

Fiscal Year:	FY 2022	Task Last Updated: FY 12/06/2021	
PI Name:	Jansson, Janet Ph.D.		
Project Title:	Dynamics of Microbiomes in Space (DynaMoS)		
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) Microbiology		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Comments:			
Project Type:	FLIGHT,GROUND	Solicitation / Funding Source:	2018 Space Biology (ROSBio) NNH18ZTT001N-FG. App B: Flight and Ground Space Biology Research
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No. of Bachelor's Candidates:		Monitoring Center:	NASA KSC
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Flight Program:	ISS		
Flight Assignment:	ISS		
Key Personnel Changes/Previous PI:	December 2021 Report: Christer Jansson, Ph.D. has left the project to meet other commitments due to retirement. Hyun-Seob Song, Ph.D. has left the Department of Energy, so is no longer with the project. Yuliya Farris was added to the project as a technician to process samples. Michelle Davison, Ph.D. was added to the project due to her expertise in microbiology.		
COI Name (Institution):	Hixson, Kim Ph.D. (Battelle Memorial Institute) McClure, Ryan Ph.D. (Battelle Memorial Institute) Rivas-Ubach, Albert Ph.D. (Battelle Memorial Institute) Farris, Yuliya (Battelle Memorial Institute) Davison, Michelle Ph.D. (Battelle Memorial Institute)		
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Task Description:	We propose to examine the population dynamics and community interactions of naturally co-adapted soil microbial consortia using multi-omics analysis, correlative molecular networking and metagenomics-based metabolic modeling, and compare results between the International Space Station (ISS) and ground control at Kennedy Space Center (KSC). We hypothesize that the selection pressure (altered atmospheric gas composition, microgravity, and increased radiation) imposed by the space station environment will alter both the microbial community population dynamics and the metabolic interactions between specific microbial community members.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Soil microorganisms are essential for life on our planet. They carry out key functions, including cycling carbon and other nutrients, and supporting plant growth. On Earth, soil microorganisms exist in communities that coordinate their metabolism to carry out different steps in complex metabolic processes. Our research is focused on a defined consortium of soil microorganisms that carry out steps required for decomposition of chitin--the second most abundant carbon polymer on Earth. It is not known how interspecies interactions may be impacted by the space environment. Therefore, our research will provide beneficial information about how soil microorganisms function in space and if their metabolism is altered when compared to normal conditions on Earth. Knowledge gained will be beneficial for future space missions that aim to achieve life-sustainable conditions that rely on natural processes carried out by soil microorganisms.
Task Progress:	<p>The DynaMoS team successfully carried out the Science Verification Test (SVT) experiments as required prior to approval for the Experiment Verification Test (EVT). The SVT was first initiated on May 17, 2021. The initial SVT had to be repeated because some of the tubes unexpectedly cracked during freezing at -80°C. Also, some of the inserts were hard to remove. Finally, splitting of the frozen soil was difficult to carry out for the different omics analyses. Solutions included substitution of the centrifuge tubes for a different brand that is resistant to cracking at -80°C, and reducing the diameters of the inserts. Lyophilization was tested and found to be adequate for removing water and loosening the soil prior to subsampling for the different omics analyses.</p> <p>A second SVT was initiated on June 2, 2021 and completed on July 11, 2021. Zero week samples were placed at -80°C on June 4; the 4 week samples were placed at -80°C on July 2. Lyophilization started July 6/7 and metabolomics processing occurred July 10-11. All of our success criteria were achieved during the second SVT. Sufficient cell biomass was collected from the inoculated soil. Sufficient DNA was collected from the inoculated soil, far higher than control (sterile, uninoculated) samples. 16S rRNA genes were sequenced from the DNA. The results indicated that the proportions of cells added to the soil samples were sufficient and that there was good representation of each of the 8 strains that were inoculated into the soil. After 4 weeks of incubation, there were some shifts in abundances of some of the microbes that were inoculated in the soil, indicating that they were active and shifting as anticipated during growth on chitin as a substrate. High quality RNA of sufficient quantity was collected from the inoculated soil and at much higher levels than in control samples. Sufficient protein was collected from the inoculated soil. In most cases, the protein yields were higher than in the control soil. We hypothesize that significant differences in the metaproteome data will emerge when the proteins are analyzed by mass spectrometry during the EVT. Sufficient metabolites were extracted from the soil with large differences between inoculated and control samples, providing evidence of bacterial activity during the incubations. A manuscript is being drafted that contains the results of the SVT experiment.</p> <p>After review of the success criteria from the SVT, the DynaMoS team was approved to carry out the EVT at the NASA Kennedy Space Center. Two members of the DynaMoS team initiated the EVT at KSC during the week of September 20, 2021. The EVT utilized KSC's ISS Environmental Simulator (ISSES) Chamber with ambient ISS conditions. The EVT consisted of fifty-two 50 ml centrifuge tubes prepared by the Principal Investigator (PI) team with microbial consortium, soil, 3D-printed plastic spacers, and cotton. Tubes were capped, wrapped with parafilm and placed in 4 zip lock bags with 13 tubes/bag and placed in a +4°C refrigerator for 6 days. On Day 7, 13 tubes (Day 0 tubes) were placed in a -80°C freezer and the other 33 tubes were placed at ambient temperature. After 28 days, 13 tubes (Day 28 tubes) at ambient temperature were placed in the -80°C freezer together with the Day 0 tubes. After 8 weeks from Day 0, another set of 13 tubes (Day 56 tubes) were placed in the -80°C freezer. After 4 months from Day 0, the last set of 13 tubes (Day 120 Tubes) will be placed in the -80°C freezer. After 7 days, all tubes will be removed from the -80°C freezer and sent to Pacific Northwest National Laboratory (PNNL) for processing. The last samples (Day 120) are still being incubated at KSC. All of the samples will be sent to PNNL in January 2022 for omics analyses.</p> <p>A Science Readiness for Flight Review (SRFR) was conducted to verify the EVT objectives and that the success criteria were met. Based on the SRFR, the DynaMoS project was approved to proceed with launch integration and mission support. The anticipated launch date to ISS will be in the Spring of 2022.</p>
Bibliography Type:	Description: (Last Updated:)