Fiscal Year:	FY 2021	**Task Last Updated:**	FY 11/30/2020
PI Name:	Bailey, Susan M. Ph.D.		
Project Title:	Telomeres and the One Year Mission Project		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
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		
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PI Organization Type:	UNIVERSITY	**Phone:**	970-491-2944
Organization Name:	Colorado State University		
PI Address 1:	Environmental and Radiological Health Sciences		
PI Address 2:	1618 Campus Delivery		
PI Web Page:			
City:	Fort Collins	**State:**	CO
Zip Code:	80523-1618	**Congressional District:**	2
Comments:			
Project Type:	FLIGHT	**Solicitation / Funding Source:**	2017-2018 HERO 80JSC017N0001-BPBA Topics in Biological, Physiological, and Behavioral Adaptations to Spaceflight. Appendix C
Start Date:	01/31/2019	**End Date:**	01/30/2026
No. of Post Docs:		**No. of PhD Degrees:**	1
No. of PhD Candidates:	1	**No. of Master' Degrees:**	
No. of Master's Candidates:		**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:	1	**Monitoring Center:**	NASA JSC
Contact Monitor:	Elgart, Robin	**Contact Phone:**	281-244-0596 (o)/832-221-4576 (m)
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Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Jeevarajan, Antony Ph.D. (NASA Johnson Space Center)		
Grant/Contract No.:	80NSSC19K0434		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	The ultimate goal of the studies proposed here is to establish temporal profiles of human telomere length dynamics and DNA damage responses of importance for maintenance of human health and performance during long-duration deep space missions. We hypothesize that telomere length dynamics (changes over time) represent a particularly relevant and informative biomarker of health for the astronauts, as it reflects the combined experiences and exposures encountered during spaceflight. That is, an astronaut's individual genetic susceptibilities, unique lifestyle stresses encountered (e.g., nutritional, psychological, physical), and particular environmental exposures (e.g., altered atmospheres, microgravity, space radiations) are all integrated and captured as changes in telomere length. Thus, the rate at which telomeres shorten provides a general measure of health that can be linked to aging, as well as to risk of developing age-related pathologies, ranging from reduced immune function and dementia, to cardiovascular disease and cancer. Importantly, functional telomeres are also essential for maintaining genomic integrity and stability, as they protect chromosomal termini from inappropriate degradation, and prevent these natural DNA ends from being recognized as broken DNA and triggering inappropriate DNA damage responses (DDRs). To identify trends in adaptations to human health and performance during long-duration low-Earth orbit, we propose telomere length and DDR/cytogenetic measures pioneered and validated in the NASA Twins Study/first One Year Mission, across the Integrated One-Year Mission Project onboard the International Space Station and the concurrent ground analog (prolonged isolation) component.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Identifying interactive effects of genetic and nongenetic telomere length determinants and DDRs will improve understanding of aging and aging trajectories (disease risk), as well as guide future studies and development of potential strategies for improving health-span not only in astronauts on long-duration missions, but for those on Earth, too.
Task Progress:	Complement of Integrated Protocols for Human Exploration Research (CIPHER) Selected for Flight (Oct 2020). First mission launch ~December 2021; first BDC ~April/May 2021. Working on details of sample collection before, during, and after spaceflight. Together with cell-by-cell analyses, approaches for more high throughput analyses (e.g., ddPCR) are being tested and optimized. We are developing machine learning strategies for predicting telomere length outcomes, which will become more and more reliable/informative as the models see more data. We are also seeking ways to test mechanisms; e.g., to assess the influence of chronic oxidative stress on telomere length. We evaluated telomere length in blood samples from humans climbing Mt. Everest, and matched twin non-climbing controls. Established Telomeres 2 stem/progenitor cell evaluation as part of Standard Measures; collaborating with Brian Crucian. Established NASA and home institution (Colorado State University-CSU) Institutional Review Boards (IRBs) – continuing process. Awaiting crew selection and recruitment into the Telomeres 2 study.
Bibliography Type:	Description: (Last Updated: 01/29/2024)
Articles in Other Journals or Periodicals	Grigoriev K, Foox J, Bexdan D, Butler D, Luxton JJ, Reed J, McKenna MJ, Taylor L, George KA, Meydan C, Bailey SM, Mason CE. "Haplotype Diversity and Sequence Heterogeneity of Human Telomeres." Genome Research, in press as of December 2020. bioRxiv preprint server. https://doi.org/10.1101/2020.01.31.929307 , Dec-2020
Articles in Peer-reviewed Journals	Afshinnekoo E, Scott RT, MacKay MJ, Pariset E, Cekanaviciute E, Barker R, Gilroy S, Hassane D, Smith SM, Zwart SR, Nelman-Gonzalez M, Crucian BE, Ponomarev SA, Orlov OI, Shiba D, Muratani M, Yamamoto M, Richards SE, Vaishampayan PA, Meydan C, Foox J, Myrrhe J, Istasse E, Singh N, Venkateswaran K, Keune JA, Ray HE, Basner M, Miller J, Vitaterna MH, Taylor DM, Wallace D, Rubins K, Bailey SM, Grabham P, Costes SV, Mason CE, Beheshti A. "Fundamental biological features of spaceflight: Advancing the field to enable deep-space exploration." Cell. 2020 Nov 25;183(5):1162-84. Review. https://doi.org/10.1016/j.cell.2020.10.050 ; PMID: 33242416 , Nov-2020
Articles in Peer-reviewed Journals	Luxton JJ, McKenna MJ, Taylor LE, George KA, Zwart SR, Crucian BE, Drel VR, Garrett-Bakelman FE, Mackay MJ, Butler D, Foox J, Grigorev K, Bezdan D, Meydan C, Smith SM, Sharma K, Mason CE, Bailey SM. "Temporal telomere and DNA damage responses in the space radiation environment." Cell Rep. 2020 Dec 8;33(10):108435. https://doi.org/10.1016/j.celrep.2020.108435 ; PMID: 33242411 , Dec-2020
Articles in Peer-reviewed Journals	Luxton JJ, McKenna MJ, Lewis A, Taylor LE, George KA, Dixit SM, Moniz M, Benegas W, Mackay MJ, Mozsary C, Butler D, Bezdan D, Meydan C, Crucian BE, Zwart SR, Smith SM, Mason CE, Bailey SM. "Telomere length dynamics and DNA damage responses associated with long-duration spaceflight." Cell Rep. 2020 Dec 8;33(10):108457. https://doi.org/10.1016/j.celrep.2020.108457 ; PMID: 33242406 , Dec-2020
Articles in Peer-reviewed Journals	Trinchant NM, MacKay MJ, Chin C, Afshinnekoo E, Foox J, Meydan C, Butler D, Mozsary C, Vernice NA, Darby C, Schatz MC, Bailey SM, Melnick AM, Guzman M, Bolton K, Braunstein LZ, Garrett-Bakelman F, Levine RL, Hassane D, Mason CE. "Clonal hematopoiesis before, during, and after human spaceflight." Cell Rep. 2020 Dec 8;33(10):108458. https://doi.org/10.1016/j.celrep.2020.108458 ; PMID: 33242405 , Dec-2020
Articles in Peer-reviewed Journals	Bezdan D, Grigorev K, Meydan C, Pelissier Vatter FA, Cioffi M, Rao V, MacKay M, Nakahira K, Burnham P, Afshinnekoo E, Westover C, Butler D, Moszary C, Donahoe T, Foox J, Mishra T, Lucotti S, Rana BK, Melnick AM, Zhang H, Matei I, Kelsen D, Yu K, Lyden DC, Taylor L, Bailey SM, Snyder MP, Garrett-Bakelman FE, Ossowski S, De Vlaminck I, Mason CE. "Cell-free DNA (cfDNA) and exosome profiling from a year-long human spaceflight reveals circulating biomarkers." iScience. 2020 Dec 18;23(12):101844. Available online 25 November 2020. https://doi.org/10.1016/j.isci.2020.101844 ; PMID: 33376973; PMCID: PMC7756145 , Dec-2020