Fiscal Year:	FY 2021	**Task Last Updated:**	FY 12/10/2020
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
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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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Zip Code:	99354-1793	**Congressional District:**	4
Comments:			
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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 of carbon and other nutrients and support of 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:	The "Dynamics of Microbiomes in Space (DynaMoS)" project aims to test the hypothesis that communities of soil microorganisms will behave differently in space due to microgravity and other conditions on the International Space Station (ISS) compared to Earth. To test this hypothesis the DynaMoS team is leveraging complementary skills in microbial ecology, multi-omics, and modeling to compare soil microbial community interactions on ISS and ground control at Kennedy Space Center (KSC). During this first year of funding, the team has developed the experimental protocol that will be tested prior to space flight. The experimental protocol consists of several steps. First, a defined community of soil microorganisms has been characterized that will be the inoculum for the DynaMoS experiments. The community consists of nine soil microorganisms that were co-enriched to grow on chitin as the sole carbon substrate. Through the process of enrichment, the resulting consortium, Model Soil Consortium-2 (MSC-2), developed metabolic interdependencies between species to enable growth on the complex chitin substrate. We have confirmed that several of these species are able to grow using chitin as the soil source of carbon and that this community is active within a soil system, making it ideal for our proposed experiments. The growth and final density of strains was characterized under a variety of preincubation conditions (for example: +/- chitin) at different temperatures to determine the optimum conditions to achieve the required cell volume and to retain cell viability as required for inoculation into sterile soil. We also sequenced all of the genomes of MSC-2 and made genome models of each to predict the metabolic potential of each community member, providing a wealth of data to draw from as we better understand species' responses under ISS or ground conditions. We have begun to examine specific species interactions in more detail within MSC-2 and have found that when pairs of species from this consortium are co-incubated together with chitin they grow better than when cultivated separately. Determining the interactions that drive this improved co-cultivation will require transcriptional analysis of each species to reveal which genes they are expressing when co-cultivated. To that end we have developed approaches that allowed us to successfully isolate high-quality DNA, RNA, metabolites, and proteins from species cultivated in soil. When applied to our future space and ground experiments this success will lead to data showing which species shift their abundance in soil with chitin under ISS and ground conditions and which genes they express, detailing interaction mechanisms between species in these environments. The complete bacterial consortium was assayed for pathogenicity in a mammalian cell culture workflow, and no indicators of pathogenicity were detected. We are currently testing each individual isolate as well.
Bibliography Type:	Description: (Last Updated:)