Fiscal Year:	FY 2021	**Task Last Updated:**	FY 03/02/2021
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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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:**	04/30/2022
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	6	**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:			
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. The experiment's Science Verification Test (SVT) was completed 2. A new hardware subsystem for temperature control was designed, developed, tested, and integrated 3. The Deep Space Radiation Genomics (DSRG) Experiment Verification Test (EVT) was completed, yielding "excellent" score under all of the mission success criteria Other hardware and protocol work performed during this project's second year include: • Peristaltic pump characterization (flow and power consumption as function of operational duration) • Characterization of metabolic pressure inside Culture Bags as function of time and environmental temperature • Optimization of the Culture Bag sealing procedure • Optimization of the Fluidic System assembly, sterilization, loading, and acceptance testing procedure • Data production for Safety Review 0/I/II • Production of all structural parts for all five Peristaltic Laboratory for Automated Science with Multigenerations (PLASM) units • HFIT buy-in for the ISS units • Flight-like software development • Integrated software and accelerometer testing to verify our software architecture can detect launch and autonomously activate the experiment passed the Van Allen belts • Development of a python code yielding a timetable to let PLASM know when can it activate the experiment, to ensure yeast growth occurs outside of Earth's magnetosphere, hence exposing the cells to the most pristine deep space radiation environment possible (i.e., not confounded by our magnetosphere).
Bibliography Type:	Description: (Last Updated: 03/05/2024)