NASA Johnson Space Center)		
Grant/Contract No.:	80NSSC18K1478		
Performance Goal No.:			

Performance Goal Text:	
Task Description:	The diverse communities of microbes that reside in the human intestinal tract play critical roles in the prevention of enteric infection for both astronauts and the general public. A comprehensive understanding of how changes in gut microbiota composition impacts susceptibility to infection has been limited by a lack of cost-effective, physiologically relevant infection models containing both human host and microbial cells. We previously developed an advanced three-dimensional (3-D) model of human colon containing inflammatory immune cells and applied it to study host-pathogen interactions, including the influence of low fluid shear microgravity analogue culture on the ability of the enteric pathogen Salmonella to colonize the host. This same model was also applied to study host-microbiota interactions using patient-derived fecal consortia from both healthy individuals and those suffering from a gastrointestinal disorder. For the proposed study, our goal is to populate our 3-D intestinal co-culture model containing immune cells with astronaut fecal microbiota (previously collected during the Microbiome spaceflight experiment) and assess its influence on infection with Salmonella cultured under microgravity analogue conditions. The outcome of these interactions will be profiled using a variety of approaches, including colonization studies, microscopy, metabolomics, 16S analysis, and cytokine analysis. The foodborne pathogen Salmonella was selected as the model pathogen as it is a leading cause of gastrointestinal disease worldwide and imposes an enormous health and socioeconomic burden. From NASA's perspective, Salmonella is considered a potential source of infection during spaceflight that could incapacitate crew members during a mission. Due to its route of access through spaceflight food, NASA specifically tests for Salmonella prior to flight and has previously disqualified food destined for the International Space Station based on the isolation of this pathogen. The proposed microgravity analogue studies combine microbiology, tissue engineering, and physics to provide new insight into the influence of spaceflight on host-microbiome interactions and the ability to protect against pathogen infection with applications for therapeutic development for spaceflight exploration and health of the general public.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	This research will enrich life on Earth through the use of space technology and the application of biomedical knowledge. Specifically, this study will utilize the microgravity spaceflight platform to 1) to broaden our knowledge of the host-pathogen interaction that leads to infectious disease, and 2) for the development of new therapeutic strategies to combat infectious disease for astronauts and the general public.
Task Progress:	We successfully performed infections under microaerobic conditions using our 3-D co-culture intestinal model containing immune cells and low shear modeled microgravity (LSMMG) and control-cultured S. Typhimurium in the presence and absence of microbiota derived from the pre-flight and post-flight stool of seven astronauts. In our work we also optimized and validated a selective and differential medium that was used in our studies to successfully quantify the recovery of S. Typhimurium from 3-D cultures associated with complex microbiota samples. This medium specifically enabled the growth of S. Typhimurium colonies, while inhibiting the growth of fecal microbiota. During these studies, we confirmed the presence of viable, culturable microbiota in stool samples. Interestingly, for several crew members, we observed different pathogenesis-related phenotypes. Collectively, our studies suggest differences in the microbiota between different crew members and for individual crew members in their pre- versus post-flight specimens. During our studies, we observed potential infection differences for S. Typhimurium in the 3-D models in the presence versus the absence of crew microbiota. We are in the process of finalizing our analysis of the cellular, nucleic acid, and supernatant data and are working on preparing an article for publication in a peer-reviewed journal.
Bibliography Type:	Description: (Last Updated: 04/23/2024)
Articles in Peer-reviewed Journals	Nickerson CA, Medina-Colorado AA, Barrila J, Poste G, Ott CM. "A vision for spaceflight microbiology to enable human health and habitat sustainability." Nature Microbiology. 2022 Apr;7(4):471-4. https://doi.org/10.1038/s41564-021-01015-6 ; PMID: 34903836 , Apr-2022