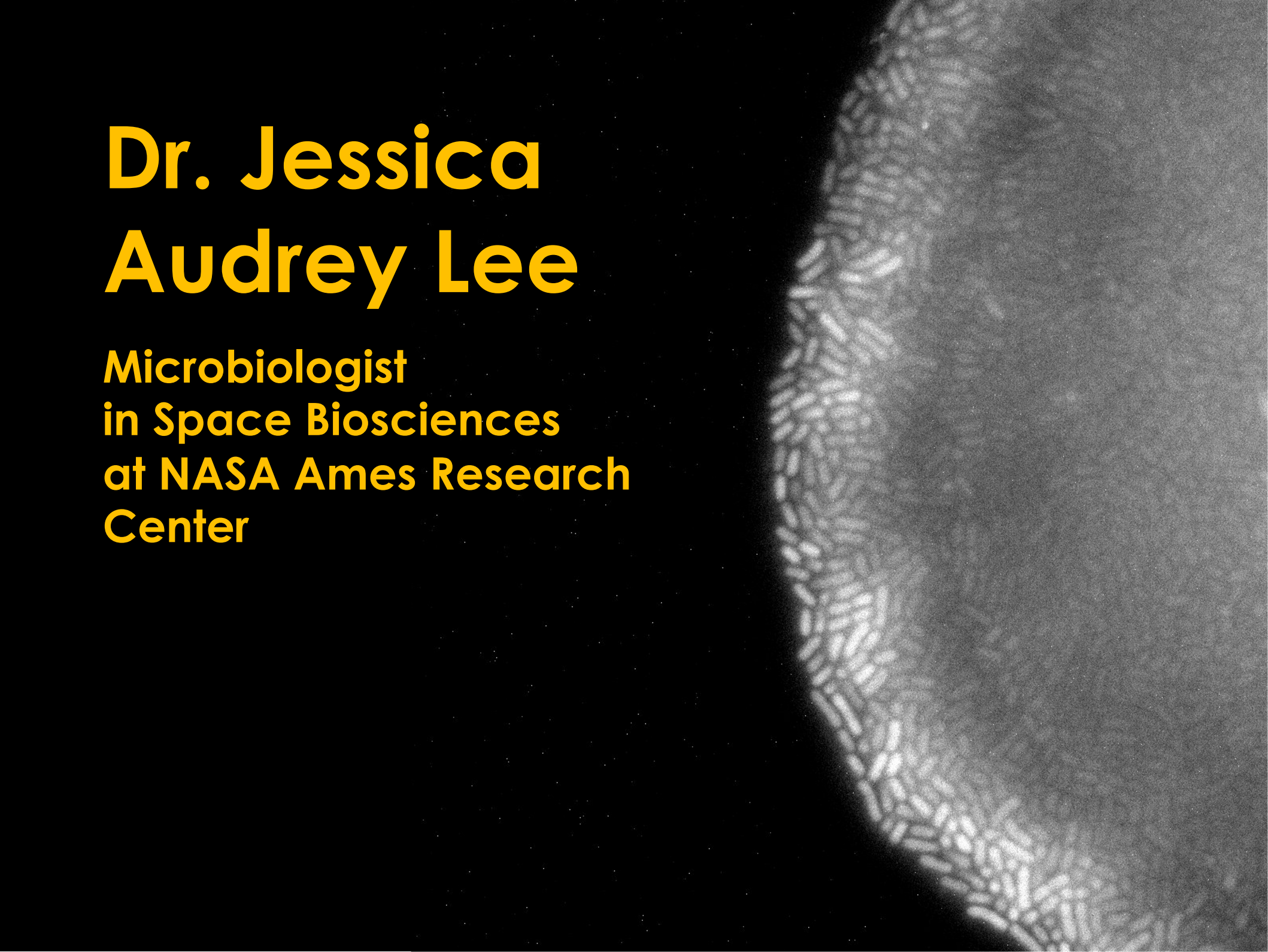
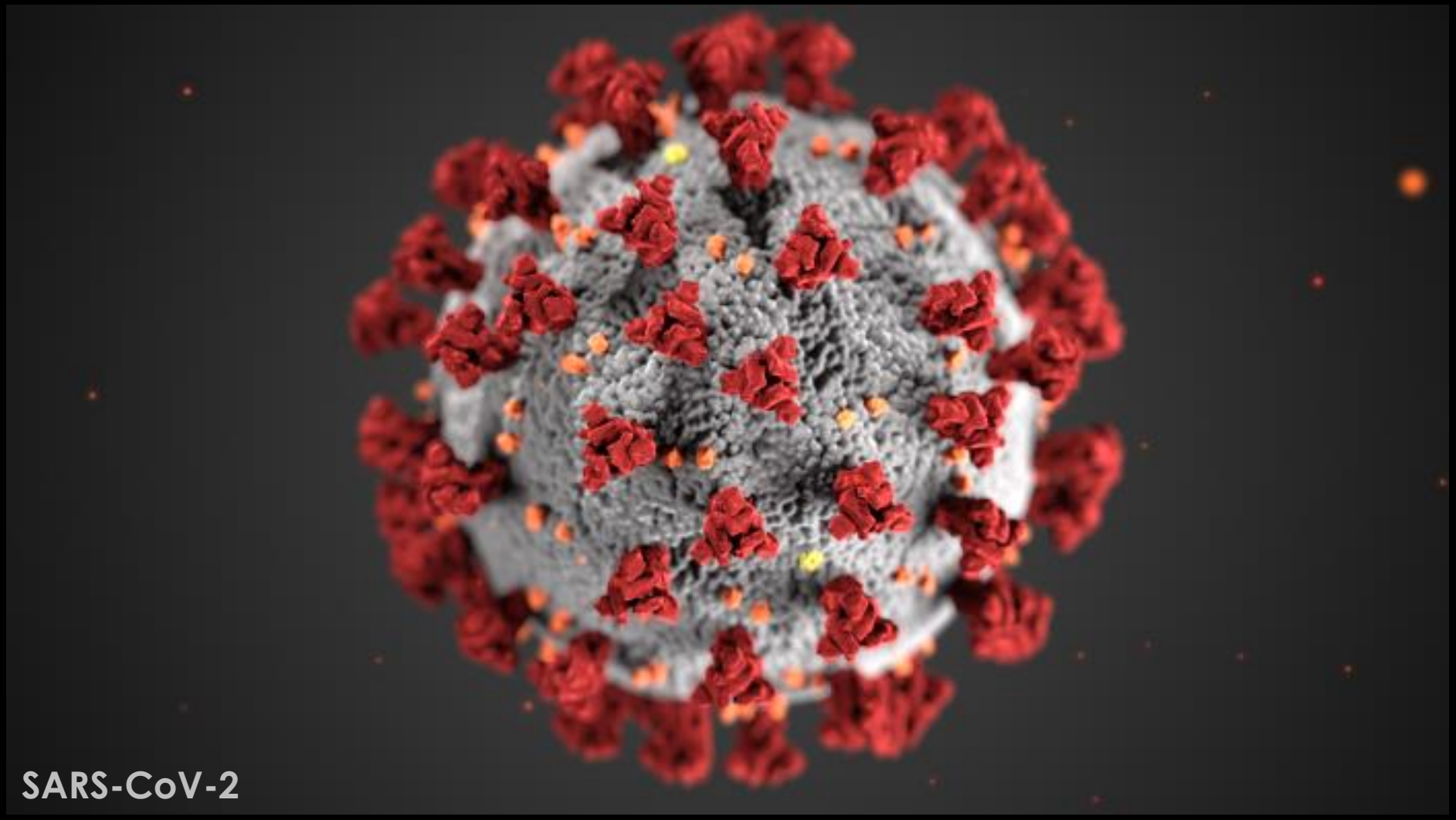
Dr. Jessica Audrey Lee

Microbiologist in Space Biosciences at NASA Ames Research Center



What are microbes?

Viruses



Credit: CDC. https://phil.cdc.gov/Details.aspx?pid=23311

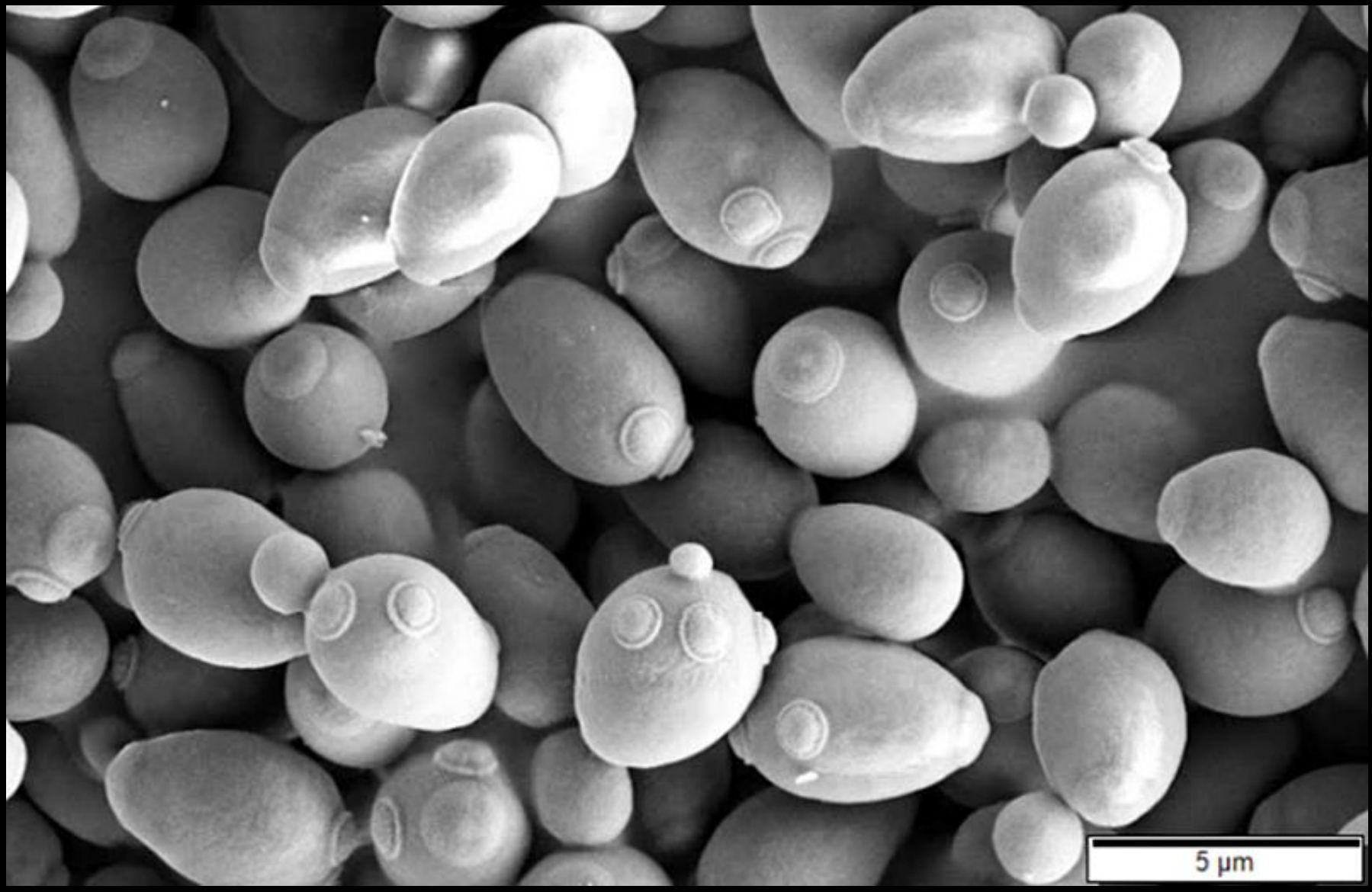
Bacteria



***Salmonella* serotype Typhi**

Credit: CDC. https://phil.cdc.gov/Details.aspx?pid=21918

Fungi



Saccharomyces cerevisiae

credit: Mogana Das Murtey and Patchamuthu Ramasamy, Creative Commons Attribution-Share Alike 3.0 Unported
https://commons.wikimedia.org/wiki/File:Saccharomyces_cerevisiae_SEM.jpg

Archaea



***Halobacterium* from the Dead Sea**

Credit: NASA. https://science.nasa.gov/science-news/science-at-nasa/2004/10sep_radmicrobe

Algae



cyanobacteria from a salt marsh near Guerrero Negro, Baja California Sur, Mexico

Credit: NASA. https://spacescience.arc.nasa.gov/microbes/images/content/gallery/lightms/publication/lyngbya.jpg

What do microbes do?

Microbes can make us sick



Credit: CDC. https://www.cdc.gov/healthywater/hygiene/etiquette/coughing_sneezing.html

Microbes can spoil our food



Credit: Vincent van Zeijst. Creative Commons Attribution-Share Alike 4.0 International
https://commons.wikimedia.org/wiki/File:Slice_of_bread_with_mould_(1).jpg

Microbes help us digest our food



Credit: NIH. https://commonfund.nih.gov/hmp

Microbes help us make our food

pickles
bread
vinegar
soy sauce
salami
cheese
yogurt
kimchi
sauerkraut



Microbes help us grow our food

communicate with plants
prevent disease
cycle nutrients
clean water
decomposition



Where do we find microbes?

San Francisco Bay





Credit: J. A. Lee

San Francisco Bay

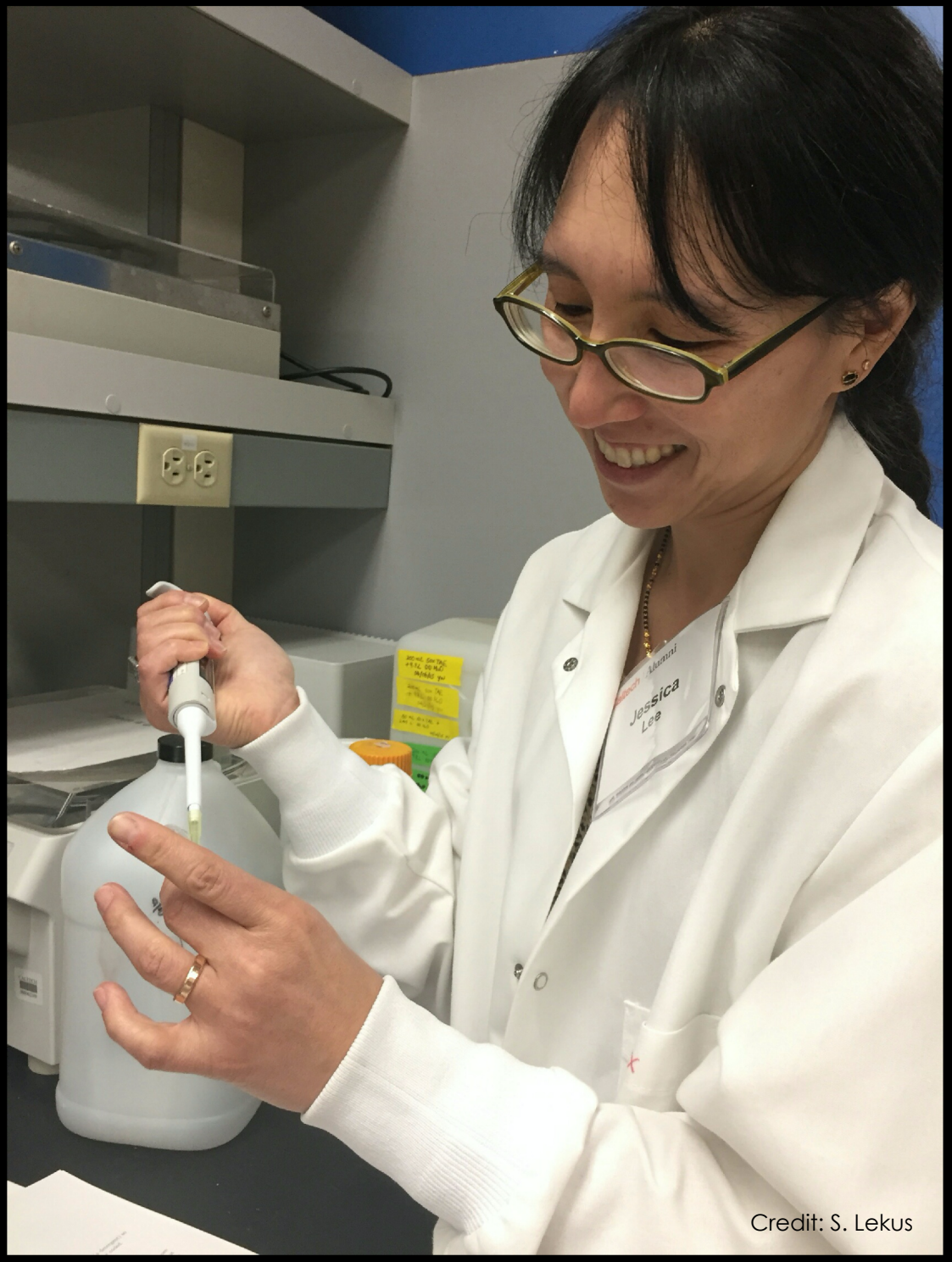


Death Valley



Credit: B. Baker

In the lab



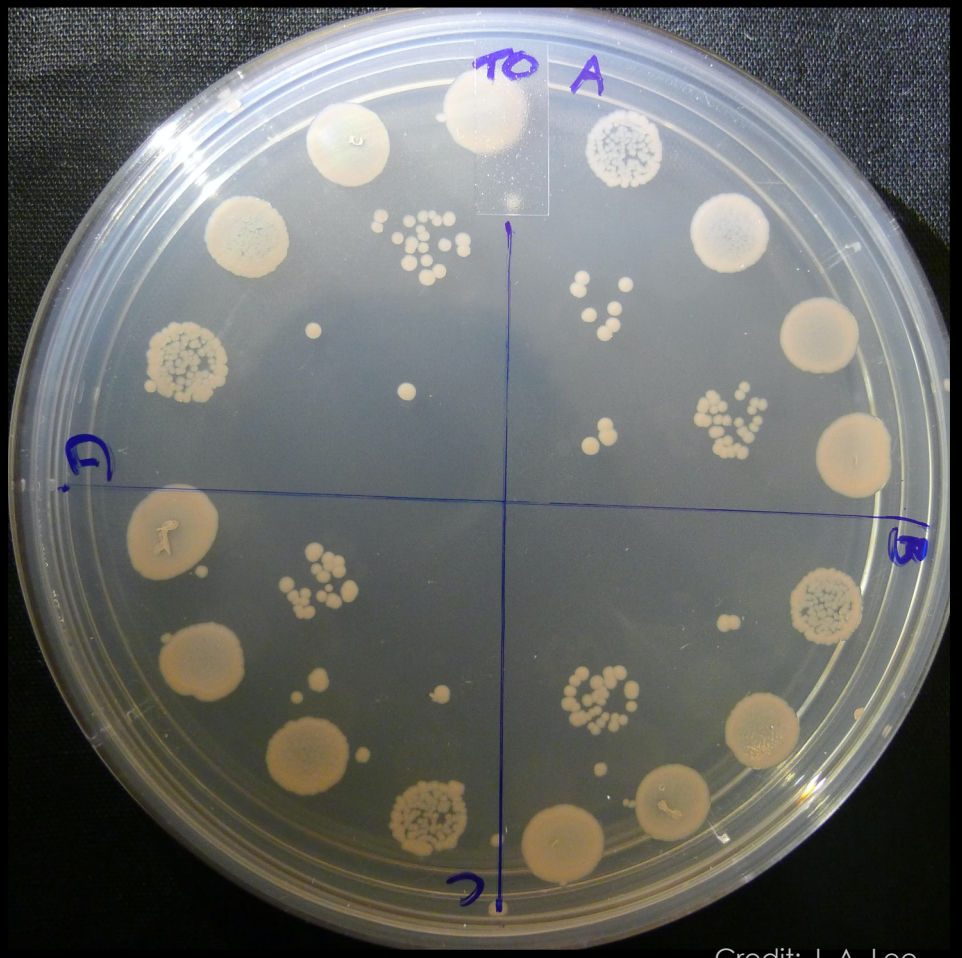
Credit: S. Lekus

In the lab



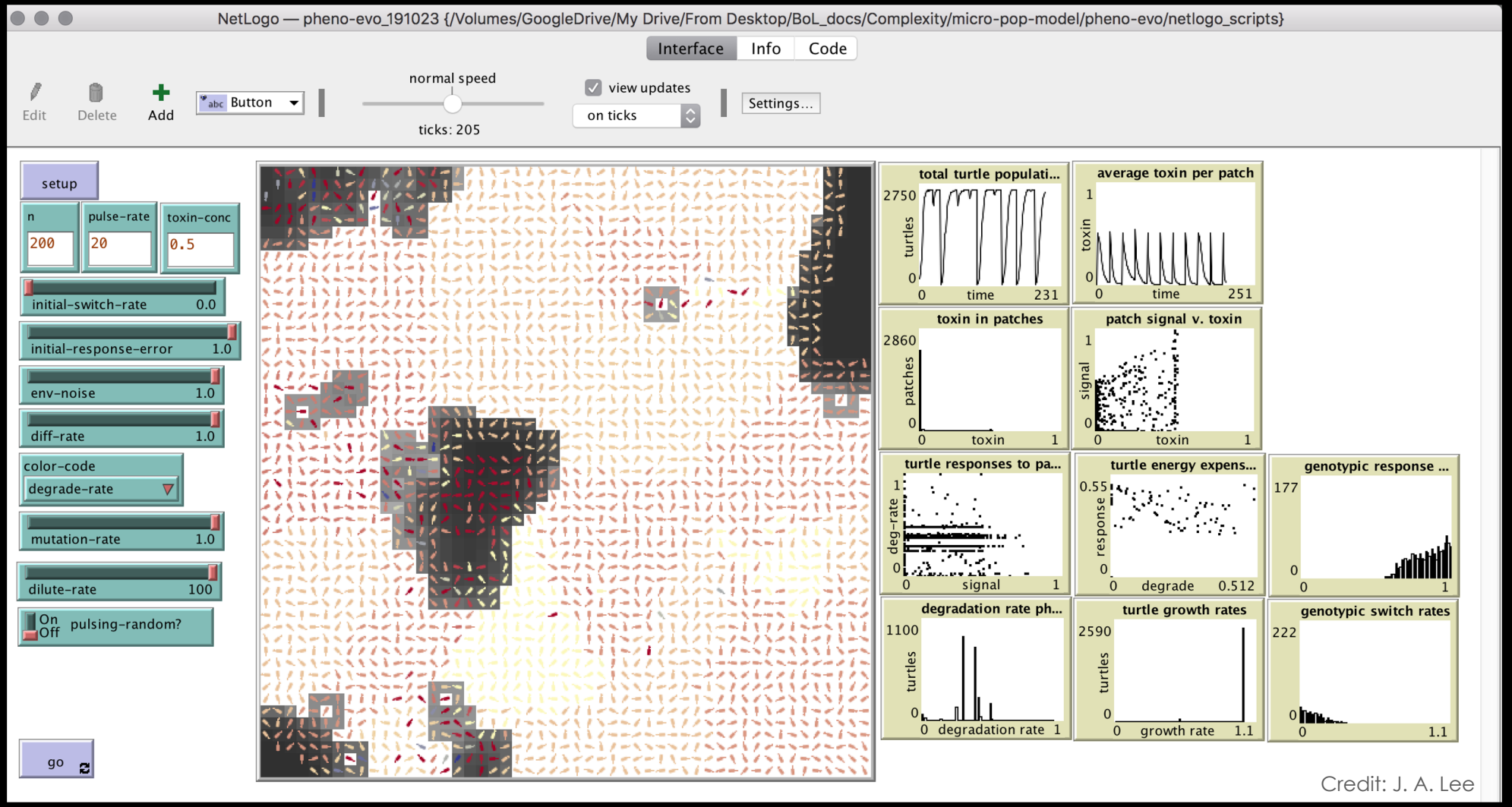
In the lab





Credit: J. A. Lee

… and in computer simulations



Credit: J. A. Lee

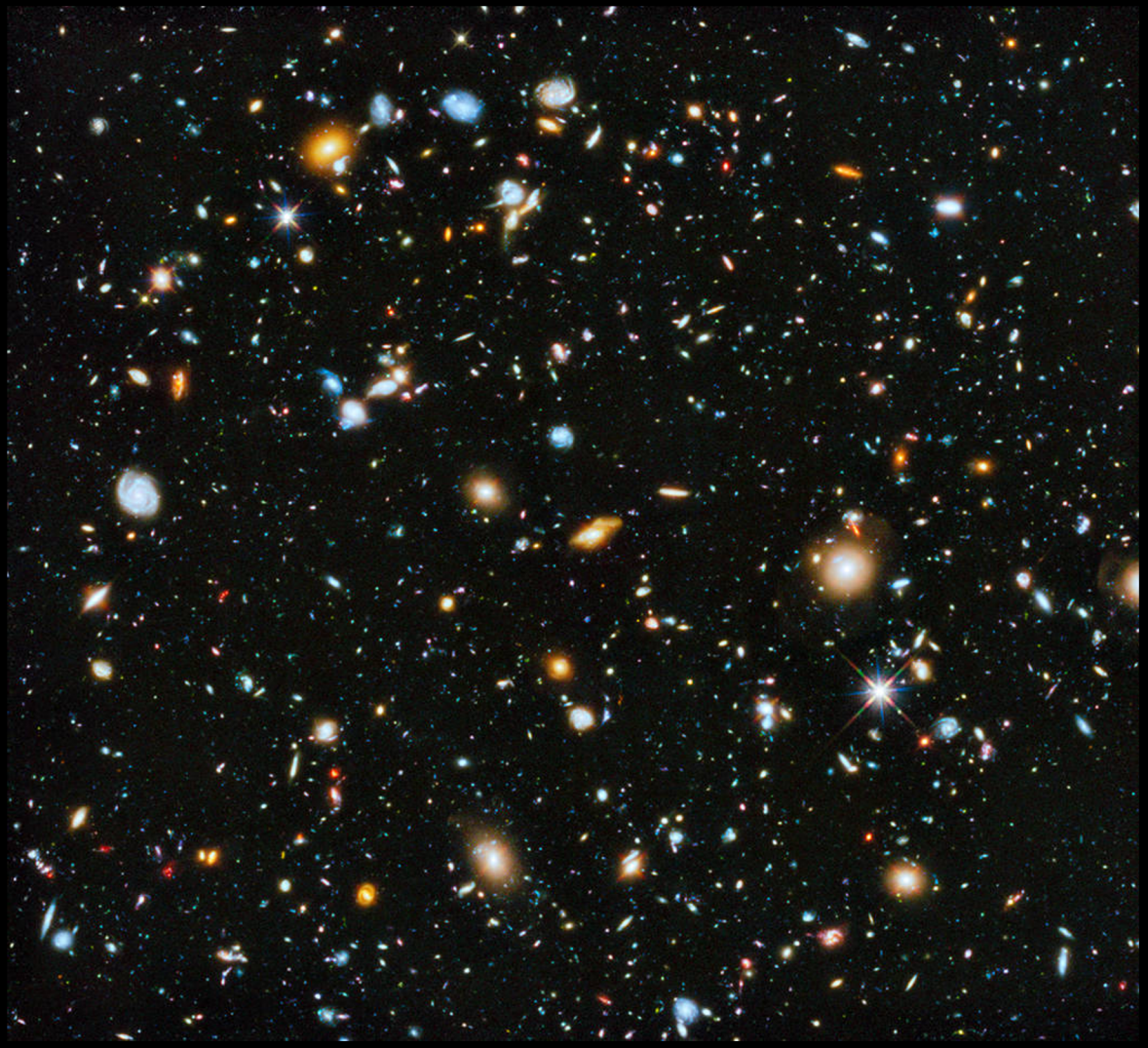
Microbes are everywhere



on Earth

Credit: NASA. https://www.nasa.gov/sites/default/files/thumbnails/image/as17-148-22727_lrg_0.jpg

Are there microbes in space?



Where?

Credit: NASA. https://www.nasa.gov/content/most-colorful-view-of-universe-captured-by-hubble-space-telescope

Space microbiologists ask 5 big questions

Is there (microbial) life out there?
What might it look like?
Astrobiology / Exobiology

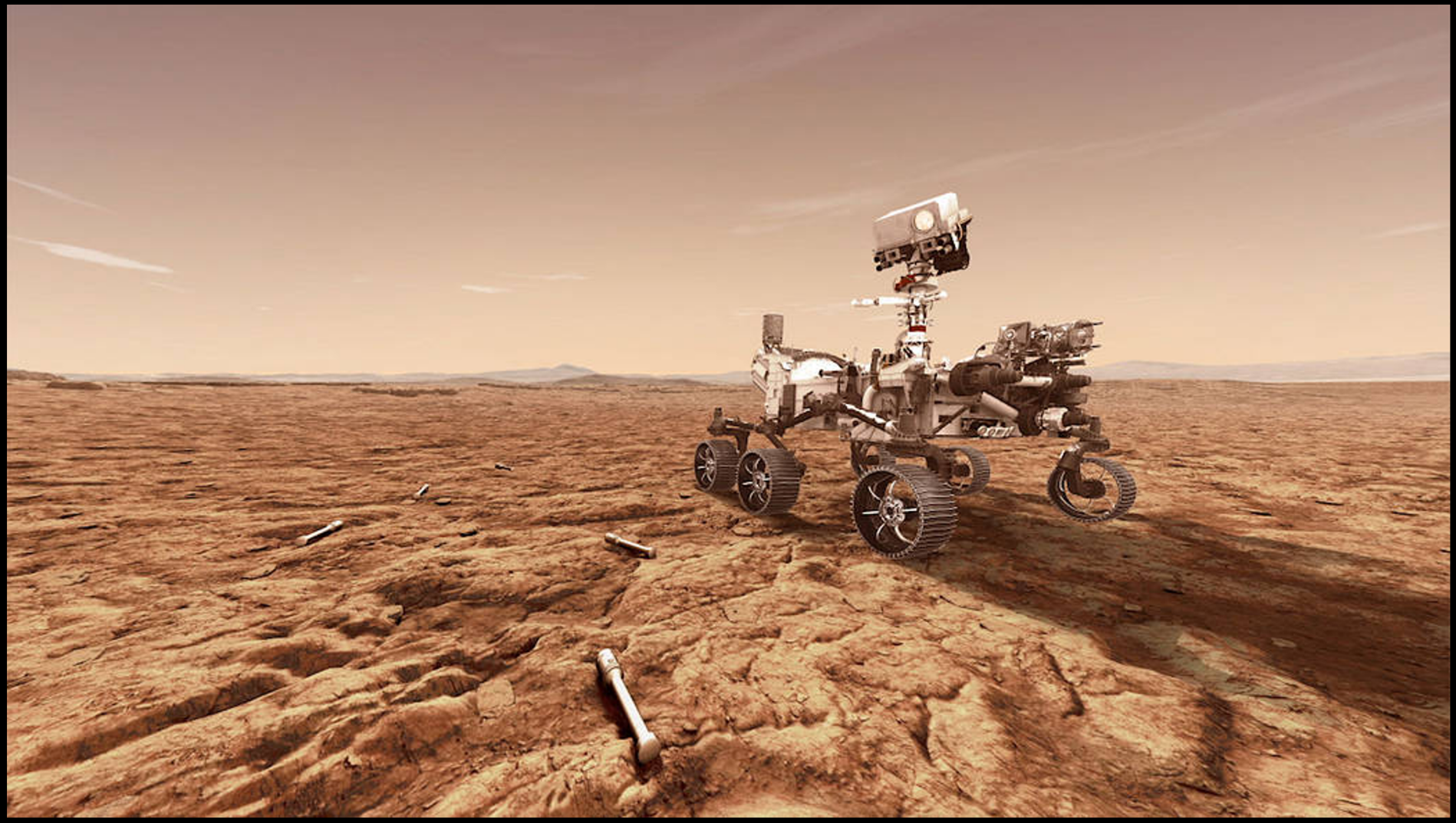
We don't know!
That is, we don't know if there is life NATIVE to other planets



Europa, Jupiter's moon

Credit: NASA. https://www.nasa.gov/europa/overview/index.html

Life detection missions search for signs

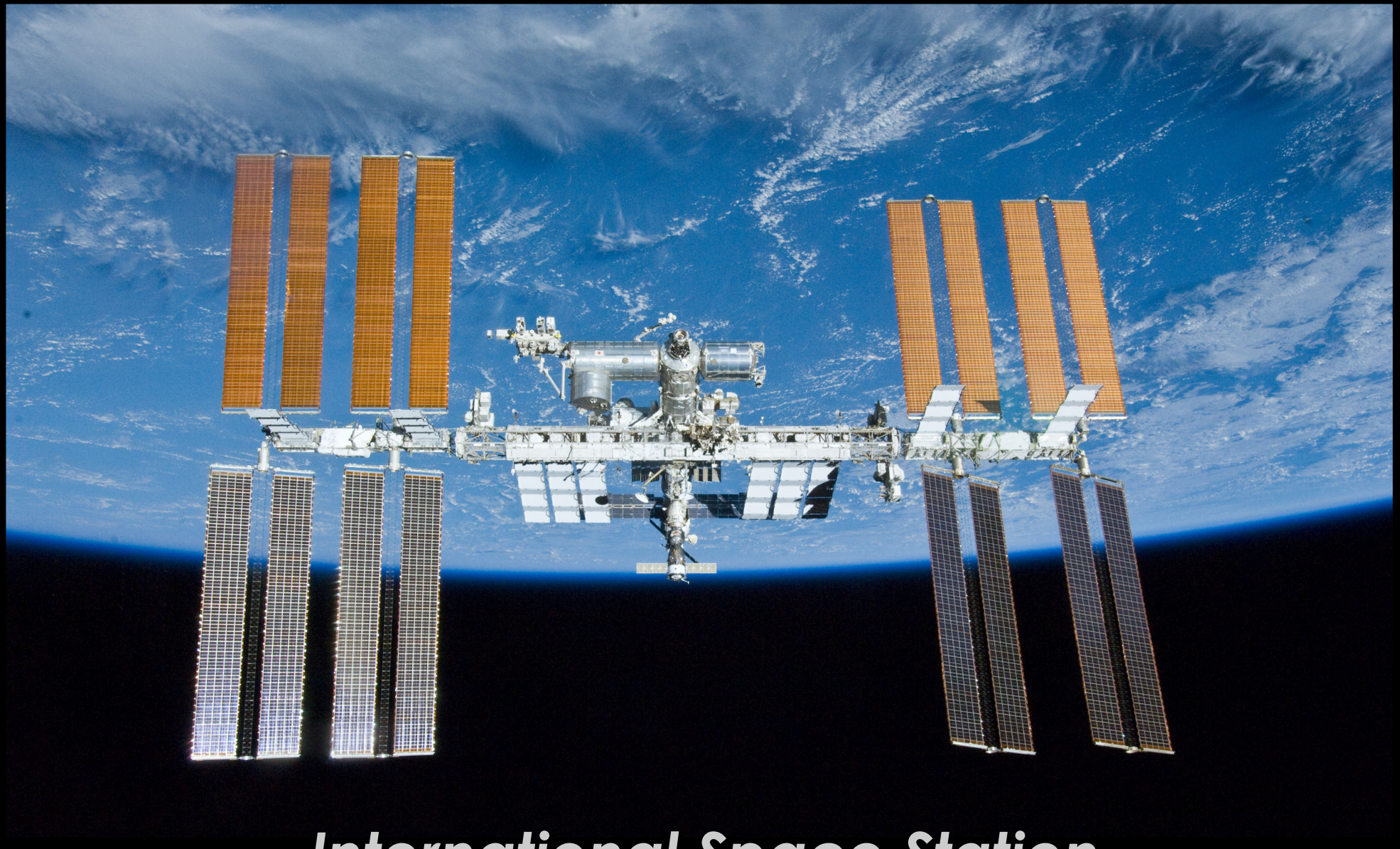


SHERLOC: Scanning Habitable Environments with Raman & Luminescence for Organics & Chemicals on the Mars Perseverance rover

Credit: NASA. https://www.nasa.gov/image-feature/mars-2020-with-sample-tubes-artists-concept

2. What microbes do we bring with us to the Space Station, and what are they doing there?

Microbial ecology of built space environments



International Space Station

Credit: NASA. https://www.nasa.gov/mission_pages/station/structure/launch/images.html

There are microbes on the ISS from people



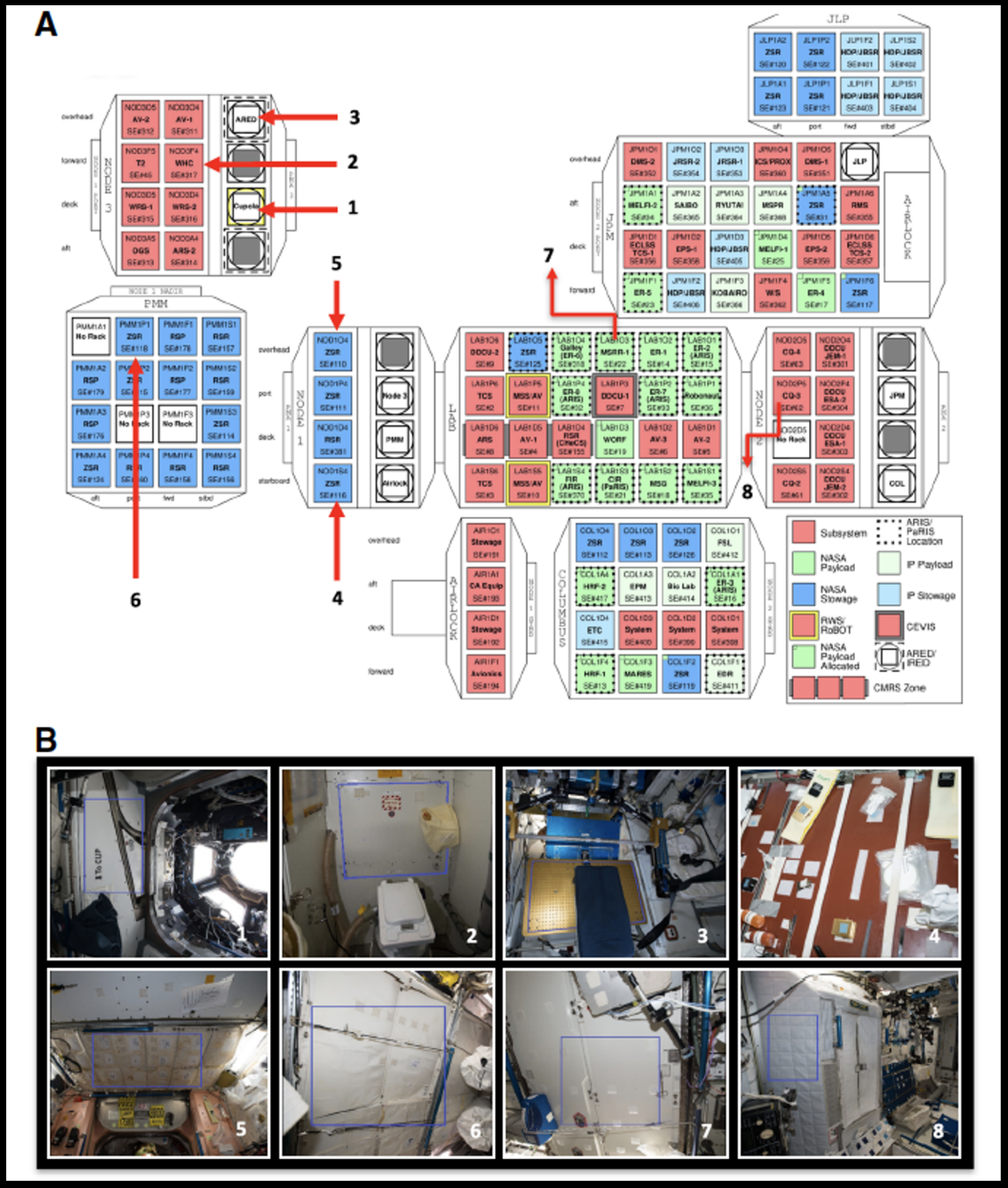
Credit: NASA. https://www.nasa.gov/mission_pages/station/images/index.html

Microbes live on plants on the ISS



Credit: NASA. https://www.nasa.gov/mission_pages/station/images/index.html

The ISS is a "microbial observatory"



Microbiologists have astronauts swab/wipe different parts of the environment and send the sample swabs back to Earth for analysis

Checinska Sielaff et al. Microbiome (2019) 7:50

3. How do we keep ourselves from contaminating other planets with Earth microbes?

Planetary Protection

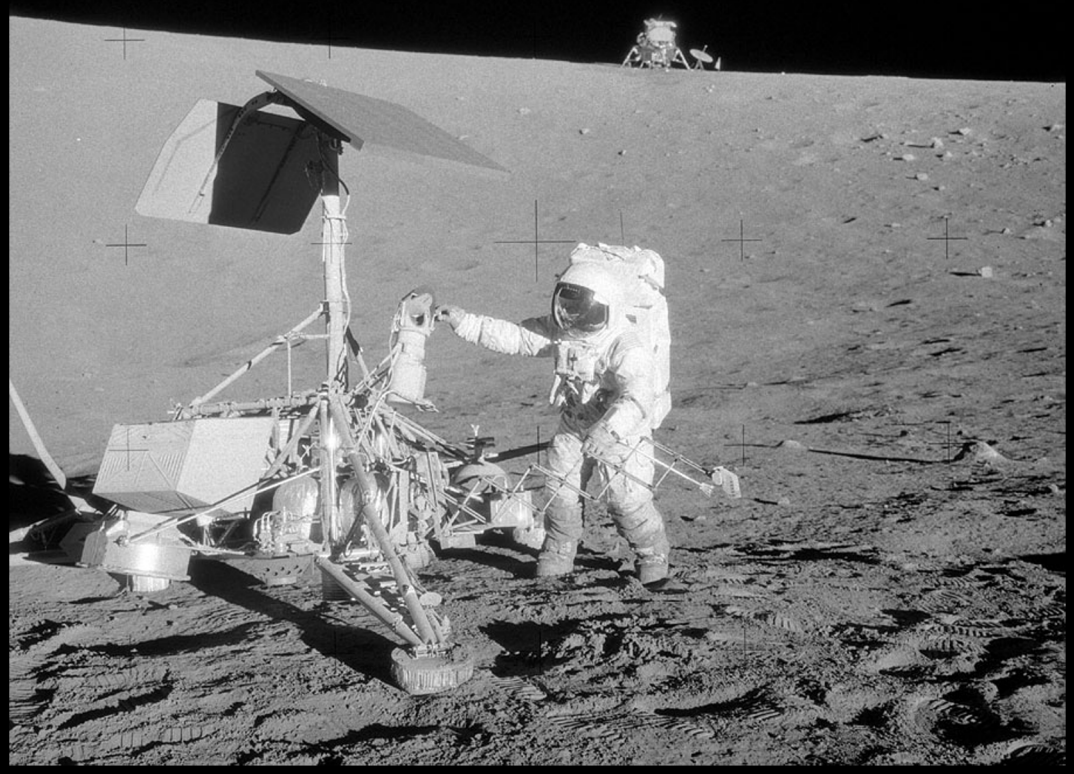
Planetary Protection means assembling spacecraft very carefully



Mars 2020 assembly clean room

Credit: NASA. https://www.nasa.gov/mission_pages/station/structure/launch/images.html

Planetary Protection means doing experiments on microbial survival in space



Apollo 12 astronaut visiting Surveyor III lander, November 1969

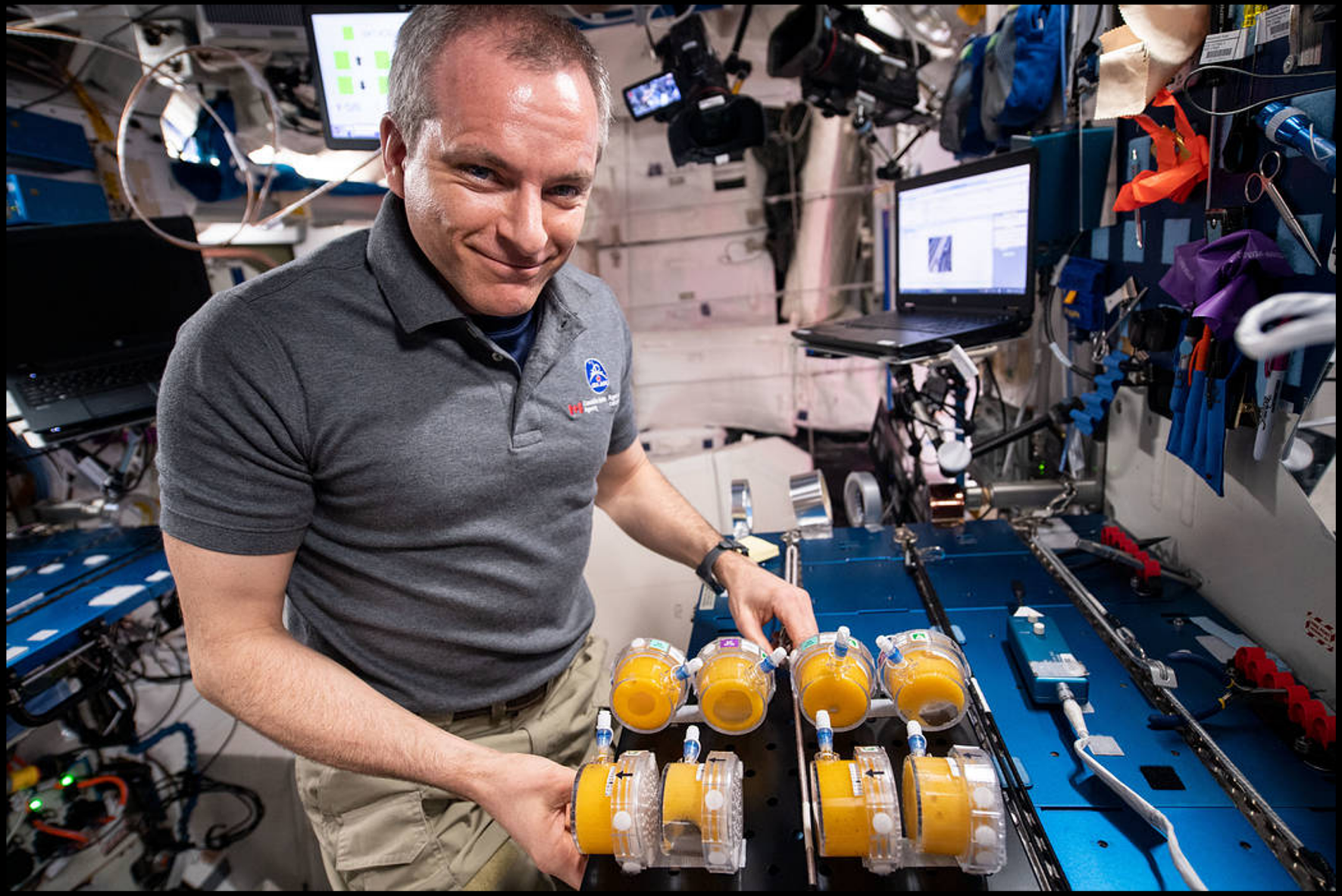


Microbial sampling of camera from Surveyor III

Credit: NASA. https://www.nasa.gov/sites/default/files/thumbnails/image/383417main_surveyor3_full.jpg

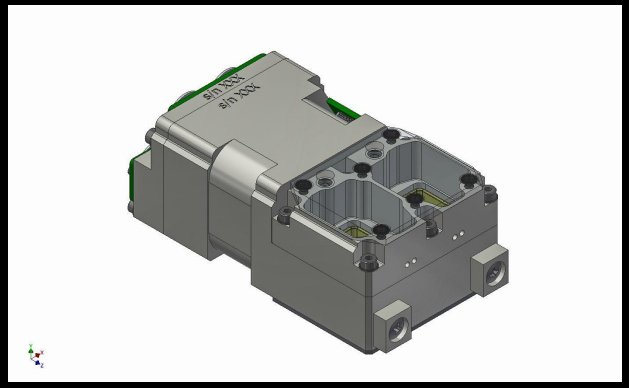
4. How can we use microbes to help sustain human life in space?

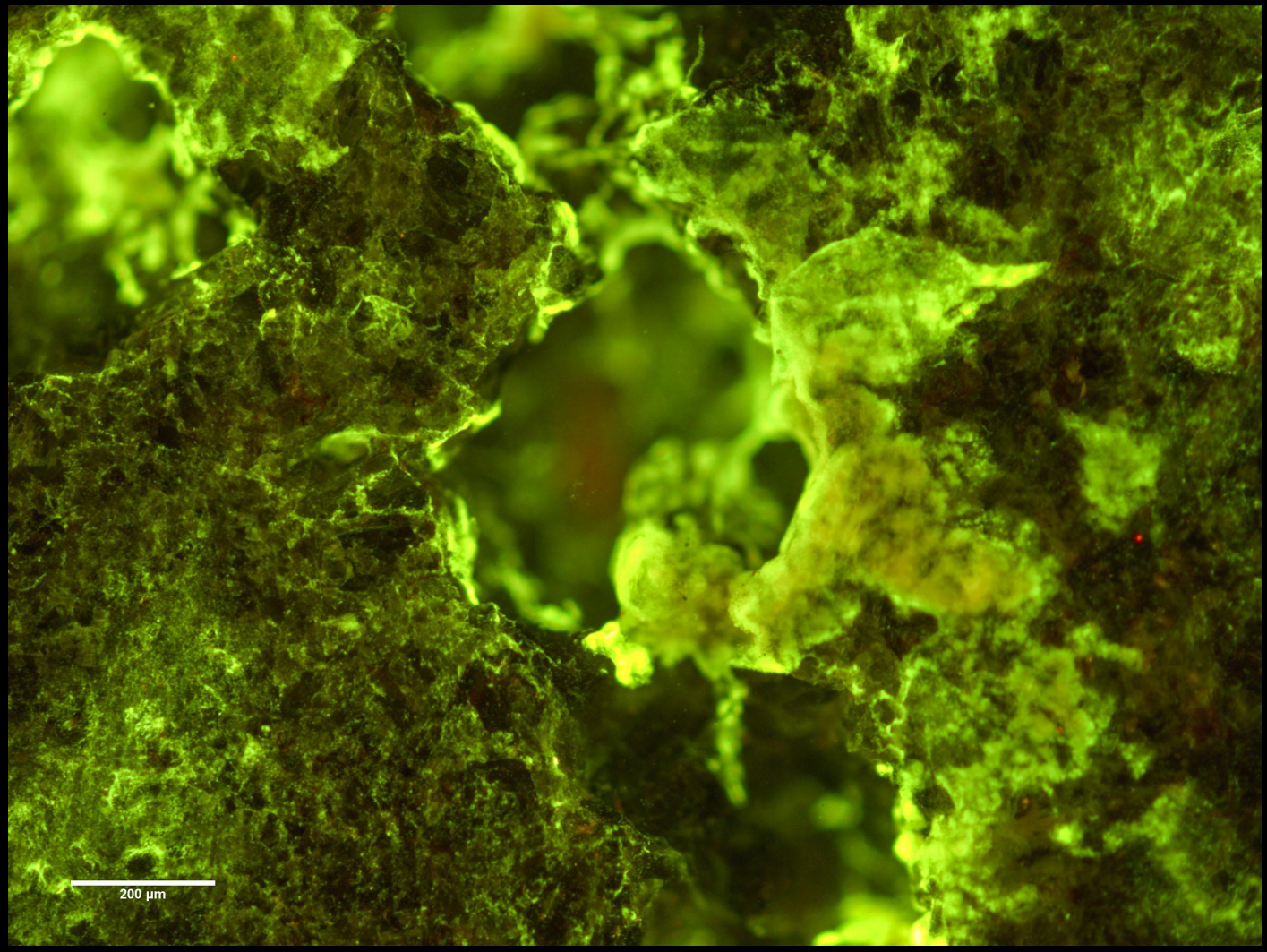
Bioengineering / Synthetic Biology



BioNutrients mission: yeast making vitamins

Credit: NASA. https://www.nasa.gov/image-feature/ames/a-space-traveler-s-recipe-for-sweet-potato-pie





Biorock experiment: space biomining

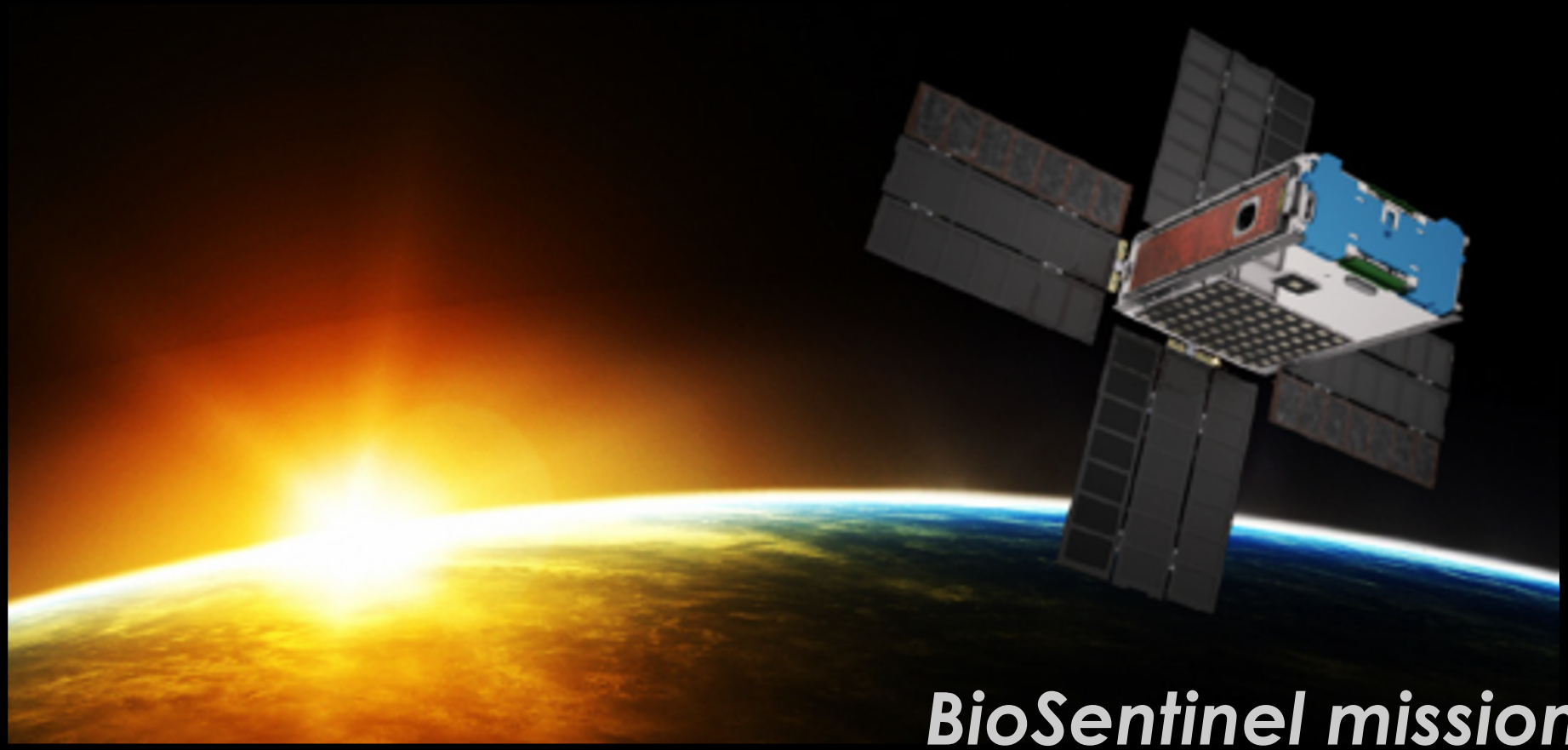
Credit: NASA. https://www.nasa.gov/mission_pages/station/research/experiments/explorer/Investigation.html?#id=7566

5. Can we use microbes to learn about how the space environment affects Earthly life?

Microbial physiology / radiation biology

We send microbes into orbit to study the effects of space

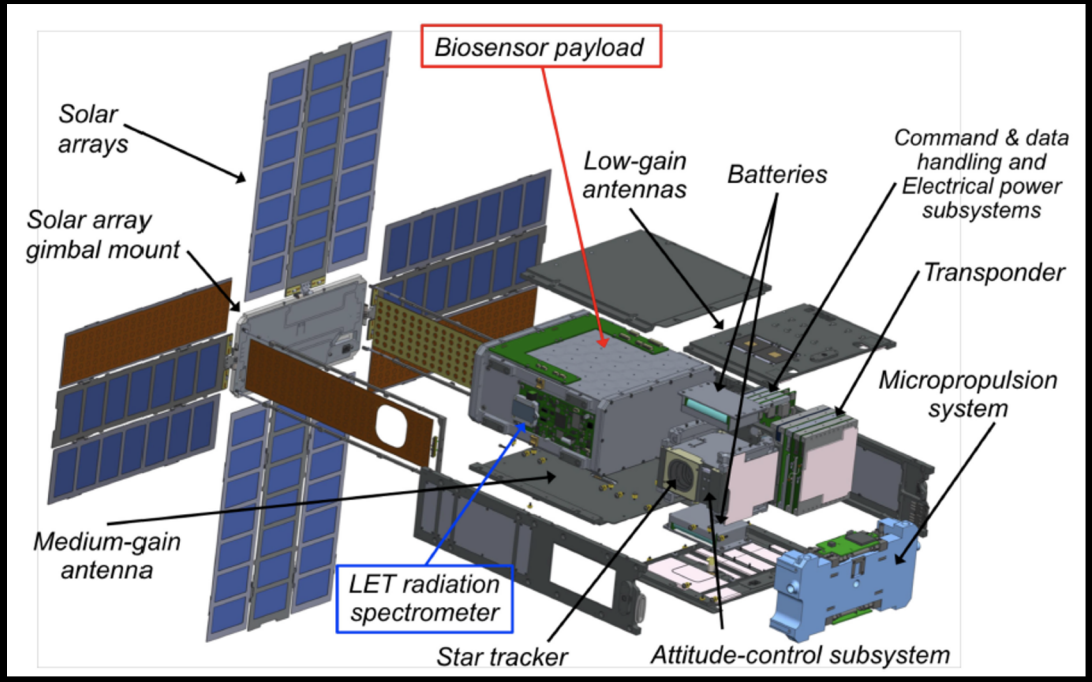


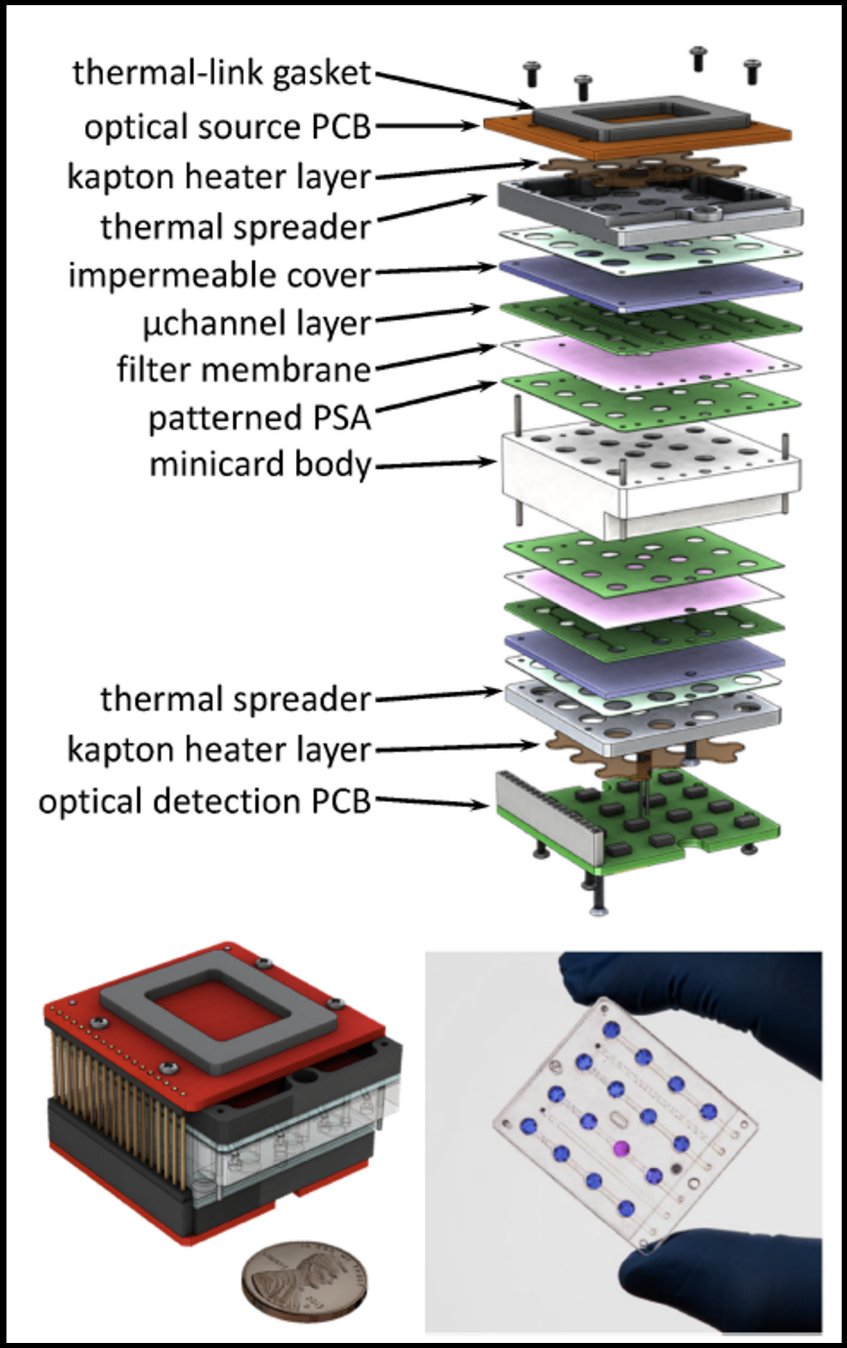


BioSentinel mission

Ricco et al. 202 doi:10.1109/MAES.2019.2953760
https://www.nasa.gov/sites/default/files/atoms/files/biosentinel_fact_sheet-16apr2019_508.pdf

BioSentinel is a self-contained culture chamber that will send back data on how yeast survive radiation





Ricco et al. DOI. No. 10.1109/MAES.2019.2953760

The Artemis program wants to return humans to the moon by 2024



Credit: NASA. https://www.nasa.gov/artemis/image-gallery

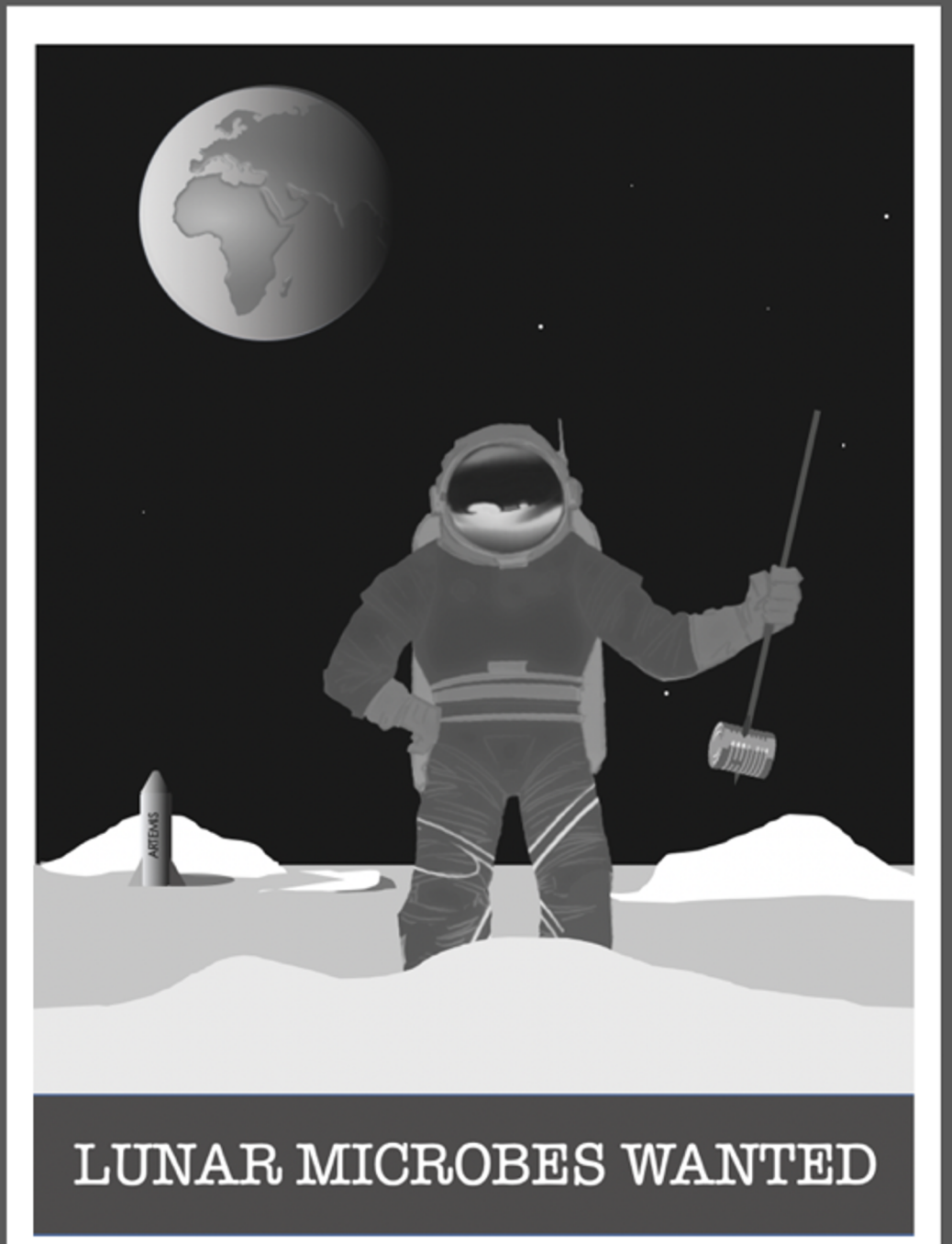
LEIA: the Lunar Explorer Instrument for space biology Applications



LEIA will be similar to BioSentinel, but on the lunar surface

Credit: NASA. https://www.nasa.gov/press-release/nasa-selects-first-commercial-moon-landing-services-for-artemis-program

Questions!



Credit: S. M. Ledford