

## 2019 Humans to Mars Summit, Human Health/Human Factors Panel

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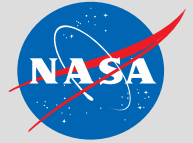
Avoid transfer of terrestrial life to habitable worlds.

Prevent release of extraterrestrial life on Earth during sample return.

In addition to verifying the biological cleanliness of spacecraft during assembly, the Office of Planetary Protection supports research for robotic and human missions with destinations at Mars, Europa, and Enceladus.

Technology development priorities:

- Genomic and metabolomic characterization of terrestrial organisms on spacecraft
- Innovative chemical and spectral tools for rapid detection of bioburden on spacecraft
- Sterilization modalities for use on putative extraterrestrial organisms

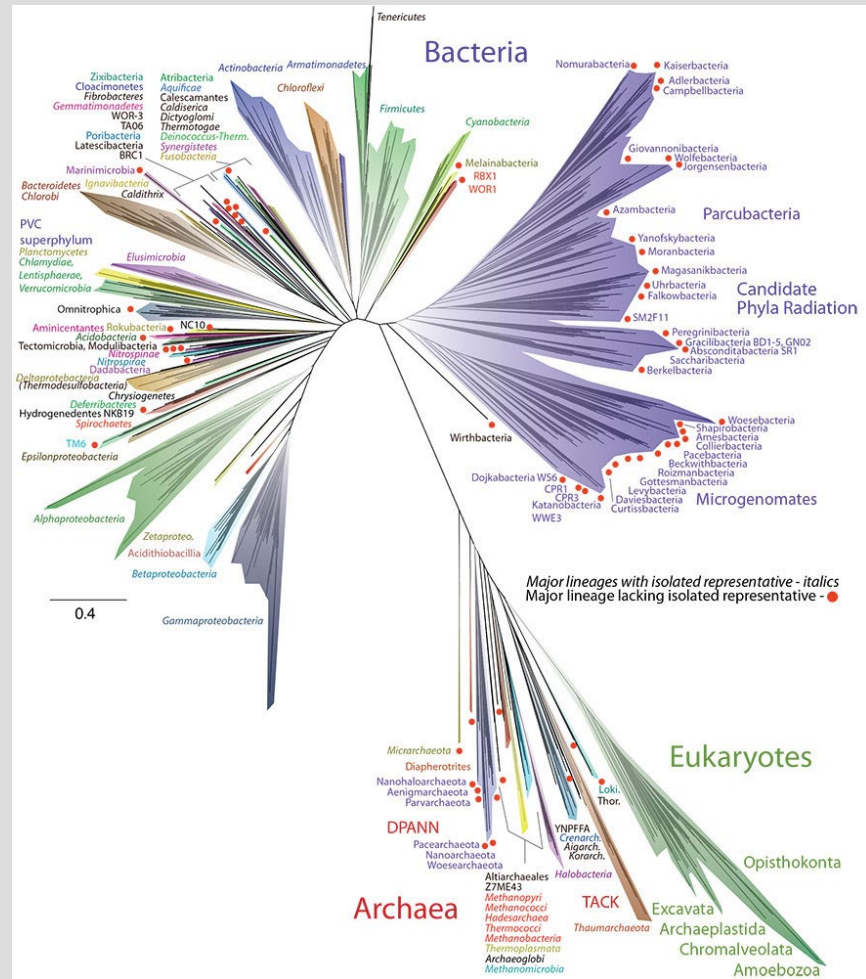


# Genomic revolution in life science

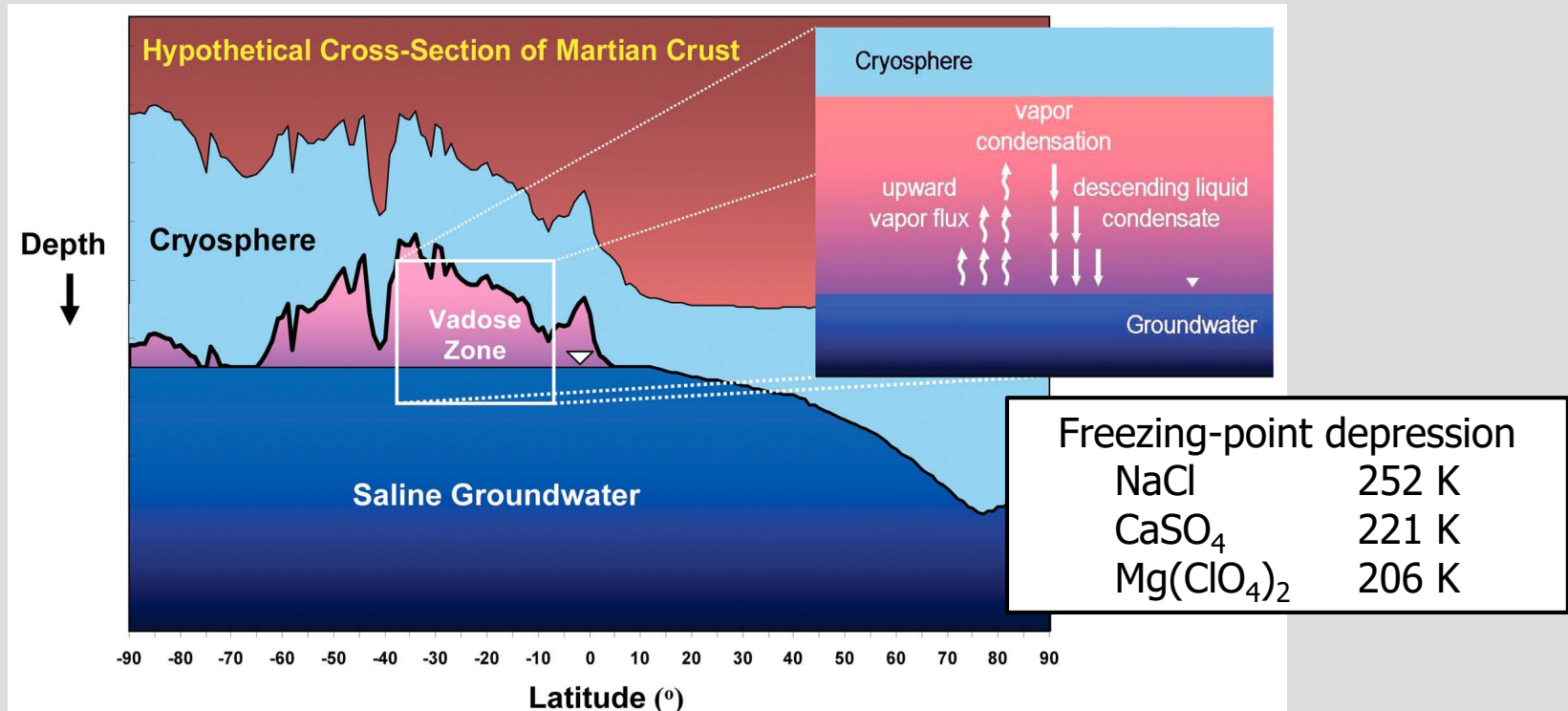
More than 1,000 newly reported organisms (red dots) were included in this revised tree and were sampled from a range of environments including hot springs, salt flats, geysers, and soils.

These organisms are known only from their genomes, they are part of the great uncultured majority.

Hug et al., 2016, Nature Microbiology



# Is life present in the subsurface of Mars?



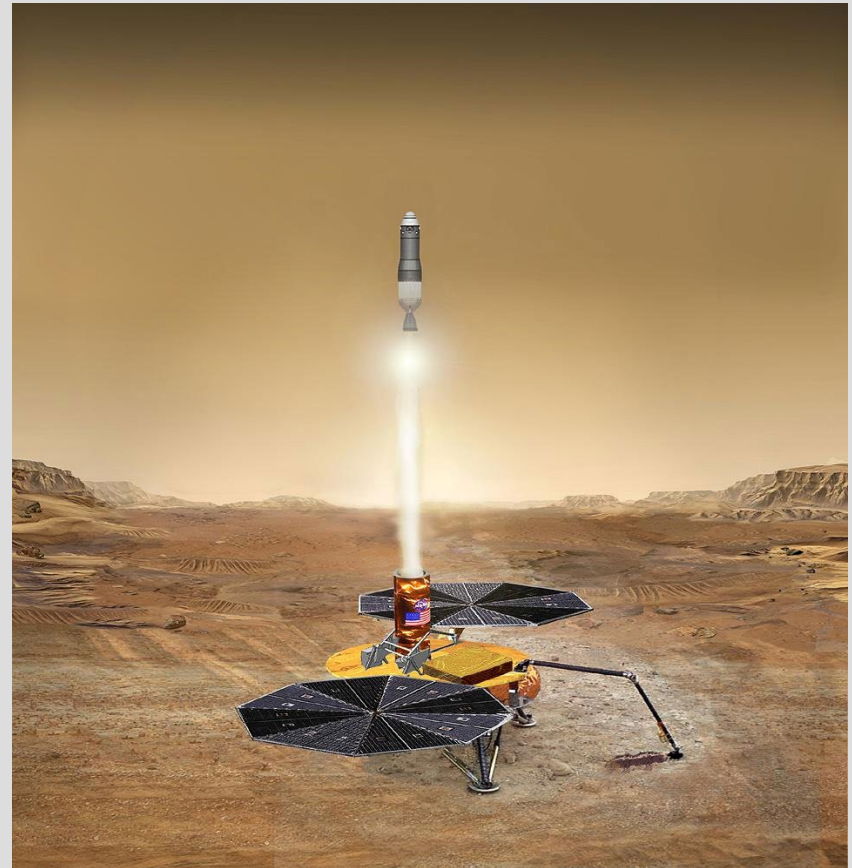
Hypothetical cross section of the present-day Martian crust. Structure and depths of ice and liquid water are critical unknowns. Where the base of the cryosphere is in contact with the water table, dissolved salts could reduce the thickness of permafrost by depressing the freezing point of groundwater.

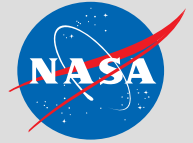
Figure from Clifford et al. (2010)

# Preventing biological contamination of Earth

Mars Sample Return is an integrated NASA/ESA campaign to drill and cache samples with the Mars 2020 rover, collect samples tubes with a small fetch rover, transfer samples to orbit with an ascent rocket, rendezvous with an orbiting spacecraft, and return samples to Earth for study.

<https://www.jpl.nasa.gov/missions/mars-sample-return-msr/>



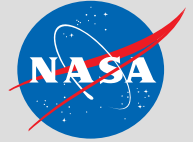


## Safe handling of samples from Mars

Although life has not been detected on Mars, it remains prudent to be prepared for contact with an active form of subsurface life or a dormant form of surface life.

Protecting Earth from biological contamination is based on three principles:

1. break the chain of contact with martian dust
2. robust containment of samples
3. sterilization of putative martian organisms or biological agents.



# Mars Sample Return in Early 2030's

## Direct Benefits for Human Missions

- Demonstration of ascent rocket for Mars
- Development of sterilization modalities for use at Mars
- Biological containment for putative extraterrestrial life
- Unsterilized samples for advanced biological study
- Chemical/physical characterization of martian dust