Fiscal Year:	FY 2020	**Task Last Updated:**	FY 05/06/2020
PI Name:	Smith, Scott M Ph.D.		
Project Title:	Space Biochemistry Profile		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Biomedical countermeasures		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HHC**:Human Health Countermeasures		
Human Research Program Risks:	(1) **Bone Fracture**:Risk of Bone Fracture due to Spaceflight-induced Changes to Bone (2) **Food and Nutrition**:Risk of Performance Decrement and Crew Illness Due to Inadequate Food and Nutrition (3) **Immune**:Risk of Adverse Health Event Due to Altered Immune Response (4) **Nutrition**:Risk of Inadequate Nutrition (5) **Osteo**:Risk Of Early Onset Osteoporosis Due To Spaceflight (6) **Renal Stone**:Risk of Renal Stone Formation		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
PI Email:	scott.m.smith@nasa.gov	**Fax:**	FY 281-483-2888
PI Organization Type:	NASA CENTER	**Phone:**	281-483-7204
Organization Name:	NASA Johnson Space Center		
PI Address 1:	Biomedical Research and Environmental Sciences Division/SK3		
PI Address 2:	2101 NASA Pkwy		
PI Web Page:			
City:	Houston	**State:**	TX
Zip Code:	77058-3607	**Congressional District:**	36
Comments:			
Project Type:	FLIGHT	**Solicitation / Funding Source:**	2012 Crew Health NNJ12ZSA002N
Start Date:	08/01/2013	**End Date:**	12/31/2021
No. of Post Docs:		**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 JSC
Contact Monitor:	Stenger, Michael	**Contact Phone:**	281-483-1311
Contact Email:	michael.b.stenger@nasa.gov		
Flight Program:	ISS		
Flight Assignment:	ISS NOTE: End date changed to 12/31/2021 per PI (Ed., 2/25/21) NOTE: End date changed to 12/31/2020 per PI (Ed., 5/10/19) NOTE: End date changed to 12/31/2019 per PI (Ed., 6/5/18)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Zwart, Sara Ph.D. (UTMB) Heer, Martina Ph.D. (University of Bonn, Germany)		
Grant/Contract No.:	Internal Project		
Performance Goal No.:			

Performance Goal Text:	
Task Description:	As long-duration spaceflights continue and the operational suite of countermeasures is modified, the food system is updated, and the duration of missions lengthens, it will be important to evaluate and monitor a broad set of biomarkers for key physiological systems. The Nutritional Status Assessment Supplemental Medical Objective (aka “Nutrition SMO”) was initiated in 2006, and has yielded significant clinical, operational, and research data. This proposal aims to extend the Nutrition SMO, under the guidelines provided in the NRA (NASA Research Announcement). Nutrition SMO data have been used to help identify or explain medical, scientific, and even engineering issues that have occurred during or after International Space Station (ISS) missions. The data have been used by Medical Operations on multiple occasions, to confirm the effectiveness of vitamin D supplementation, to test for nutrient toxicities (secondary to supplement use), to evaluate blood and urine chemistries after instances of kidney stones and gout symptoms in crewmembers, and to evaluate the effects of using a new exercise device on bone and calcium metabolism. The ISS Program Office has used these data to determine factors contributing to the Urine Processor Assembly failure and to make forward operational decisions. Perhaps most striking, the data provided evidence that one-carbon metabolism may be altered in crewmembers who experienced vision changes post flight, the highest Human Research Program risk. The relationship between nutritional status and 1-carbon metabolism would likely never have been discovered if the Nutrition SMO were not being conducted. The impact of the data collected to date provides a strong rationale for continuing with an updated version of this protocol, eliminating some tests while expanding others, to provide a repository of data to other scientific Disciplines. We have extensive experience with these types of analyses, sample and data management, transfer to data archives, and data reduction for medical, management, and research purposes.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	The findings from this study will help us better understand physiological adaptation to spaceflight, and will help evaluate countermeasure effectiveness. These results help the ISS Program, the Human Research Program (HRP), Space Medicine, Office of the Chief Health and Medical Officer (OCHMO), NASA engineers, individual astronauts, and other experiments. These results will also inform the general, medical, and scientific communities on human health and physiological issues in an altered gravity environment. There could be significant potential implications of these findings.
Task Progress:	This protocol was terminated after E56/57, ending collection of valuable data with impact to the ISS Program, HRP, OCHMO, Space Medicine, ECLSS (Environmental Control and Life Support Systems), other investigations, and to individual astronauts. We are completing data analysis, and working to publish these findings in both primary and collaborative publications.
Bibliography Type:	Description: (Last Updated: 05/24/2023)
Abstracts for Journals and Proceedings	Smith SM, Heer M, Zwart SR. "Biochemical Profile: Providing insight into human adaptation to spaceflight on ISS missions." Presented at 2020 NASA Human Research Program Investigators’ Workshop, Galveston, TX, January 27-30, 2020. Abstracts. 2020 NASA Human Research Program Investigators’ Workshop, Galveston, TX, January 27-30, 2020. , Jan-2020
Abstracts for Journals and Proceedings	Smith SM, Heer MA, Zwart SR. "Nutrition and human space flight: Evidence from 4-6 month missions to the International Space Station." Submitted to Nutrition 2020--Live Online, June 1-4, 2020. Abstracts. Nutrition 2020--Live Online, June 1-4, 2020. , Jun-2020
Abstracts for Journals and Proceedings	Romaniello SJ, Gordon GW, Skulan J, Smith SM, Zwart SR, Anbar AD. "Evaluating spaceflight-induced bone loss in astronauts using Ca isotopes." Presented at the Goldschmidt 2019 Conference, Barcelona, Spain, August 18-23, 2019. Abstracts. Goldschmidt 2019 Conference, Barcelona, Spain, August 18-23, 2019. , Aug-2019
Articles in Peer-reviewed Journals	Shelhamer M, Bloomberg J, LeBlanc A, Prisk GK, Sibonga J, Smith SM, Zwart SR, Norsk P. "Selected discoveries from human research in space that are relevant to human health on Earth." npj Microgravity. 2020 Feb 12;6:5. eCollection 2020. Review. https://doi.org/10.1038/s41526-020-0095-y ; PubMed PMID: 32128361; PubMed Central PMCID: PMC7016134 , Feb-2020
Articles in Peer-reviewed Journals	Sibonga JD, Spector ER, Keyak JH, Zwart SR, Smith SM, Lang TF. "Use of quantitative computed tomography to assess for clinically-relevant skeletal effects of prolonged spaceflight on astronaut hips." J Clin Densitom. 2020 Apr-Jun;23(2):155-64. Epub 2019 Aug 26. PubMed PMID: 31558405 , May-2020
Articles in Peer-reviewed Journals	Sibonga J, Matsumoto T, Jones J, Shapiro J, Lang T, Shackelford L, Smith SM, Young M, Keyak J, Kohri K, Ohshima H, Spector E, LeBlanc A. "Resistive exercise in astronauts on prolonged spaceflights provides partial protection against spaceflight-induced bone loss." Bone. 2019 Nov;128:112037. Epub 2019 Aug 7. https://doi.org/10.1016/j.bone.2019.07.013 ; PubMed PMID: 31400472 , Nov-2019
Articles in Peer-reviewed Journals	Frings-Meuthen P, Luchitskaya E, Jordan J, Tank J, Lichtinghagen R, Smith SM, Heer M. "Natriuretic peptide resetting in astronauts." Circulation. 2020 May 12;141(19):1593-5. https://doi.org/10.1161/CIRCULATIONAHA.119.044203 ; PMID: 32392103 , May-2020
Books/Book Chapters	Heer M, Baecker N, Smith SM, Zwart SR. "Nutritional countermeasures for spaceflight-related stress." in "Stress Challenges and Immunity in Space: From Mechanisms to Monitoring and Preventive Strategies." Ed. A. Choukèr. Cham: Springer International Publishing, 2020. p. 593-616. https://doi.org/10.1007/978-3-030-16996-1_33 , Jan-2020
Books/Book Chapters	Smith SM, Lane HW, Zwart SR. "Spaceflight metabolism and nutritional support." in "Principles of Clinical Medicine for Space Flight. 2nd edition." Ed. M.R. Barratt, E. Baker, S.L. Pool. New York: Springer, 2020. Ch. 13. p. 413-439. https://doi.org/10.1007/978-1-4939-9889-0_13 , Jan-2020