

## 2022 Annual Report: CULTURE-BASED ENVIRONMENTAL MICROBIOLOGY MONITORING OF CROP-BASED SPACE FOOD SYSTEMS (VEGGIE MONITORING)

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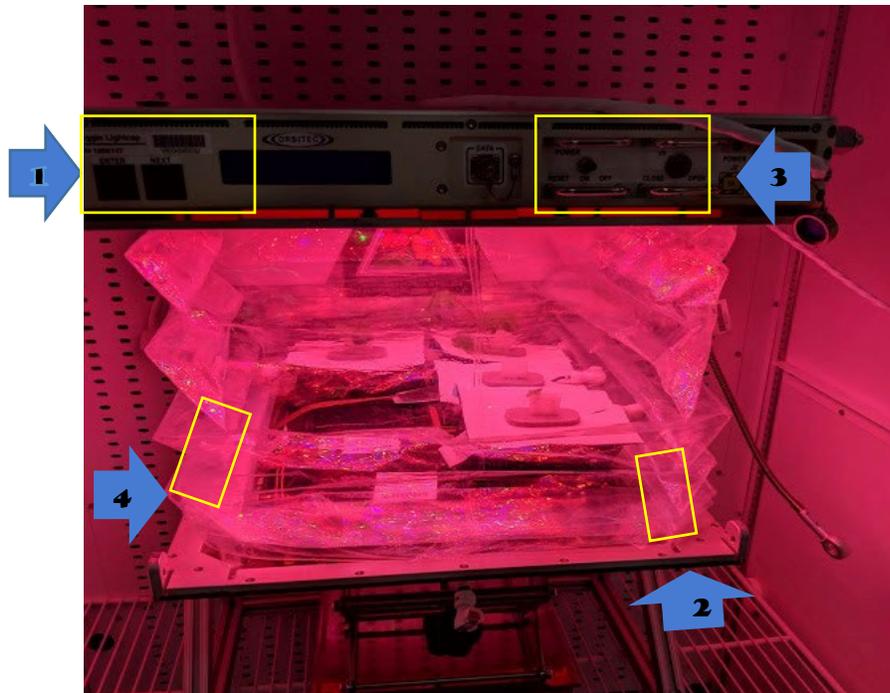
Astronauts collecting Microbial Monitoring samples on-orbit during Increments 65 and 66

### Introduction:

Crewmembers live and work in a closed environment that is monitored to ensure their health and safety. Quarterly monitoring of the microorganisms in the International Space Station (ISS) environment supports crew safety and contributes to a large set of environmental microbial data from the air, surface, and water samples that are collected. This study leverages quarterly operational Environmental Health System (EHS) sampling by collecting additional microbial samples from the surface of the station's Veggie plant production system. Longer exploration missions may require spaceflight-based systems for growth of plants, and this investigation is expected to provide additional data to help establish requirements to protect these systems, plants, and crew, mitigating adverse microbial exposure.

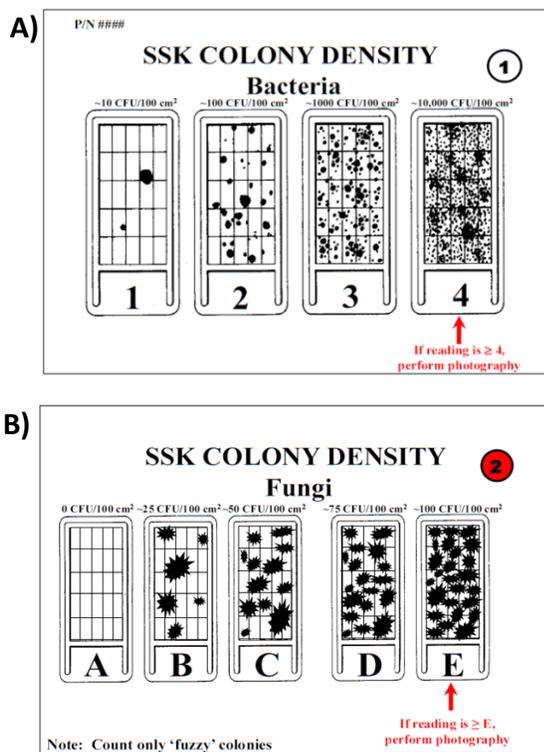
### Methods:

For each Veggie Monitoring sampling session, crewmembers collected a total of 8 surface samples for bacterial and fungal analysis from various sample sites (Figure 1) on the exterior and interior surfaces of the Veggie unit using the Surface Sampling Kit (SSK), then the samples were stored in a warm place to incubate. After 5 days of incubation, the crewmember observed and recorded microbial proliferation based on a growth density chart (Figure 2). After analysis the samples were stowed on-board then returned to the NASA JSC Microbiology lab where they were further analyzed. If growth was observed, each morphologically distinct colony were sub-cultured and isolated onto a respective medium for identification. Microorganisms are identified via methods including microscopy, biochemical analysis, and Sanger sequencing of DNA according to JSC Microbiology policy, procedures, and practices.



**Figure 1: Examples of Veggie Unit Surface Sample Locations:**

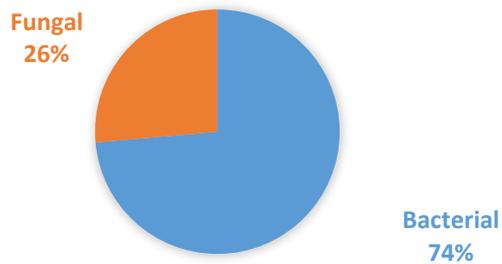
1. Veggie Lightcap Control Panel, top-left
2. Underneath front vent screen for Bellows Chamber, bottom-right
3. Veggie Control Panel, top-right
4. Exterior surface of Bellows Chamber, front-left



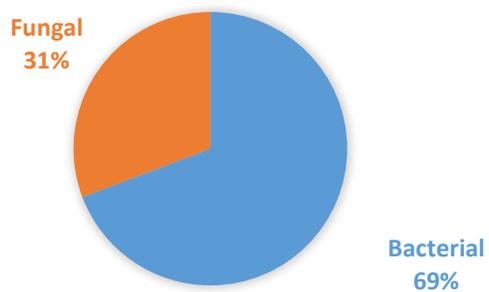
**Figure 2: In-flight SSK Growth Density chart displaying criteria for enumeration in bacteria (A) and fungi (B).**

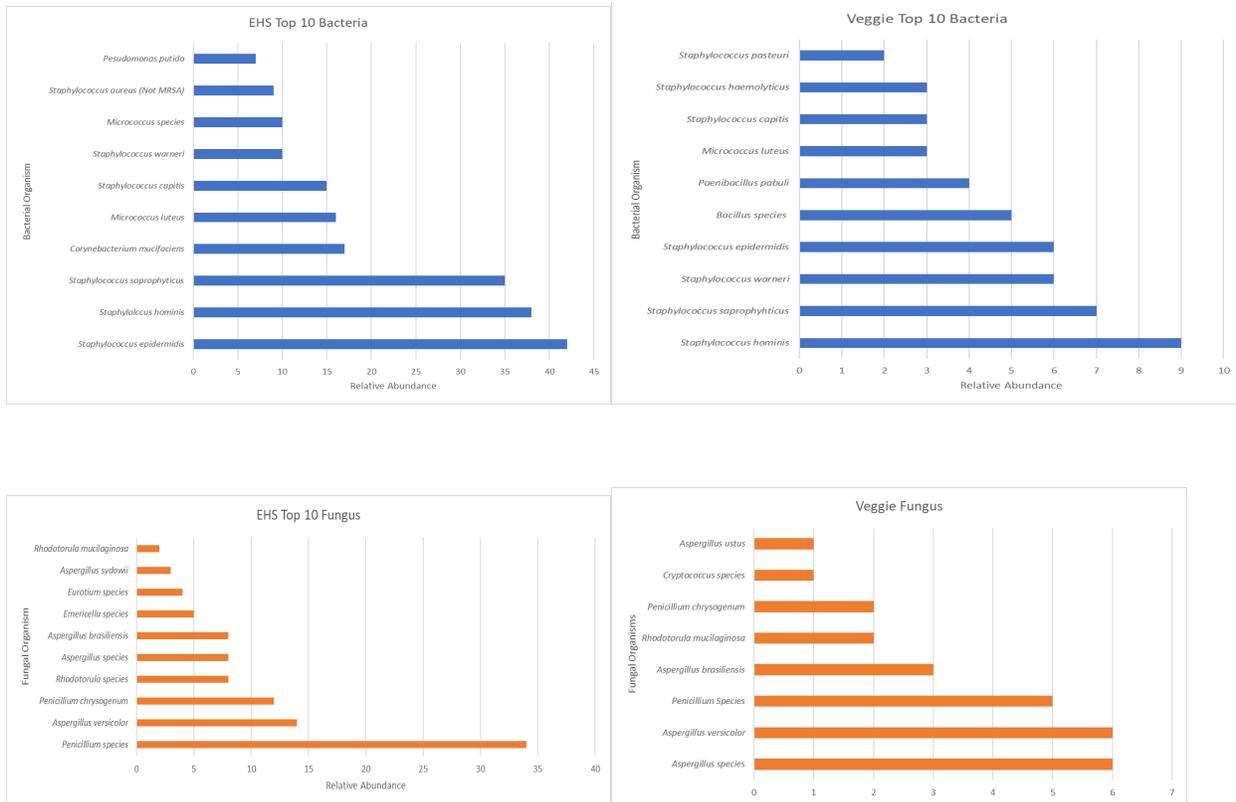
Collection Date	Mission
Sep-19	Soyuz 58
Jan-20	Soyuz 59
Apr-20	Soyuz 61
Oct-20	Soyuz 62
Dec-20	SpaceX-21
Apr-21	Soyuz 63
Jun-21	SpaceX-22
Sep-21	SpaceX-23
Jan-21	SpaceX-24
Mar-22	SpaceX Crew 3

### EHS ORGANISMS



### VEGGIE ORGANISMS





**Figure 3 Veggie Sampling Sessions and Results**

**Results and Discussion:**

Based on the data from the surface sample collections of the Veggie unit (Figure 3), there is a strong correlation between this data and microbes historically found in the surrounding ISS surfaces. Human commensal and common organisms from the environment were recovered from the returned samples to date. Some samples had growth of microorganisms, while others were devoid of growth. Sites were chosen based on previous results and likelihood of astronaut contact. Access to the interior of the unit is coordinated in between Veggie Unit payloads and as a result, fewer samples have been collected inside of the units. Future collections will continue to target surface sample collection from within the unit to fully comprehend the impact of microbes on system, plant, and crew health. Results continue to suggest a robust microbial community affiliated with the Veggie unit and will be compared to historical ISS data to for a comprehensive evaluation.

**Forward Work:**

- Continue surface sampling of the Veggie facility with possibility of the supplementation of air and water sample collection.
- Continue to develop a baseline microbial community for Veggie unit used for in-flight requirements.
- Rotate sample collection sites for better representation of microbial population.
- Collaborate with KSC scientists to utilize data as part of the future development of a crop-based food system for the ISS and beyond.