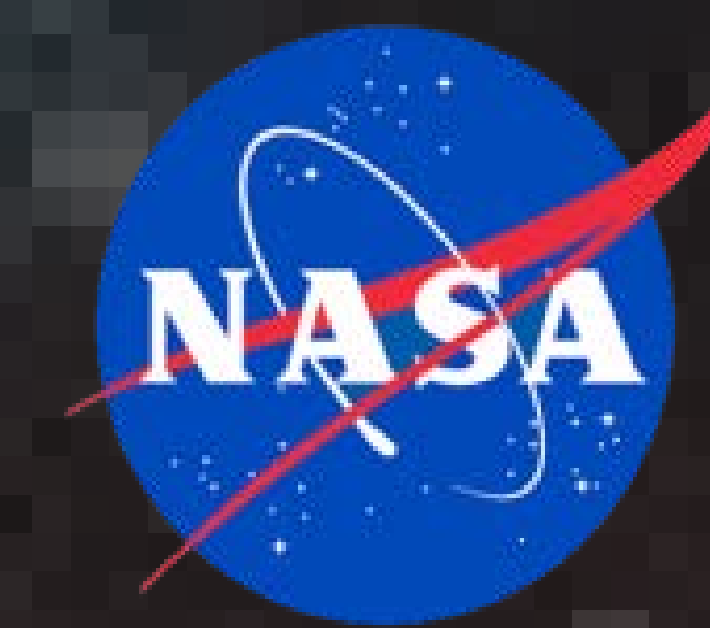




CULTURE-BASED ENVIRONMENTAL MICROBIOLOGY MONITORING OF CROP-BASED SPACE FOOD SYSTEMS (VEGGIE MONITORING)



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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 microbial concentration and diversity data from air, surfaces and water samples. 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:

Crewmembers collected a total of 8 surface samples for bacterial and fungal analysis from various sample sites on the exterior surface of the Veggie unit using the Surface Sampling Kit (SSK) and stored them in a warm place to incubate. After 5 days of incubation, the crewmember observed and recorded microbial proliferation based on a growth density chart. Samples were stowed and returned to Earth to the NASA JSC Microbiology lab via Soyuz 59, where they are enumerated and examined for microbial growth. If growth is observed, each morphologically distinct colony is sub-cultured and isolated onto a respective medium for identification. Microorganisms are identified via methods including microscopy, biochemical analysis, and molecular sequencing of DNA according to JSC Microbiology policy, procedures, and practices.

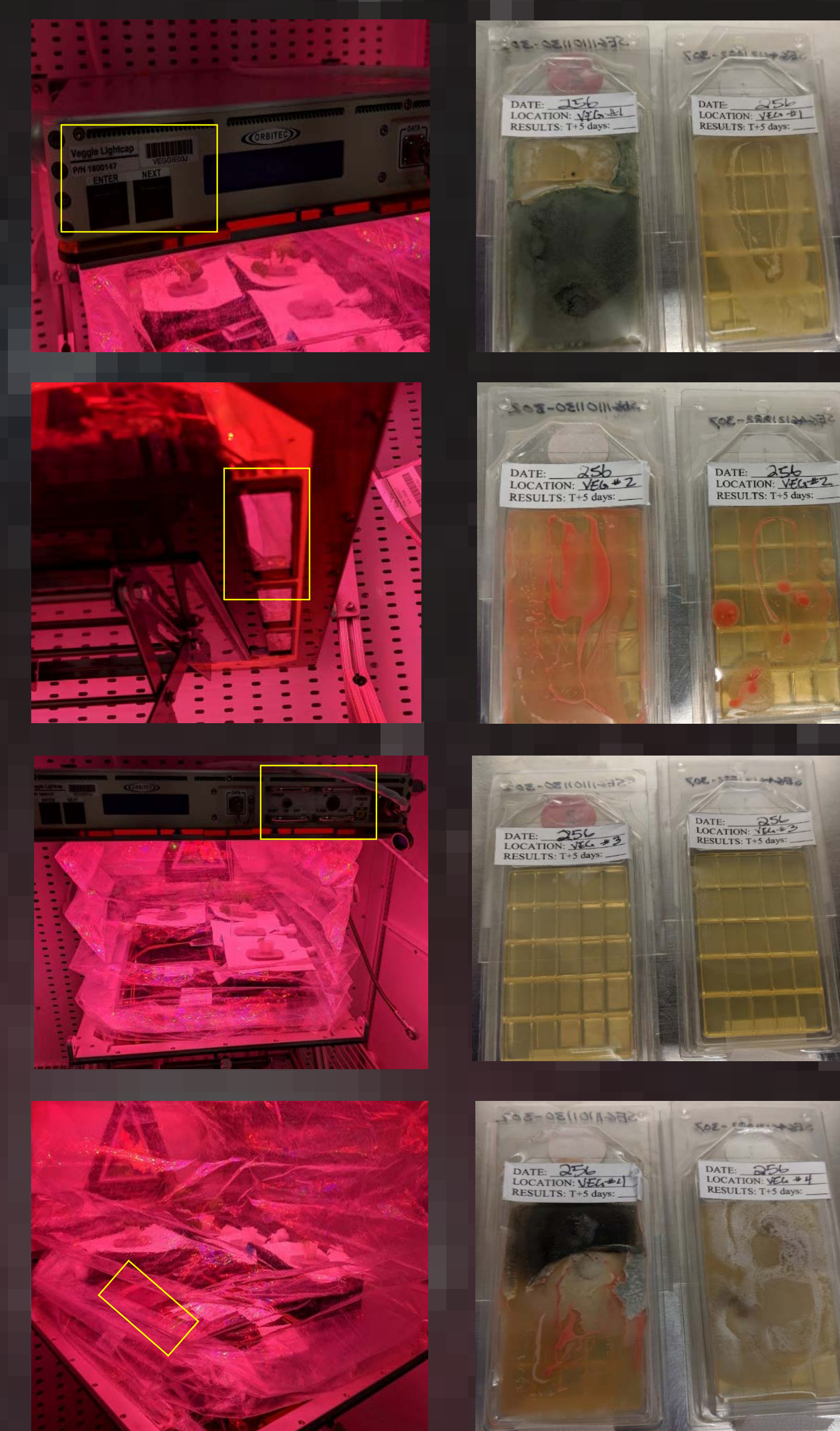
Results:

Sample Identification:	VEG01-B	VEG01-F
Density Chart (In-Flight Count)	1	b
Ground Enumeration total (CFU)	2	2
Microorganisms Isolated:	<i>Bacillus species</i> <i>Bacillus species</i>	<i>Penicillium species</i> <i>Penicillium chrysogenum</i>

Sample Identification:	VEG02-B	VEG02-F
Density Chart (In-Flight Count)	2	a
Ground Enumeration (total CFU)	4	TNTC <i>Rhodotorula mucilaginosa</i>
Microorganisms Isolated	<i>Staphylococcus pasteurii</i> <i>Staphylococcus pasteurii</i> <i>Rhodotorula mucilaginosa</i> <i>Cryptococcus species</i>	

Sample Identification:	VEG03-B	VEG03-F
Density Chart (In-Flight Count)	1	a
Ground Enumeration (total CFU)	0	0
Microorganism Isolated	N/A	N/A

Sample Identification:	VEG04-B	VEG04-F
Density Chart (In-Flight Count)	2	b
Ground Enumeration (total CFU)	3	0
Microorganism Isolated	<i>Aspergillus versicolor</i> <i>Brevibacillus species</i>	<i>Aspergillus versicolor</i> <i>Rhodotorula mucilaginosa</i> <i>Aspergillus ustus</i> <i>Penicillium species</i>



Initial Sampling Session: September 13, 2019



Samples received by the NASA JSC Microbiology lab on October 7, 2019.

Discussion:

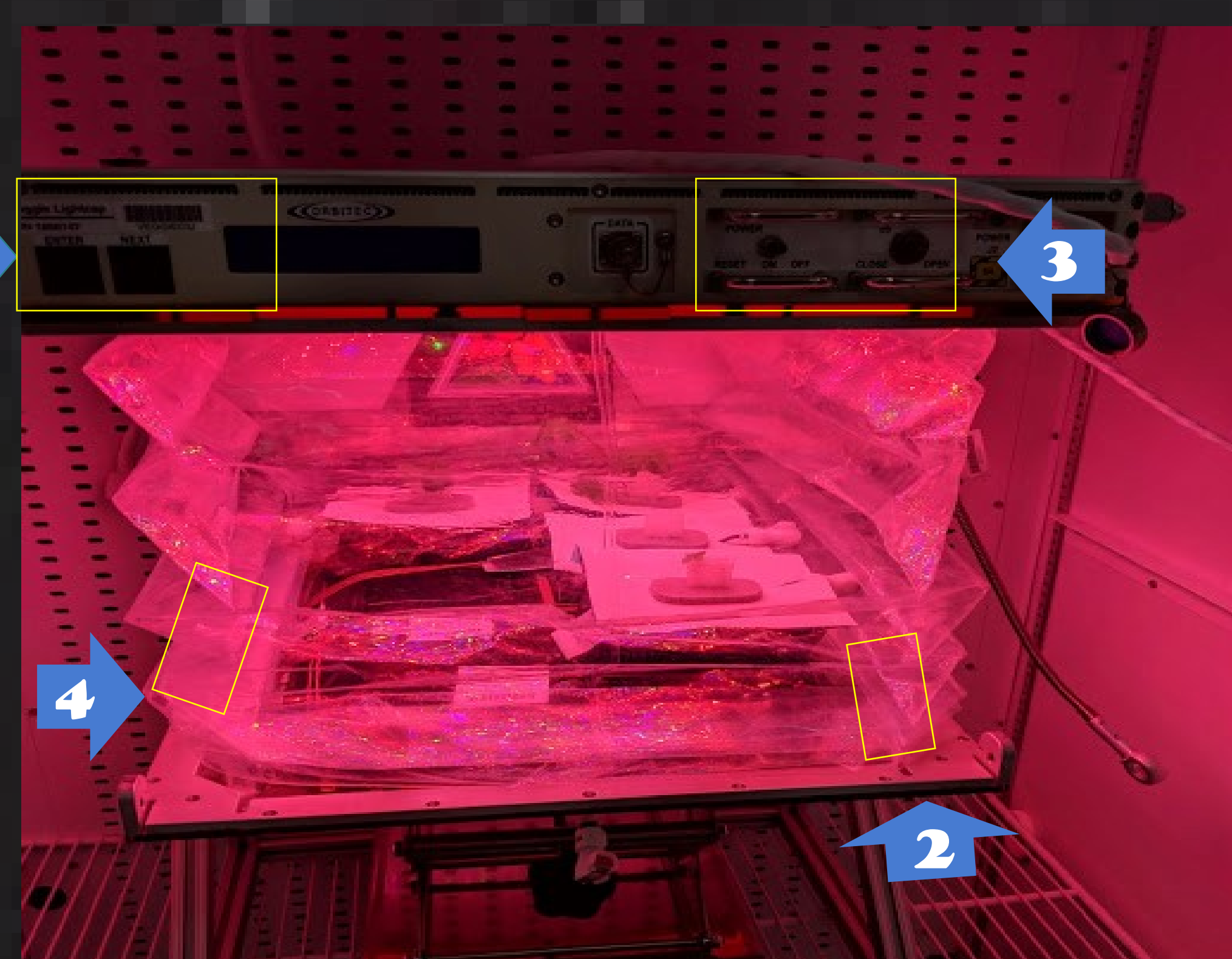
Based on the data from the inaugural surface sample collections of the Veggie unit, there is a strong correlation between this data and historically recovered microbes from the rest of the ISS environment. All organisms recovered are a part of human commensal and are ubiquitous throughout nature. Three of four sampling locations yielded growth of microorganisms, while one location was devoid of growth and will be changed to another location for the next quarterly surface sampling. This data suggests a robust microbial community affiliated with the Veggie unit, though further research and data collection is needed. In order to catalogue the Veggie environment, surface sample collection from within the unit is highly suggested to fully comprehend the impact of microbes on system, plant, and crew health.

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

Acknowledgements:

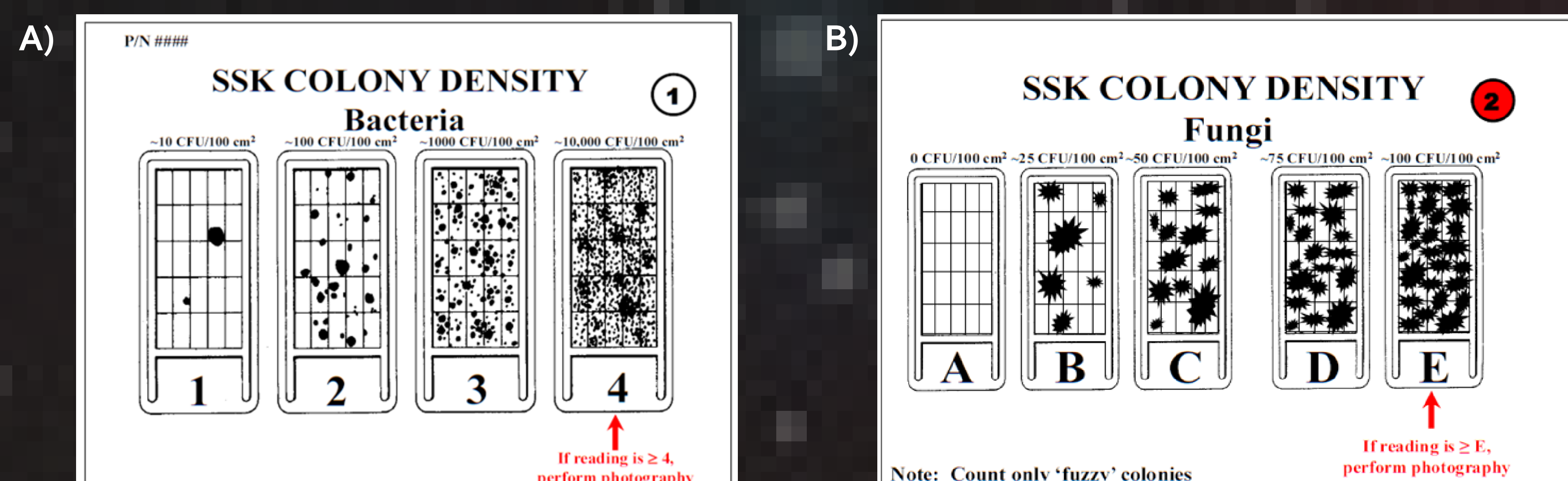
Special thanks to the Environmental Health Systems Team, Biomedical Engineering Team, the KSC Veggie Team, Research Operations and Implementation team, and the JSC Microbiology Team for their support and valuable contributions.



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

In-flight SSK Growth Density chart displaying criteria for enumeration.



Bacterial Density Scale 1-4

Fungal Density Scale A-E