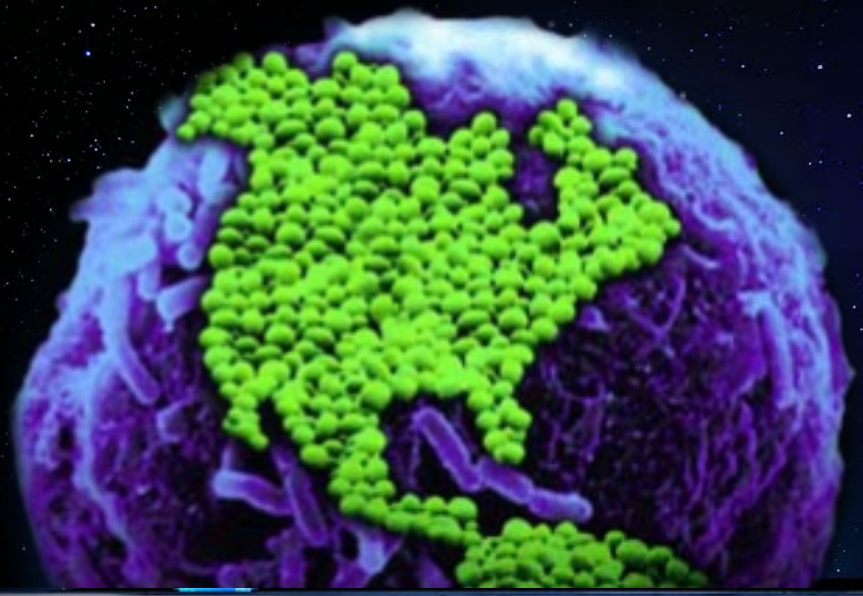
# Tools and Operations to Monitor Human Health Impacts

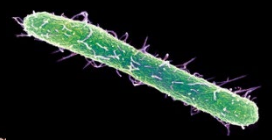
National Aeronautics and Space Administration

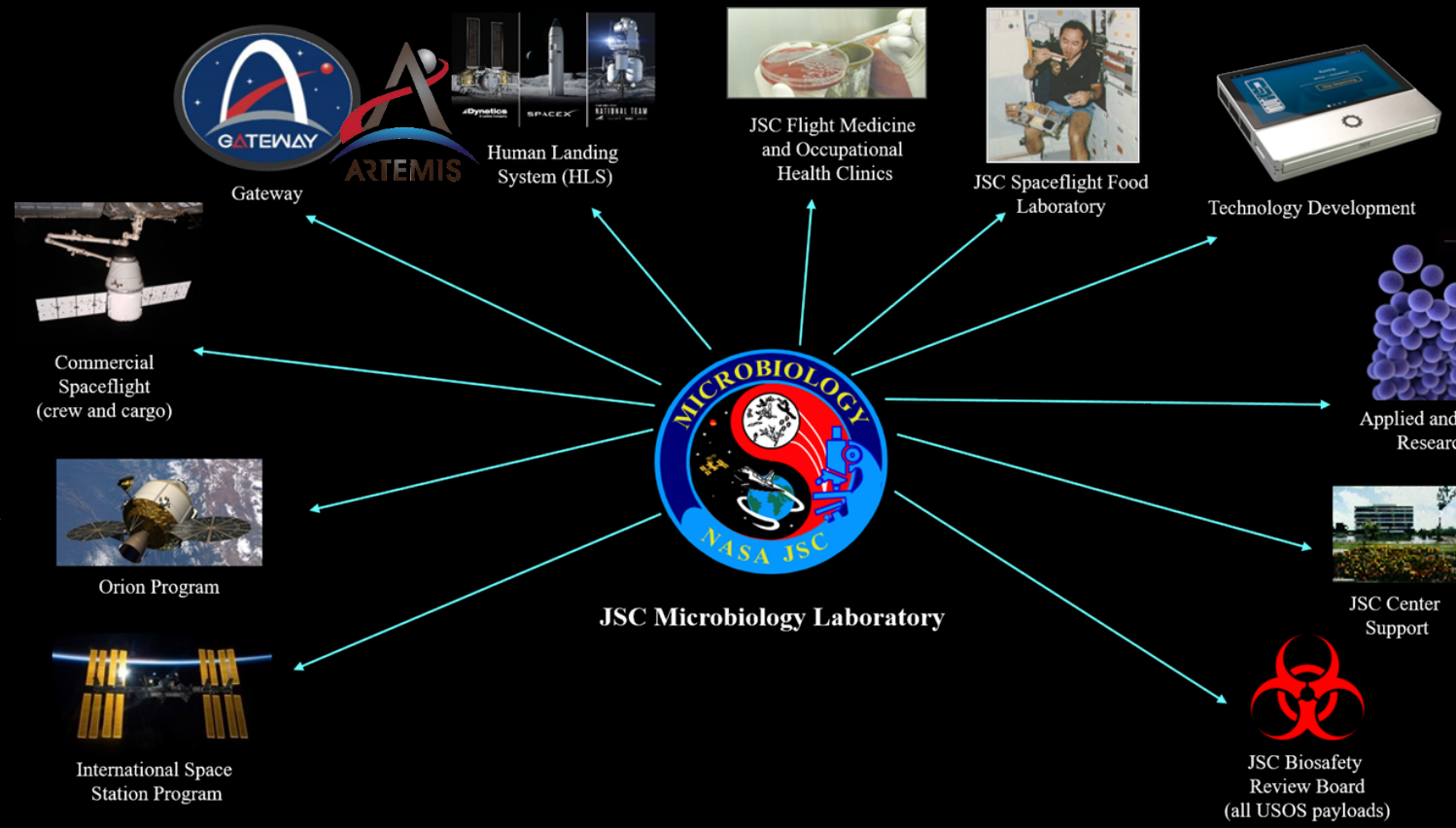


Sarah Wallace, Ph.D.
NASA JSC
Human Health and Performance Directorat
Microbiology Laboratory (SK4)

# NASA Microbiology's Goal

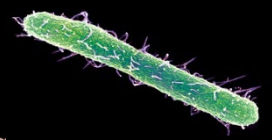
- Mitigate microbial risk to crew health, safety, and performance during the human exploration of space
- Prevent adverse effects associated with microbes to the vehicle
- Research – understand how the spaceflight environment impacts microbial behavior
- Test new technology to increase our ability to assess microbial risk






# Goal of NASA Microbiology

- Hold the requirements that dictate the microbial acceptability limits of the water, air, surfaces, and spaceflight foods
  - How much is there?
  - What is there?
- Responsible for delivering certification of flight readiness status
- Responsible for implementing routine pre-flight and in-flight microbial monitoring practices as a check of contamination controls
- Responsible for remediation when monitoring reveals microbial loads above the acceptability limits or the presence of medically-significant organisms

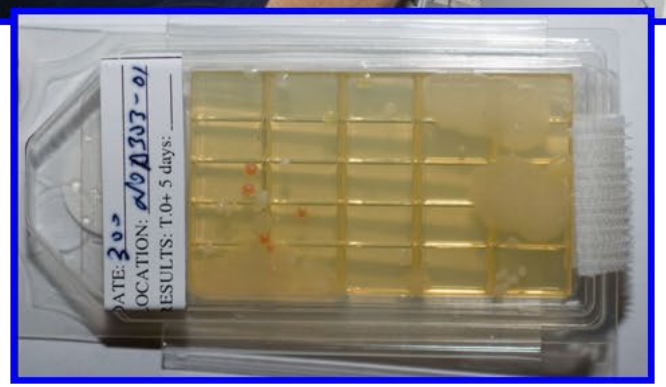
# NASA Microbiology Requirements

| Surface | Air | Water |
|---|---|---|
| 10,000 cfu/ 100 $cm^2$ bacteria | 1,000 cfu/$m^3$ bacteria | 50 cfu/ml bacteria |
| 100 cfu/ 100 $cm^2$ fungi | 100 cfu/$m^3$ fungi | Non-detectable/100 ml fungi |
| | | Non-detectable/100 ml coliforms |
| **Frequency** | | |
| Quarterly | Quarterly | Monthly (coliforms) |
| | | Quarterly (enumeration) |

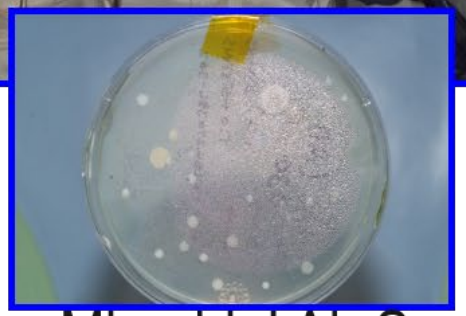
- Total counts reflect system performance (engineering requirement) and are not as important for health assessments
- The identification of organisms is critical to crew health risk assessments
- NASA has always identified organisms and included the identities as part of the risk assessment process
- For Commercial Cargo and Crew preflight testing, the requirement is to provide both **levels and identifications** of microorganisms
- NASA will be requiring both **levels and identifications** for all future programs (including in-flight capabilities)

# Microbial Monitoring of the ISS

## Routine Sampling: ISS Surfaces, Air, and Water

SSK - Surface Sampling Kit

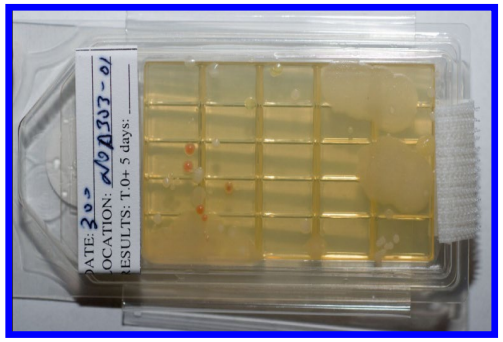


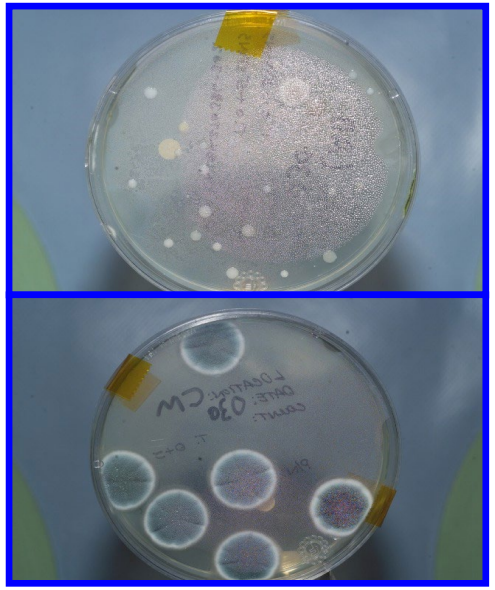
MAS – Microbial Air Sampler

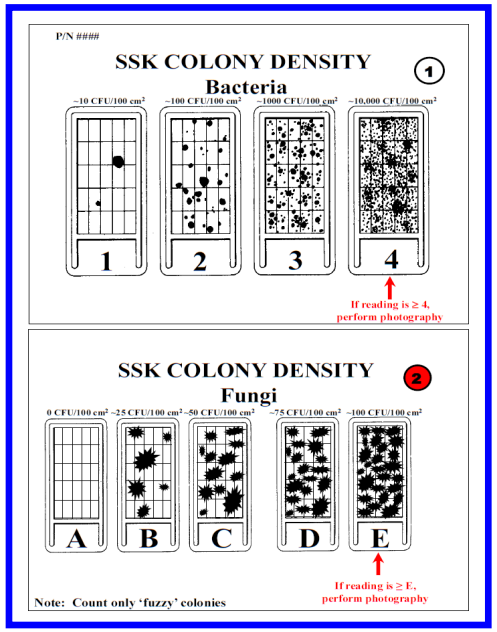

EHS Water Kit – Environmental Health Systems Water Kit

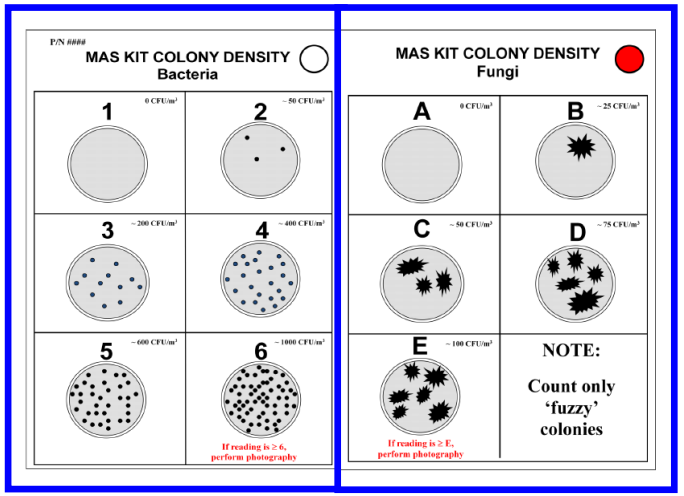
# Microbial Monitoring of the ISS

## Routine Sampling: ISS Surfaces, Air, and Water








# NASA Microbiology Requirements

## Commercial Cargo / Crew

**3.3.10.4.1.6 SURFACE MICROBIAL CONTAMINATION**

The COTS vehicle interior surface microbial contamination shall be controlled such that levels do not exceed the following acceptability limits defined for the ISS **and no microorganisms that pose a risk to crew health or ISS environment are isolated**.

Internal Surfaces:
10,000 Colony Forming Units (CFU) / 100 $cm^2$ bacteria
100 Colony Forming Units (CFU) / 100 $cm^2$ fungi

Requirement Evolution

## Gateway

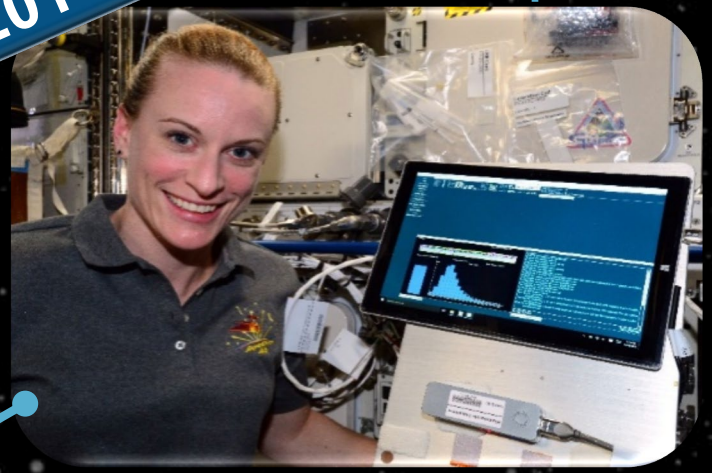
The Gateway CHP Subsystem shall monitor, through **enumeration and identification**, microorganism development

Internal Surfaces:
10,000 Colony Forming Units (CFU) / 100 $cm^2$ bacteria (or equivalent)
100 Colony Forming Units (CFU) / 100 $cm^2$ fungi (or equivalent)

*Rationale: Monitoring consists of both **enumeration and identification** (**determination of medically significant organisms**). Interior surfaces that become contaminated with harmful microorganisms pose a risk to crew health and performance. While pre-flight screening and protocols ensure minimal risk of contamination, interior surfaces may become contaminated over time. While crew is present, monitoring is expected to be non-continuous, meaning device remains stowed until needed. While crew is not present, no monitoring is required. There is no inflight alerting required as data is evaluated on the ground.*

2016

## Biomolecule Sequencer

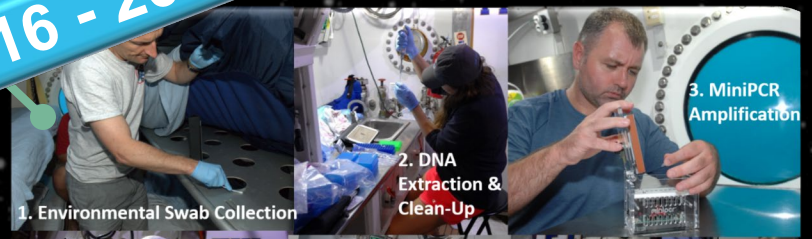


2017

## Genes in Space-3


2016 - 2017

## Swab-to-Sequencer





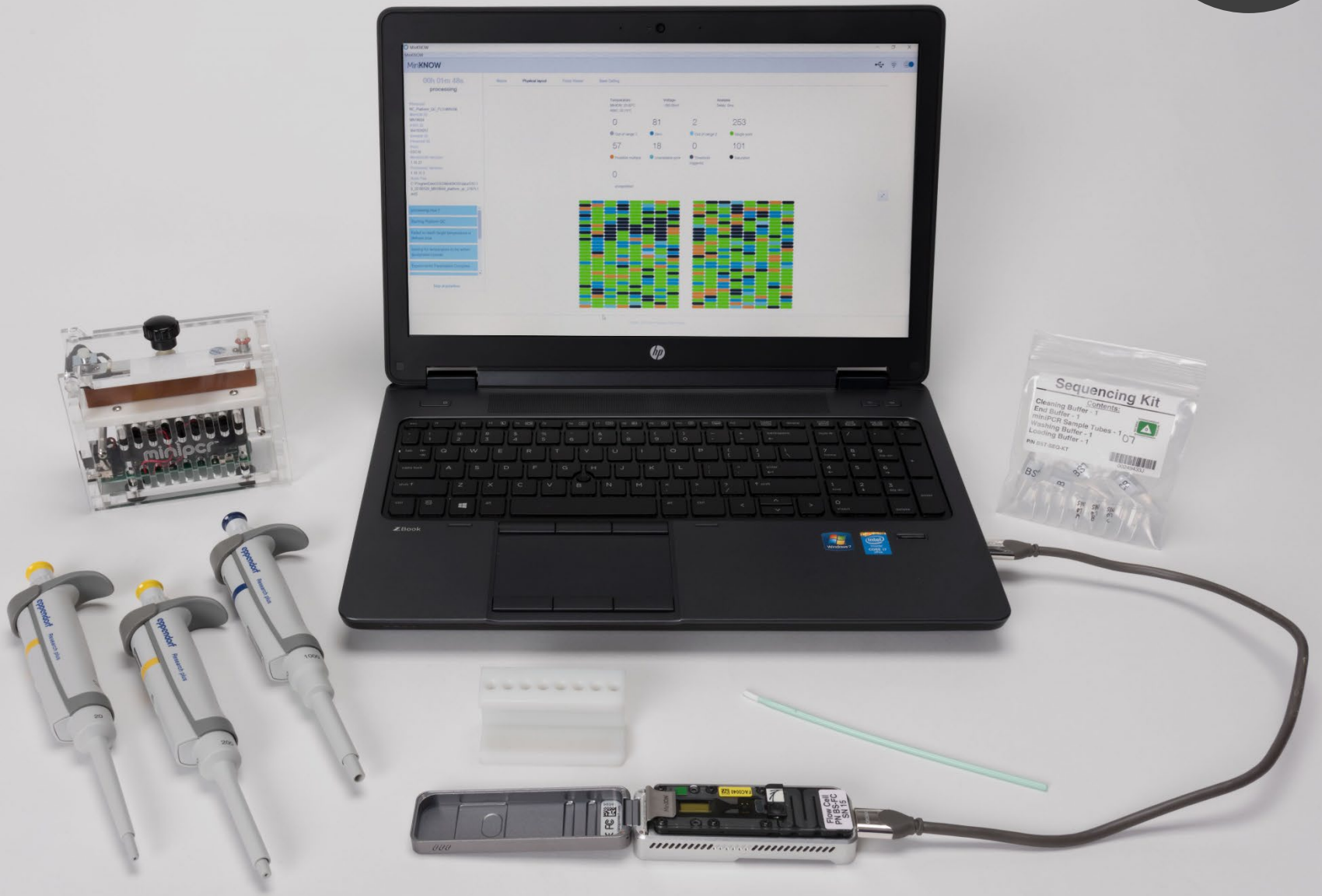
2018 - 2022

## BEST → BioMole

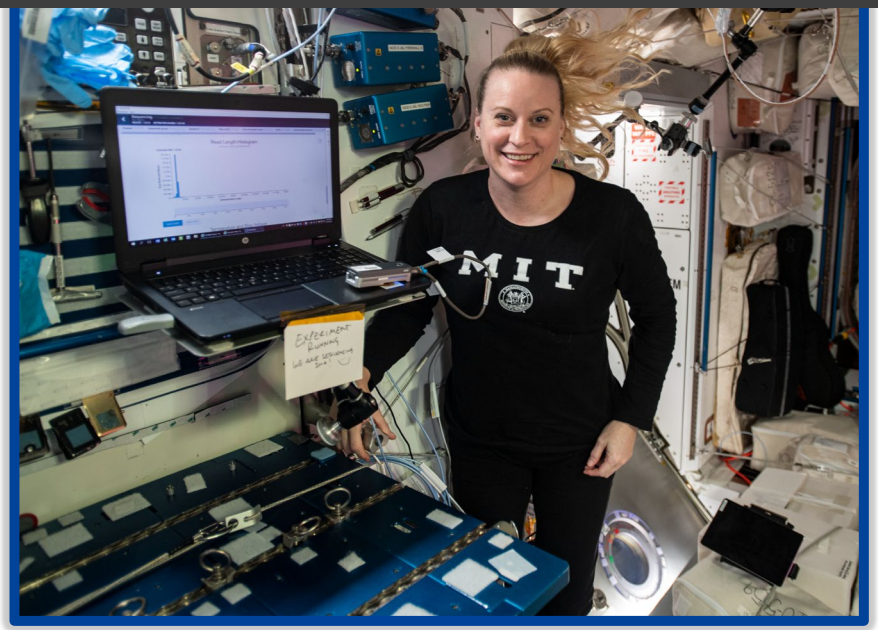
# BioMole

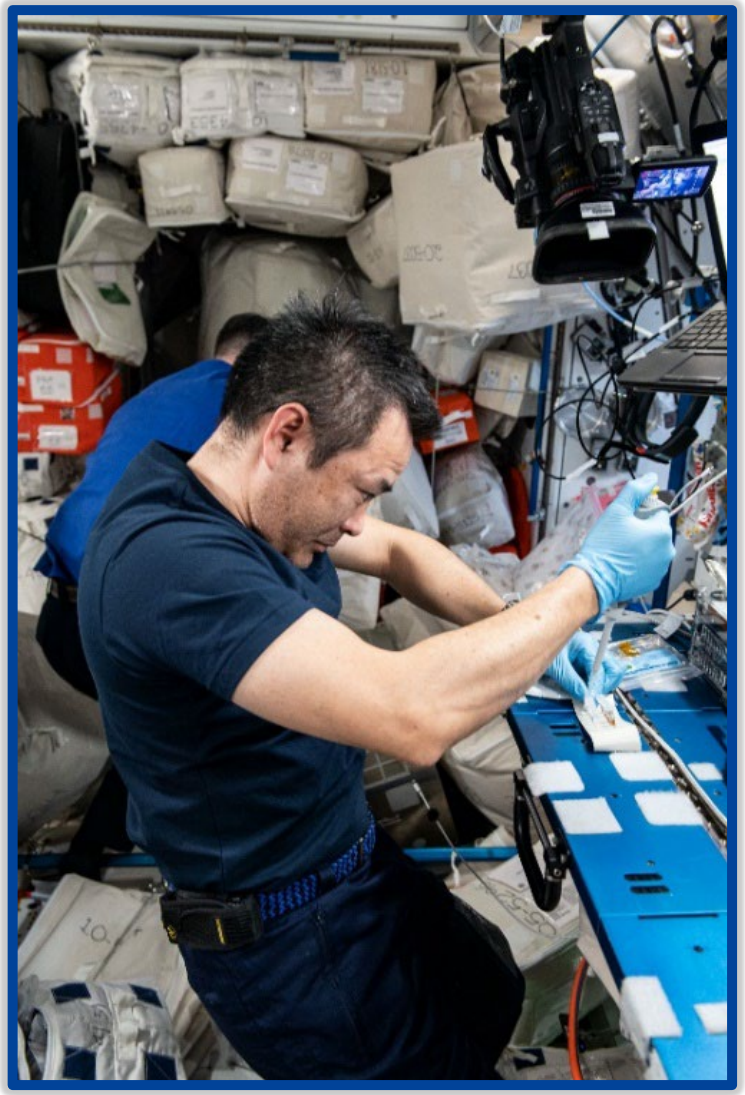
BioMole

- the set of hardware, consumables, and procedures required to support sample preparation and nanopore sequencing onboard the ISS
- the BEST method moved from a scientific payload to Crew Health Care Systems (CHeCS) operational hardware

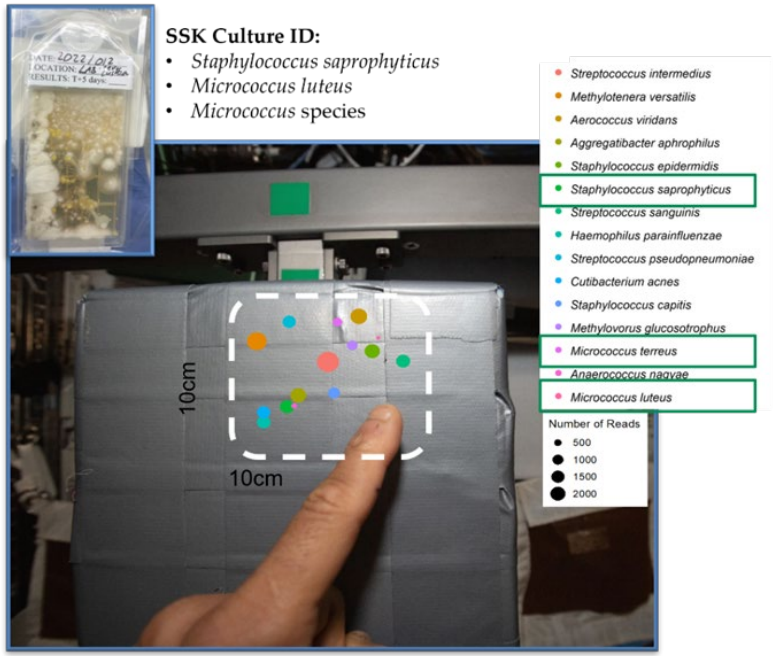


# BioMole: Surfaces



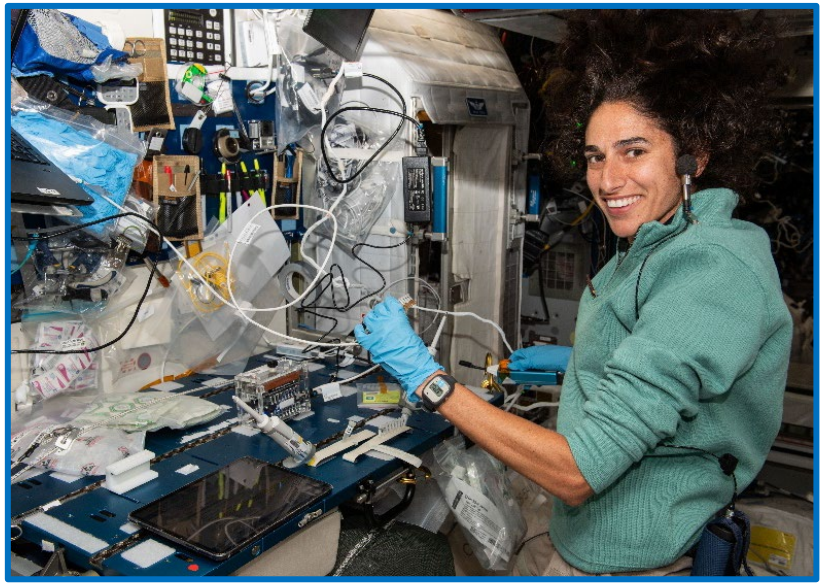



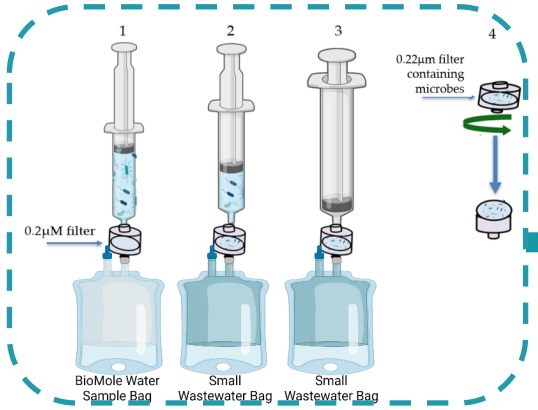
CEVIS Seat



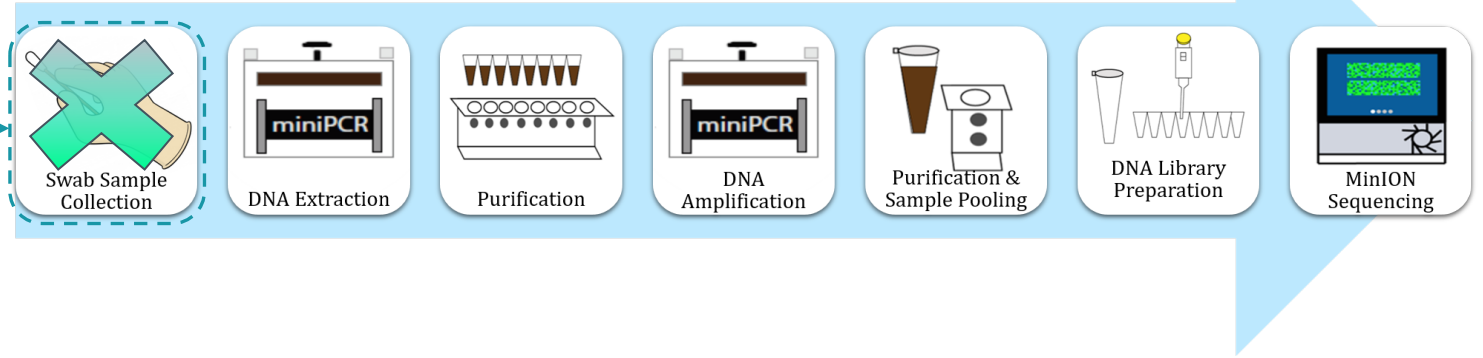
# BioMole: Water

2023 - 2024

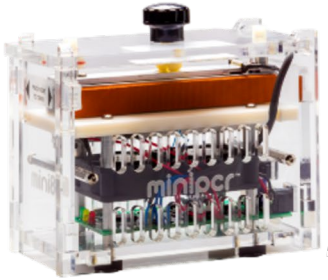




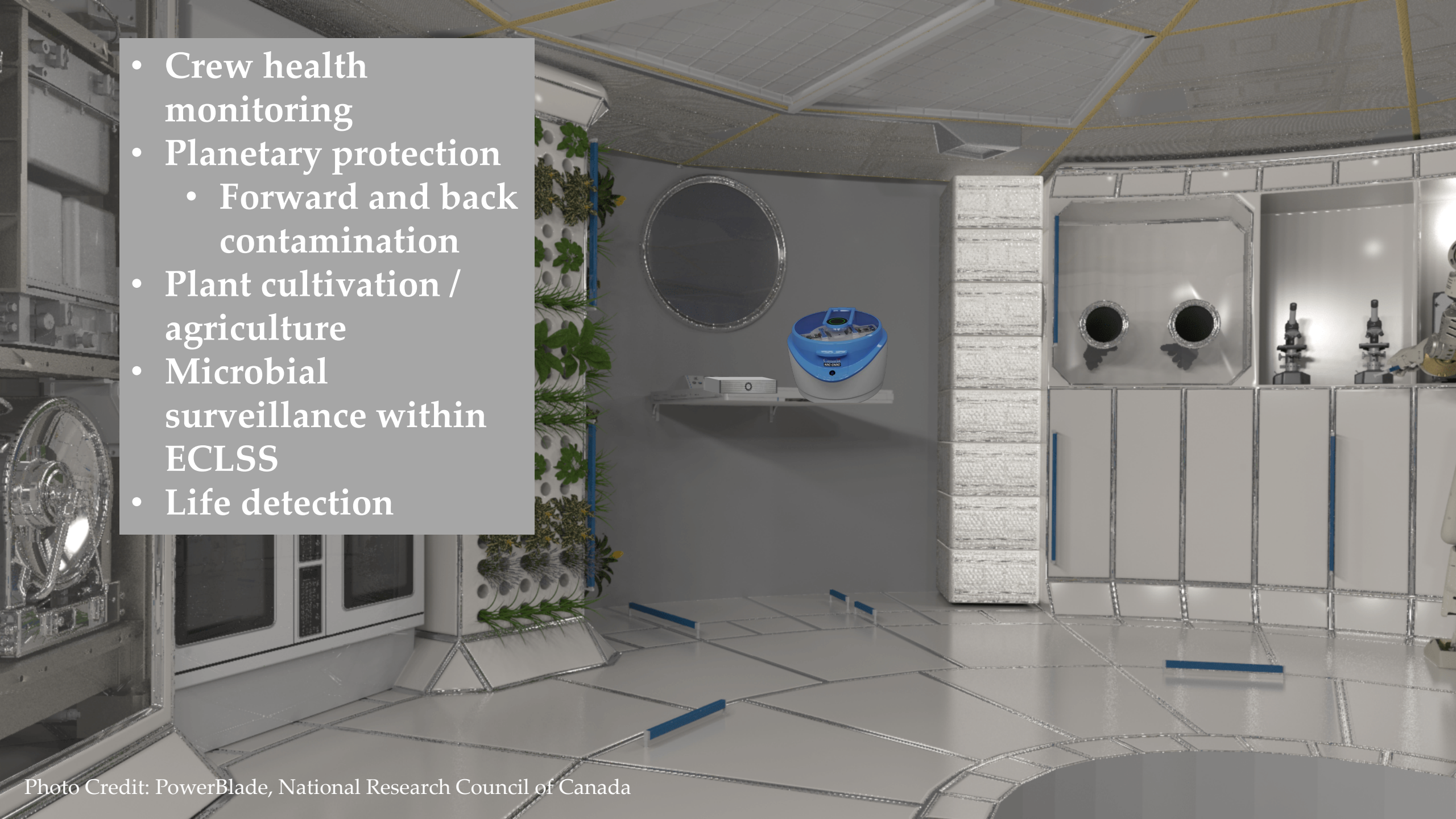

## Replace surface swabbing with water filtration for a Filter-to-Sequencer method



# GATEWAY

MSM = Microbial Surface Monitor
MWM = Microbial Water Monitor
BioMole Method Baselined for Gateway



- Crew health monitoring
- Planetary protection
  - Forward and back contamination
- Plant cultivation / agriculture
- Microbial surveillance within ECLSS
- Life detection

Photo Credit: PowerBlade, National Research Council of Canada

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## Collaborators / Flight & Ground Support Team


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Sissel Juul, Ph.D.
Dan Turner, Ph.D.
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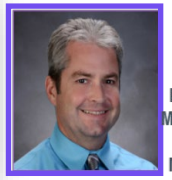
Genes in Space-3 & 6 / BEST Flight Team
Teresa Tan
Melissa Boyer

BEST / Genes in Space-6 Ops Lead
Linda Gibson

Janejit Gensler, NASA BioMole



William Wallace, Ph.D. NASA

NEEMO 21 Team
Reid Wiseman, NASA
Megan McArthur, NASA
Marc O Griofa
Matthias Maurer, ESA
Noel Du Toit
Dawn Kernagis

NEEMO 22 Team
Kjell Lindgren, NASA
Trevor Graff
Pedro Duque, ESA
Dom D'Agnostion
Mark Hulsbeck
Sean Moore

# Spaceflight Molecular Biologists


Kate Rubins, Ph.D.


Peggy Whitson, Ph.D.


Ricky Arnold


Serena Aunon-Chancellor, M.D.


Christina Koch


Nick Hague


Chris Cassidy


Aki Hoshide


Raja Chari


Jasmin Moghbeli


Mike Barratt, M.D.


Jeanette Epps, Ph.D.


Suni Williams

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Thank you!
We are going. And where we go, microbes follow!