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| **Fiscal Year:** | FY 2023 | **Task Last Updated:** | FY 11/28/2022 |
| **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 | | |
| **PI Email:** | janet.jansson@pnnl.gov | **Fax:** | FY |
| **PI Organization Type:** | GOVERNMENT | **Phone:** | 509-375-3982 |
| **Organization Name:** | Battelle Memorial Institute (Pacific Northwest National Laboratory) | | |
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| **City:** | Richland | **State:** | WA |
| **Zip Code:** | 99354-1793 | **Congressional District:** | 4 |
| **Comments:** | | | |
| **Project Type:** | FLIGHT,GROUND | **Solicitation / Funding Source:** | 2018 Space Biology (ROSBio) NNH18ZTT001N-FG. App B: Flight and Ground Space Biology Research |
| **Start Date:** | 02/07/2020 | **End Date:** | 12/31/2023 |
| **No. of Post Docs:** | 0 | **No. of PhD Degrees:** | 0 |
| **No. of PhD Candidates:** | 0 | **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:** | ISS | | |
| **Flight Assignment:** | ISS<br>NOTE: End date changed to 12/31/2023 per PI (Ed., 6/23/23) | | |
| **Key Personnel Changes/Previous PI:** | June 2023 Update per the PI: Ryan McClure, Ph.D., will coordinate this project, following the retirement of Janet Jansson, Ph.D. (Ed., 6/23/23). 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. November 2022 Report: Former CoInvestigator Michelle Davison, Ph.D. has left the project to pursue another position. Marci Garcia has joined the project as a technician to process samples. | | |
| **COI Name (Institution):** | Hixson, Kim Ph.D. ( Battelle Memorial Institute )<br>McClure, Ryan Ph.D. ( Battelle Memorial Institute )<br>Rivas-Ubach, Albert Ph.D. ( Battelle Memorial Institute )<br>Farris, Yuliya ( Battelle Memorial Institute ) | | |
| **Grant/Contract No.:** | Department of Energy IAA | | |
| **Performance Goal No.:** | | | |

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| **Performance Goal Text:** | |
| **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:** | June 2023 Update: NOTE: Continued by "Dynamics of Microbiomes in Space (DynaMoS)" (PI: McClure) due to Dr. Jansson's retirement and departure from the project. Please see the record under PI McClure for subsequent reporting. The DynaMoS team successfully carried out the Experiment Verification Test (EVT), which was approved, and set up the experiment that was launched to the International Space Station (ISS). The ISS experiment is still ongoing, with an anticipated return to Earth on SpaceX-26 in early January 2023.<br><br>The EVT was initiated at NASA Kennedy Space Center (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 seven, 13 tubes (Day 0 tubes) were placed in a -80°C freezer and the other 33 tubes were placed at ambient. After 28 days, 13 tubes (Day 28 tubes) at ambient were placed in -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. And after 3 months from Day 0, the last set of 13 tubes (Day 90 Tubes) were placed in the -80°C freezer. After 7 days of freezing storage to mimic transport to Earth, all tubes were removed from the -80°C freezer and sent to PNNL for processing. All of the samples were sent to Pacific Northwest National Laboratory (PNNL) while frozen (using a dedicated truck) in January 2022 for omics analyses.<br><br>At PNNL, the omics analyses for the EVT were carried out in the Spring of 2022. A Science Readiness for Flight Review (SRFR) was conducted with NASA Biological and Physical Sciences (BPS) on April 1, 2022. A hardware readiness review was conducted on June 5, 2022 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.<br><br>The multi-omics data that were collected from the EVT revealed how the 8 species comprising Model Soil Consortium-2 (MSC-2) interacted during degradation of chitin in sterile soil. A manuscript is in preparation that describes the results of the EVT experiment. The 4 omics datasets were the following over the 4 time points (Day 0, 4 weeks, 8 weeks, 12 weeks) of the experiment: 1) 16S rRNA gene amplicon sequence data that were used to monitor population shifts of the 8 species; 2) metatranscriptome sequence data (total RNA) that were used to profile which genes were expressed by the 8 species; 3) metaproteome data (total proteins) that were used to determine which proteins were made by the 8 species; 4) metabolite data (total metabolites) that were used to monitor chitin decomposition products – and other metabolites – in the soil during the incubation. The incubations were carried out with 2 different concentrations of MSC-2 cells (108 and 109 cells per gram). The species representations over time were similar for both cell concentrations in the RNA and protein data. Pearson correlations of the species abundances in the 16S rRNA gene amplicon data revealed positive and negative interactions between the 8 members of the MSC-2 community. All 4 omics datasets revealed that there was a large shift from Day 0 to 4 weeks, and that over time there was continued succession of the different members of the MSC-2 community, RNA expression, protein production, and metabolites.<br><br>Together, these data reveal that over time the chitin is degraded by interacting members of the MSC-2 community in soil. The data clearly reveal that different members of MSC-2 carry out different steps in the decomposition of chitin. For example, the Streptomyces sp. is primarily responsible for carrying out the initial conversion of chitin to chitobiose. By contrast, the Sphingopyxis sp. becomes a dominant player at later steps in the chitin decomposition pathway.<br><br>The launch to ISS was successfully carried out on SpaceX 25 on July 14, 2022. To prepare the samples for the launch, two sets of DynaMoS personnel traveled to KSC. The first trip was from June 1-8 for the initial planned launch that was scrubbed. The team traveled again to KSC from July 5-12, 2022 to prepare the samples for the July launch date. The team carried out the same protocol as for the EVT above, except that the number of inoculated soil samples were doubled to 104 so that half (52) could be incubated at KSC and the other half (52) on the ISS.<br><br>For the ongoing experiment on the ISS, all of the samples have been collected by the crew and placed into cold storage in the Minus Eighty-Degree Laboratory Freezer for ISS (MELFI) while awaiting the January 2023 return to Earth on Space-X 26. All of the ground control samples at KSC have also been collected to coincide with the sampling dates on the ISS. Starting July 17, 2022, on ISS the Day 0 science bag was inserted in to MELFI and the other 3 bags were stowed at ambient in Cargo Transport Bag (CTB). Ground control science bags were also transferred to the -80 freezer and to ISSES chamber 4 in the same order. Bag 2 (4 weeks) was transferred to MELFI on August 15 and Ground Control also transferred to the SSPF freezer. Bag 3 (8 weeks) was moved to MELFI on September 12 and at KSC on the same day. The last samples were collected on October 13, and they are still in cold storage at KSC and on the ISS. Once all samples from the ISS arrive on Earth, they will be shipped together with the ground control samples to PNNL for multi-omics analyses using the same protocols that were validated for the EVT. |

| Bibliography Type: | Description: (Last Updated: ) |
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