Fiscal Year:	FY 2023	**Task Last Updated:**	FY 05/01/2023
PI Name:	Zea, Luis Ph.D.		
Project Title:	Multi-Generational Genome-Wide Yeast Fitness Profiling Beyond and Below Earth's van Allen Belts		
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		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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PI Web Page:			
City:	Boulder	**State:**	CO
Zip Code:	80309-0429	**Congressional District:**	2
Comments:			
Project Type:	FLIGHT	**Solicitation / Funding Source:**	2018 Space Biology (ROSBio) NNH18ZTT001N-Artemis1 (EM1). App A: Orion (Artemis-1) (formerly Exploration Mission-1)
Start Date:	05/01/2019	**End Date:**	04/29/2024
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	1	**No. of Master' Degrees:**	0
No. of Master's Candidates:	0	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	1	**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 04/29/2024 per NSSC information (Ed., 5/31/23) NOTE: End date changed to 04/30/2023 per NSSC information (Ed., 4/12/23)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Stodieck, Louis Ph.D. (University of Colorado, Boulder) Nislow, Corey Ph.D. (University of British Columbia, Canada)		
Grant/Contract No.:	80NSSC19K0708		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	As human space exploration expands beyond lower Earth orbit, it is necessary to characterize the effects of space radiation, microgravity, and the combination thereof on cells. Because it is complicated to have large sample numbers when studying the effects of different factors on humans, scientists commonly use model organisms that share some of the key aspects being studied. In this case, we will use yeast, as around 70% of its essential genes have a significant human homolog. More specifically, this project will use a molecularly barcoded yeast genome-wide knockdown collection that will enable the systematic interrogation of the effect of microgravity, space radiation, and a combination thereof in each gene. Each strain in the collection has a single gene deleted and a representative molecular barcode that enables quantifying the fitness of each mutant under the test conditions, by measuring the relative abundance at different points in time. To differentiate the effects of microgravity and space radiation on each strain, an experimental set will be flown beyond the van Allen belts on Orion's Exploration Mission 1 (EM-1) (considered in microgravity and irradiated by space radiation) and equivalent sets will be cultured asynchronously on board the International Space Station (ISS) (considered in microgravity but mostly – although not completely – protected of space radiation by the van Allen belts) in our smart incubator (Space Automated Bioproduct Lab (SABL)) and on Earth (also in a ground SABL). Each of the ISS and Earth experiments will include two sets: one where the temperature profile experienced during the EM-1 flight is replicated, and a second cultured at a constant temperature to determine the potential role of temperature variation on the results from EM-1. The first aim of this project is to identify the metabolic and genomic pathways in yeast affected by microgravity, space radiation, and a combination of both. The second one is to differentiate between gravity and radiation exposure on single-gene deletion mutants' ability to thrive in the spaceflight environment. We hypothesize that mutants lacking genes associated with DNA repair, recombination, and replication will have lower survivability rates beyond the van Allen belts than their below van Allen belts- or Earth-controls The experiment is designed to have a controlled start after Orion is past the van Allen belts, grow ~21 generations of the deletion series, and fix or preserve samples for post-flight analyses. Should the automated controlled approach be considered inappropriate for implementation on EM-1, we have a passive approach that is based on dotting each mutant individually on agar. We have performed both approaches in space in the past. This project will address three Space Biology Program Science Elements, three Objectives, three Guiding Questions, and four Decadal Survey's highest priority Recommendations by preserving nucleic acids of different generations of the yeast deletion series cultures grown in space, beyond as well as below the van Allen belts (and uploading the genomic and transcriptomic data to GeneLab).
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	This project integrates data on the molecular and cellular mechanism of radiation damage, which can serve to improve prediction of risk of cancer as a function of radiation dosage and to evaluate the effectiveness of potential countermeasures.
Task Progress:	1. PLASM was modified to include more AA batteries, hence extending how long the experiment can remain viable between pre-flight integration and experiment performance in space. 2. The new configuration of PLASM was tested and verified functional and ready for flight. 3. PLASM was integrated at NASA Kennedy Space Center (KSC) and handed over to NASA for launch. 4. After a couple of Space Launch System (SLS) launch scrubs, NASA kindly handed PLASM back to us. 5. PLASM was refreshed (batteries, science, and otherwise) and handed over again to NASA. 6. SLS launched and Orion successfully completed its mission. 7. Orion splashed down back to Earth. 8. Samples were received from NASA. 9. Full (100%) functionality of the flight hardware developed for this project (PLASM) during the Artemis I flight was confirmed. 10. Culture growth was confirmed in 12 out of the 12 samples. 11. No contamination measured in any of the 12 samples. 12. Data acquisition and analysis has begun. 13. Performance of ground controls has begun.
Bibliography Type:	Description: (Last Updated: 03/05/2024)
Articles in Peer-reviewed Journals	Zea L, Piper SS, Gaikani H, Khoshnoodi M, Niederwieser T, Hoehn A, Grusin M, Wright J, Flores P, Wilson K, Lutsic A, Stodieck L, Carr CE, Moeller R, Nislow C. "Experiment verification test of the Artemis I 'Deep Space Radiation Genomics' experiment." Acta Astronaut. 2022 Sep;198:702-6. https://doi.org/10.1016/j.actaastro.2022.06.018 , Sep-2022
Books/Book Chapters	Pathak Y, Araújo dos Santos M, Zea L. (Eds.) "Handbook of Space Pharmaceuticals." Cham, Switerland: Springer, 2022. 978-3-31-950909-9. https://doi.org/10.1007/978-3-319-50909-9 , Jan-2022