CASE STUDY

How the Open Science Data Repository Accelerates Host-Gut Microbiome Discoveries

NASA's Open Science Data Repository (OSDR) houses spaceflight omics datasets, such as metagenomics, transcriptomics, and metabolomics studies, as well as datasets pertinent to phenotype, behavior, and more.

Authors of the publication "*Spaceflight alters host-gut microbiota interactions*" used three OSDR datasets to enhance their study of mammalian health in space, specifically, host-gut interactions, including data derived from NASA's Rodent Research missions (*Gonzalez et al, 2024*). By analyzing how microgravity and space radiation disrupt biological systems such as host-gut interactions, researchers provide insights into the challenges that astronauts will face during extended space exploration.

Gut Microbiota in Spaceflight Conditions

Gut microbes have been popularized in public media in terms of health benefits such as probiotic and even pre-biotic food marketing. In deeper scientific literature, microbiota are well-represented in spaceflight discussions, but specific host-gut interactions are less established. This study presents metagenomic analyses that demonstrated changes in key bacterial populations vital to host health, namely short-chain fatty acid (SCFA) and bile acid metabolism. For instance, microbes that serve as bile acid metabolizers such as *Extibacter muris* and *Dysosmobacter welbionis* were enriched, while butyrate producers such as *Intestinimonas butyriciproducens* were depleted. These disruptions are linked to host metabolic irregularities, including lipid accumulation and impaired glucose metabolism.

Multi-omics analyses identified over 13,000 gene regions that were affected by spaceflight factors, hence providing clues into the microbial genes implicated in metabolism and immune function. These insights enable a developing understanding of how changes in microbiota affect the health of the host during spaceflight.

Host Gene Expression and Health

Through analyses of the OSDR datasets (OSD-245, OSD-247, OSD-249), researchers found major changes in how genes were expressed in the liver and colon due to shifts in gut microbiomes. These changes disrupted important pathways for bile acid, cholesterol, and fat metabolism. Intestinal tissues were associated with decreased bile acid secretion and increased cholesterol buildup, whereas liver tissues were associated with increased activity in genes linked to fat storage and production. This combination is often indicative of fatty liver disease and metabolic syndrome.

Spaceflight conditions also affected circadian rhythm genes, which help regulate nutrient absorption, digestion, and immune health. These changes are similar to issues seen in astronauts, namely insulin resistance and exacerbated inflammatory responses.

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"Accessibility to data accelerates discoveries."

OSDR's Impact on Space Health Research

Accessibility to data accelerates discoveries by allowing more minds to work simultaneously on available data that is often already scarce in nature. OSDR offers a centralized platform for open access to transcriptomics datasets, including processed data to support using standardized analysis pipelines that were developed by Analysis Working Groups (AWGs).

By integrating transcriptomic, metagenomic, and functional data, OSDR enabled researchers to connect microbiome changes with systemic host responses, the underlying molecular mechanisms of spaceflight-induced pathologies. Authors additionally expressed that recognizing the types of analyses conducted by others using OSDR datasets helped to validate and confirm the direction of their intended research. This demonstrates the value of open science and its ability to address space health research – using consistent standards and methods – effectively.

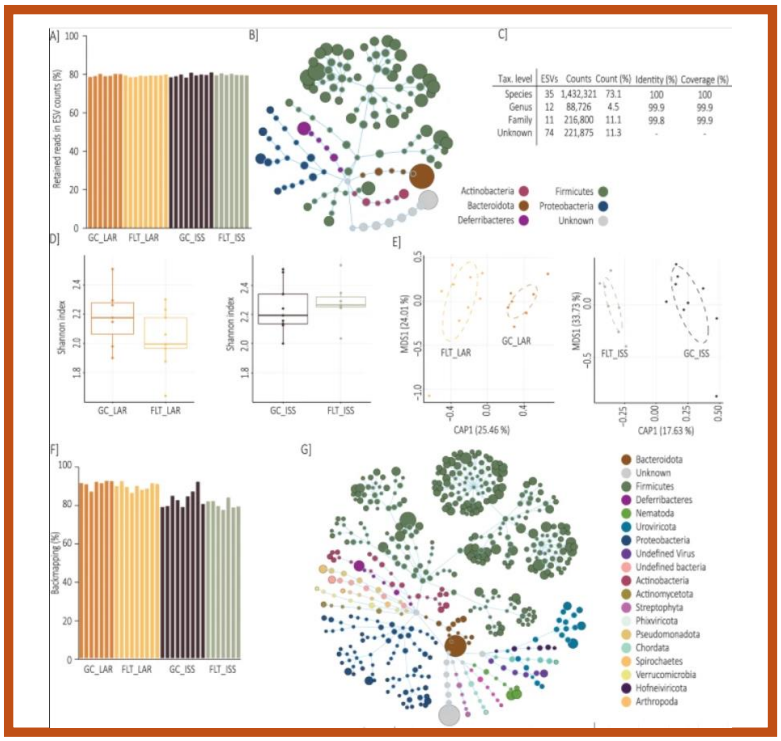

Image shown is Figure 2: Ground control, live animal return and ISS murine gut microbiome capture from the publication from the OSDR-enabled publication.

Implications for Space Exploration

This research highlights the importance for gut microbiota – and their interactions with us as their hosts – are for staying healthy during spaceflight. Changes in how the gut and body interact can lead to severe issues ranging from problems with metabolism, weakened immune systems, and liver damage. Finding countermeasures to mitigate these risks, such as through tailored diets, is necessary before long-duration space missions to the Moon, Mars, and beyond can become truly possible.

Want to know more? Access these links!

Spaceflight alters host-gut microbiota interactions

Datasets Available through OSDR:

OSD-245 OSD-247 OSD-249