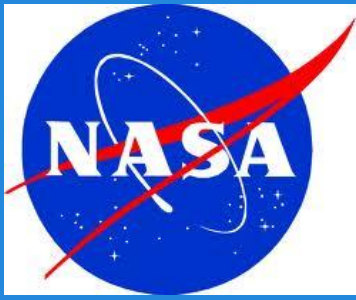




# From the Laboratory to the Classroom: Characterization of Microorganisms Residing on Mars-Based Spacecraft

Ryan Hendrickson, CSU Star Student

Mentor: J. Nick Benardini

Co-Mentor: Wayne Schubert

Biotechnology and Planetary Protection Group 325N

# Project Goals

1. Characterization and preservation (*i.e.* storage/working stocks) for 60 Mars Exploration Rover (MER) isolates.
2. Generation and optimization of a streamlined lyophilization procedure for the Spacecraft Microbial Archive.
3. Create lessons/activities for the Microbial Ecology Research Combining Citizen and University Researchers on ISS (the International Space Station) (MERCCURI) Project.

# Project Background

## **Planetary Protection's chief goal is to prevent both:**

- forward contamination is the transfer of viable organisms from Earth to another celestial body
- backward contamination is the transfer of extraterrestrial organisms back to the Earth's biosphere, if such exist.

## **Importance**

- Create a NASA-based microbial archive
- Enhanced understanding of organisms associated with clean rooms and spacecraft surfaces
- Limit false positive detection potential in the quest to find life beyond Earth

# Characterization and preservation (*i.e.* storage/working stocks) for 60 Mars Exploration Rover (MER) isolates



Opportunity  
July 7, 2003-Present

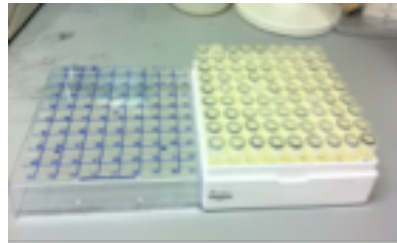


# Sterilization and Sampling



# MER Isolate Workflow

Future Work



**Frozen Storage**



**Revival**



**16S Characterization**



**Preservation**



**Vapor Hydrogen Peroxide**

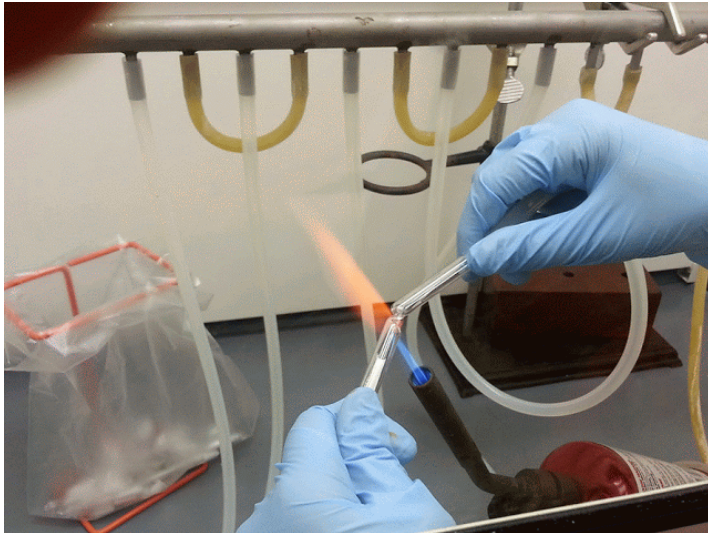


**Omnilog Biochemical Assay**



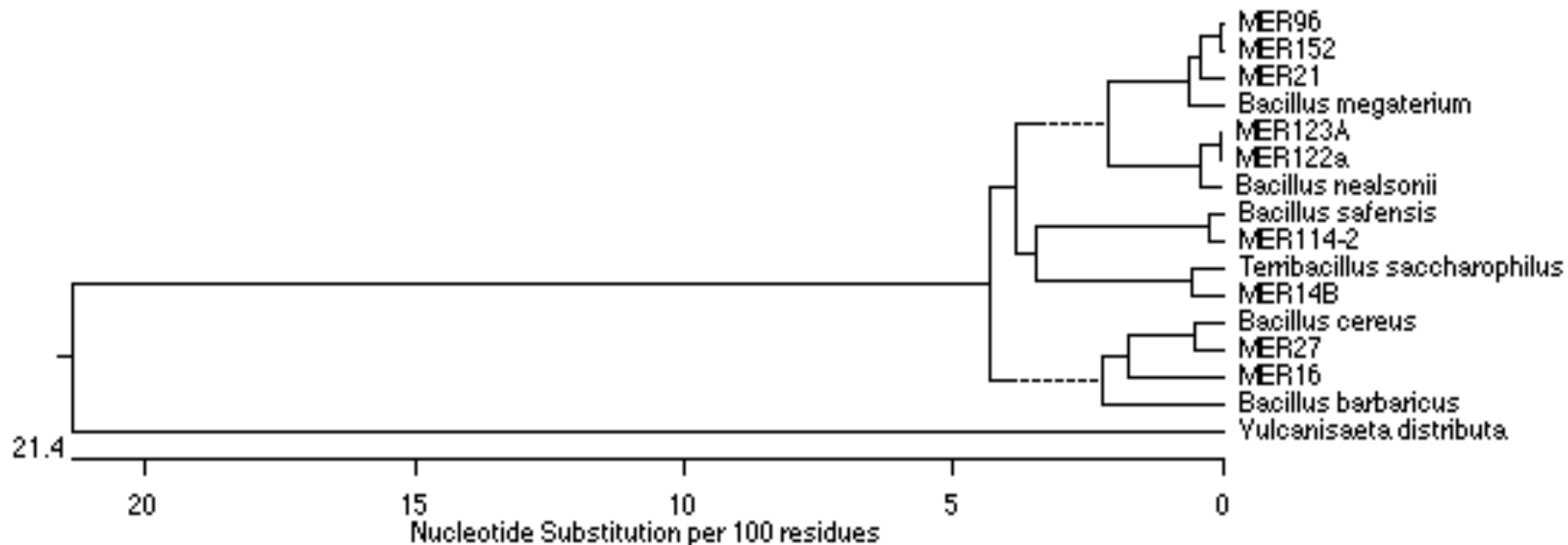
**API Carbon Assay**



A detailed image of a Mars rover, likely the Mars Exploration Rover (MER), on the surface of Mars. The rover is positioned on the reddish-brown, rocky terrain. It features two large solar panels extended to the sides, a central body with various instruments, and six wheels. The background shows a hazy, orange-tinted sky and distant hills.

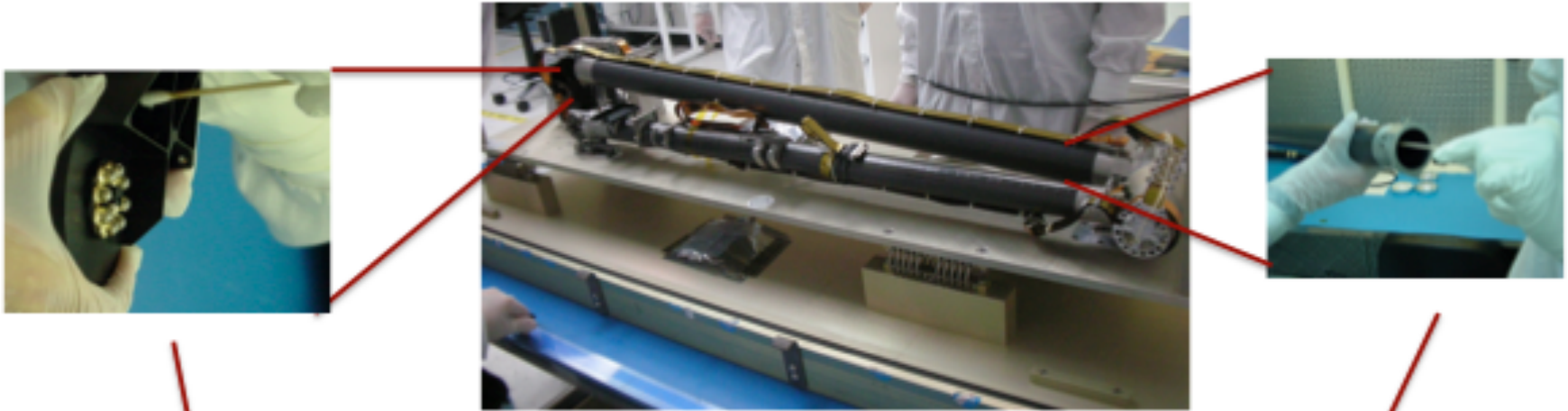
# Results

- Generation of working and long-term stock cultures for 60 isolates.
- Phylogenetic characterization of 60 isolates. Assisted to complete MER collection and draft peer-reviewed manuscript in progress.
- Completed a streamlined lyophilization protocol. Tested this protocol on over 75 isolates.

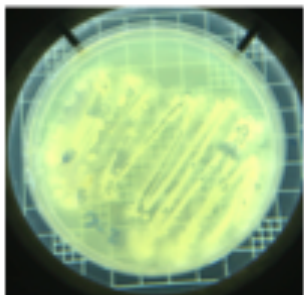




# From the lab to the classroom...

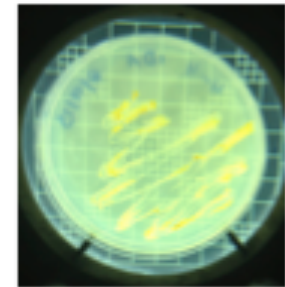


**We found them:** on the InSight Instrument  
Deployment Arm at MDA US Systems LLC,  
**Date isolated from:** June 2013



*Bacillus subtilis*

Description: Gram positive, rod  
shape, endospore former



*Macroccoccus caseolyticus*

Description: Gram positive, non  
motile, non spore forming, cocci

# Microbial Ecology Research Combining Citizen and University Researchers on ISS (MERCCURI)

- 1) Astronauts swabbing the surfaces of the ISS
- 2) Collection of swabs on Earth (samples taken by the public from shoes and cell phones) up to 2000 isolates
- 3) Microbial playoffs – contest to see which public isolates grow the fastest in microgravity



# MERCCURI Project in Action





# Project Involvement



Established and fostered the relationship with Project MERCURI

Planned and implemented the incorporation of isolates from JPL (Spacecraft Microbial Archive)

Created 4 lesson plans/activities for the classroom

- Prelaunch Lesson- basic environmental sampling and MERCURI sampling
- Prelaunch Lesson with JPL isolates- basic environmental sampling, MERCURI sampling, and JPL isolate voting
- Post Launch/PreData Lesson- basic environmental sampling
- Post Launch/Data Analysis- analyzing OD readings, discussion

Generation of JPL isolate templates

Identification and shipment of candidate isolates to UC Davis



# My Experience at JPL









# Acknowledgments



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- Karen Buxbaum, Mars Program Office Sponsor
- JPL Line Management – 352N GS's - Andy Spry, Ph.D. Greg Davis, Ph.D., Melissa Jones, Ph.D.
- Aleskandra Chechinska
- Members of Biotechnology and Planetary Protection Group
- JPL Summer Students



## University of Idaho

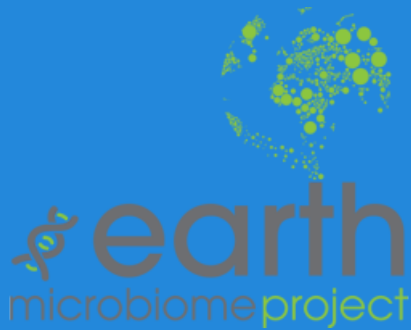
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- Stephanie Smith, Ph.D. Candidate

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- Cassie Conley – Technical Monitor
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  - Mars Program Office



# Project MERCCURI



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SPACE FLORIDA



microBEnet  
microbiology of the Built Environment network

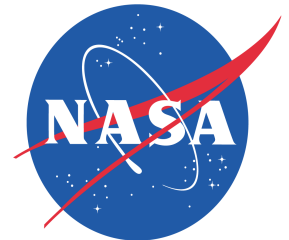




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**100Kin10**  
ANSWERING THE NATION'S CALL



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