Fiscal Year:	FY 2023	**Task Last Updated:**	FY 08/24/2022
PI Name:	Paul, Anna-Lisa Ph.D.		
Project Title:	Hypobaric Plant Biology in Space Exploration - Molecular Responses of Arabidopsis to Combined Effects of Low Atmospheric Pressures and Microgravity of Spaceflight Vehicles		
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) Plant Biology		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Zip Code:	32611-0690	**Congressional District:**	3
Comments:			
Project Type:	Flight,Ground	**Solicitation / Funding Source:**	2020 Space Biology NNH20ZDA001N-SB E.12. Flight/Ground Research
Start Date:	10/21/2021	**End Date:**	10/20/2024
No. of Post Docs:		**No. of PhD Degrees:**	
No. of PhD Candidates:	1	**No. of Master' Degrees:**	
No. of Master's Candidates:		**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:		**Monitoring Center:**	NASA KSC
Contact Monitor:	Haveman, Natasha	**Contact Phone:**	857-225-6244
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Flight Program:	ISS		
Flight Assignment:			
Key Personnel Changes/Previous PI:	Addition of a research scientist, Dr. Mingqi Zhou, who was added to to his transcriptomic and hypobaric studies in the past.		
COI Name (Institution):	Ferl, Robert Ph.D. (University of Florida, Gainesville)		
Grant/Contract No.:	80NSSC22K0214		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Atmospheric pressure and composition are among the engineering variables considered in the design and construction of spaceflight vehicles and extraterrestrial habitats. Simply put, the costs of maintaining a pressure vessel at one atmosphere have been traded away throughout the history of spaceflight vehicle design and are traded away in future designs. And while the effects of hypobaria on plant biology are now well understood, there exist no studies on the combined effects of hypobaria and microgravity. In other words, the dominant physical manifestation of spaceflight, microgravity, has been left out of our understanding of plant hypobaria. We therefore propose to examine plant responses and physiological adaptations to the combined effects of low pressure while in the microgravity of the International Space Station (ISS). The objective of this proposal is to develop a refined understanding of the metabolic processes involved in plant responses and physiological adaptations to low pressure environments within space exploration vehicles and habitats. The long-term goal of this line of research is a fundamental understanding of low pressure plant biology within exploration vehicles and structures, with a practical goal of contributing to the design of plants that thrive in challenging exploration environments. The essential drivers of this project are that hypobaric environments will likely be a feature of future exploration vehicles and habitats, together with the knowledge that plants mount complex and costly metabolic responses to hypobaria. Furthermore, plants mount complex and sometimes unexpected responses to spaceflight and altered gravity environments. We hypothesize that the combination of hypobaria and microgravity will have a synergistic effect on the physiological adaptation to this complex environment, and that the patterns of gene expression will reveal strategies to both understand and help ameliorate the combined effect. These responses will also inform fundamental understanding of how plants adapt to changing terrestrial habitats facing complex and novel stressful environments. There is a facility on the ISS that is well suited for these experiments: the Combustion Integrated Rack (CIR). The CIR has a pressure vessel that can be programmed telemetrically to the gas composition and pressures relevant to our study. There is also a CIR ground unit that can be similarly programmed for parallel ground controls, thereby enabling the precise dissection of the effects of the orbital environment on plant biology within the pressure vessel. The proposed research will provide fundamental insights into the biological impact of novel atmospheric environments, a focus area that is itself specifically identified in the Decadal Study. (Ed. Note. The National Academies of Sciences, Engineering, and Medicine Decadal Survey on Biological and Physical Sciences Research in Space 2023-2032). More importantly, this Hypobaric Plant Biology in Space Exploration study seeks to fundamentally examine combined spaceflight effects in order to develop an understanding of emergent response properties that are not predicable from an examination of the individual responses.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	This research contributes to a greater understanding of the role of transcriptomic changes to the plant in response to both hypobaric and microgravity environments. Further, it will be the first experiment to test whether the interplay between hypobaric stress to plants and microgravity growth of plants has synergistic effects.
Task Progress:	The summary below is a brief description of the work completed in the last year for the hypobaria-microgravity project. This work summarizes the work done to successfully complete the Experiment Verification Test (EVT) to demonstrate International Space Station (ISS) flight readiness. Two genotypes of Arabidopsis (Arabidopsis thaliana L.) will be used: wild ecotype Columbia-0 (Col-0) and Col-0 deficient in a gene sensitive to low pressure environments. The gene of interest is highly induced in response to hypoxia in terrestrial environments and is also induced by spaceflight. These two seed lines will be used for the bulk of the biochemical work done, such as transcriptomics, on the upcoming flight experiment. The experiment also calls for four reporter gene lines for an imaging plate to be flown along side the wild type (WT) and knockout plant lines. These seed lines are currently in development for upcoming testing and flight experiments.
Bibliography Type:	Description: (Last Updated: 05/19/2025)