National Aeronautics and Space Administration

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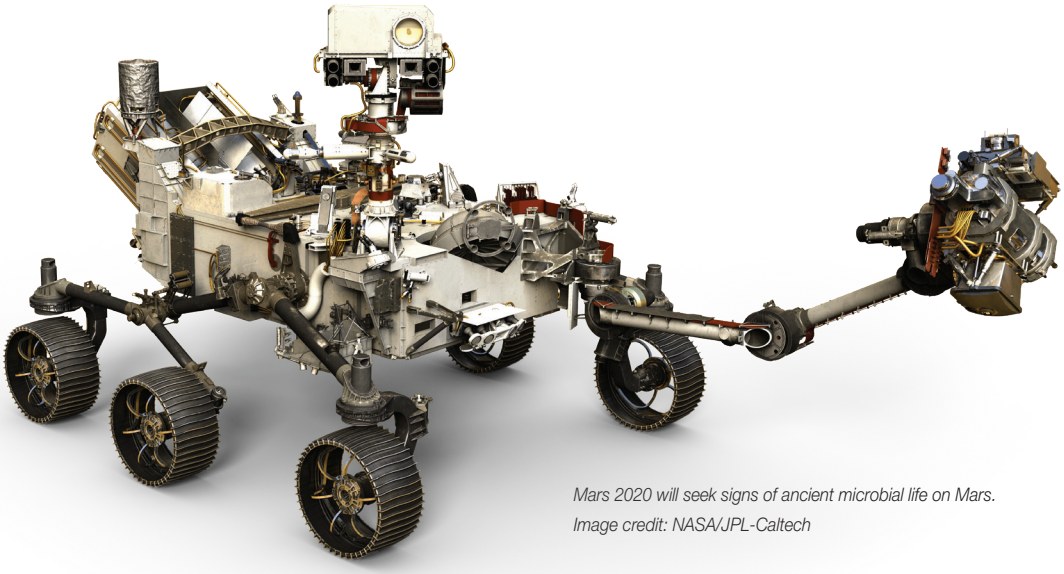
Biological Cleanliness for Mars 2020



Mars 2020 will seek signs of ancient microbial life on Mars.
Image credit: NASA/JPL-Caltech

Previous Mars missions have established that there are places on the surface of Mars that had environmental conditions suitable to support life in the ancient past. These conditions include long-term liquid water on the planet's surface long ago and the presence of key chemical ingredients. Whether life actually existed on the Red Planet is still an open question. NASA's Mars 2020 mission will take the next logical step in Mars exploration and search for signs of past microbial life on the Red Planet.

SEEKING SIGNS OF PAST LIFE

A biosignature is an object, substance, or pattern observed in a sample—rocks, sediment, atmosphere—that could have been produced by life as we know it. If microbial life did exist on Mars, it could have left behind signs of its presence, or biosignatures, in the planet's regolith and its rock record. The Mars 2020 rover will search for these biosignatures at its landing site in Jezero Crater using a suite of advanced instruments.

The rover will study the landscape and analyze rocks and regolith down to a scale that is compatible with finding traces of past life. The Mars 2020 rover will collect and store a set of rock and sediment samples that could be returned to Earth by a future mission. The rover and a small helicopter that will fly with it to Mars will test new technologies to benefit future robotic and human exploration of Mars.

NASA works diligently to keep its Mars-bound spacecraft extremely clean. Spacecraft must carry only a minimum amount of biological material from Earth. As it is the first mission to collect samples of Mars rock and sediment that could be returned to Earth in the future, Mars 2020 will meet its cleanliness requirements and do much more to preserve the scientific integrity of the samples.

KEEPING IT CLEAN

The Mars 2020 team at work. Image credit: NASA/JPL-Caltech

A bacterial spore is a dormant form of life that helps microorganisms endure tough environments. Only certain kinds of microorganisms can produce this resilient form of life. When conditions threaten their lives, key parts of such microorganisms can go dormant inside their protective structures. When conditions become more favorable again, the spores can transform back into cells, grow, and multiply after hundreds to even thousands of years. This is why spore-forming bacteria are a focus during spacecraft cleaning.

At launch, the entire Mars 2020 spacecraft, which includes the rover, the Mars helicopter, the descent stage, cruise stage, heat shield and backshell, must carry less than 500,000 spores—that's a tiny number as far as spores go and wouldn't even cover a typical smartphone camera lens. Of this number, parts of the Mars 2020 spacecraft that are intended to land on Mars, such as the parachute and the descent stage, must have no more than 300,000 spores in total. The rover itself is allocated just 41,000 spores, spread out over the rover's large surface area.

To meet these cleanliness standards, engineers assemble the rover and spacecraft in a "clean room." This type of room has air filters that limit dust particles, and its surfaces and floors are frequently treated with strong cleaning solutions to kill and remove living microbes.

Mission hardware is cleaned using techniques that have proven effective on many previous missions and are designed not to damage the spacecraft. This includes techniques such as hand-wiping the hardware with special sterile cloths and alcohol wipes, heating durable parts to high temperatures (230 to 392 degrees Fahrenheit, or 110 to 200 degrees Celsius), and cleaning some parts with hydrogen peroxide vapor.

Cleaning and sampling hardware in the Spacecraft Assembly Facility. Image credit: NASA/JPL-Caltech

GETTING TO MARS SAFELY

At launch, the Atlas V rocket launching Mars 2020 will be pointed along a trajectory that would not intercept Mars. That's because only some portions of the Atlas V can be cleaned as thoroughly as the spacecraft. Once the spacecraft separates from the launch vehicle's upper stage, the spacecraft will be redirected toward landing on Mars. This is known as "trajectory biasing,"

and it ensures that the launch vehicle has a less than 1 in 10,000 chance of accidentally encountering Mars for 50 years after launch.

The rover will land at Jezero crater. The scientific community recommended this location because it is where an ancient crater lake once existed, and in which a river delta formed and is preserved. A variety of measurements from orbit have shown that this region could have collected and preserved ancient organic molecules and other potential signs of microbial life from the water and sediments that flowed into the crater billions of years ago. In addition, the material carried into the delta from a large watershed may contain a variety of minerals from inside and outside the crater.

Since the mission is seeking signs of ancient—not current, or "extant" life—it can accomplish its scientific goals without visiting a potential "special region." This is a type of region that could have water ice or liquid water in some form within 16 feet (five meters) of the surface.

ENHANCED MEASURES FOR RETURNED SAMPLE SCIENCE

The samples that Mars 2020 will carry may be brought back to Earth by a future mission for more detailed study. This is why the mission must take many additional cleanliness precautions beyond what's required of missions that might simply explore the surface of Mars. This effort identifies possible terrestrial contamination and preserves the scientific integrity of the samples for possible future analysis on Earth, or "returned sample science."

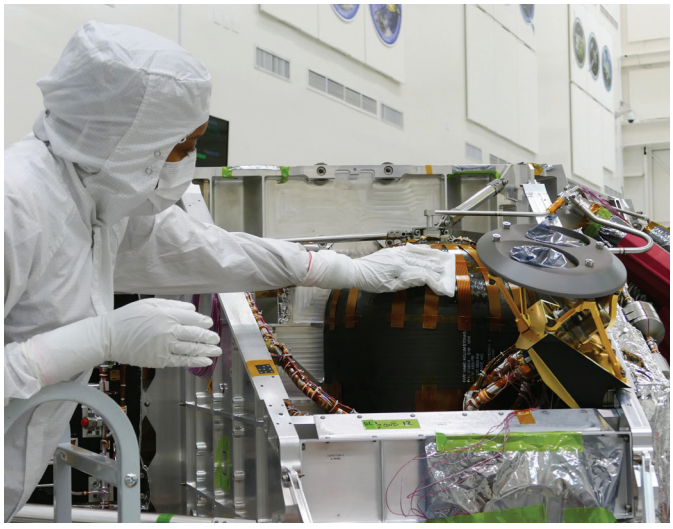
As part of this effort, the mission team determines how clean the sample tubes are through all mission phases.

Before launch, project teams take samples of hardware surfaces using wipes or swabs, and study microbes collected from those surfaces in a laboratory. The cleaning process is repeated if necessary. The data collected during hardware sampling helps scientists identify any microbes that may still be present on the hardware after cleaning. This includes microbes that can survive clean room environments despite a lack of nutrients and having endured repeated exposure to strong cleaning chemicals. This process is one of several tools available to scientists that would help them clearly identify any living or dead microbes that may have hitchhiked from Earth as Earth-sourced contamination, and that would not be an indication of Martian extraterrestrial life.

The parts of the rover that directly contact Mars during sample collection will be assembled in "aseptic" spaces, which provide an increased level of stringency for cleanliness that some sample collection hardware must meet. These parts are also thoroughly sterilized, exceeding the cleanliness standards of tools that doctors use in surgery. Mission teams will also identify and keep track of any known materials that remain on the spacecraft after thorough cleaning. This helps maintain a list of what's known to be on board before the sample tubes leave Earth.

PROTECTING MARS SAMPLES

The elements of the Mars 2020 rover that participate in sample collection are handled with extra care. The mission will also thoroughly document the sample collection process and related storage activities so that this information is available for future analysis.

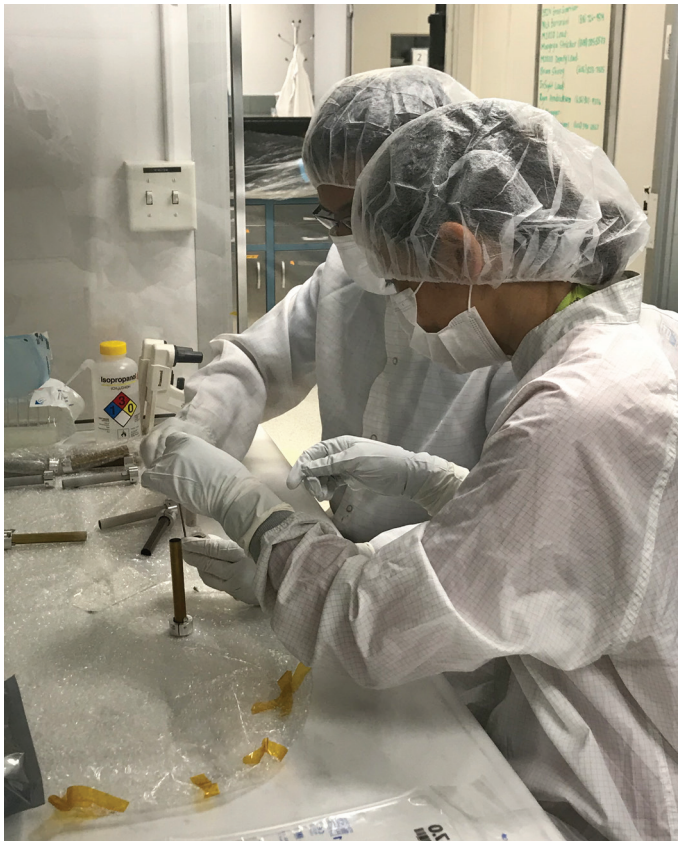


Before launch, project teams take samples of hardware surfaces using wipes or swabs, and study microbes collected from those surfaces in a laboratory.
Image credit: NASA/JPL-Caltech

Mars 2020's sampling system will carry 43 metallic tubes to store samples of rock and sediment obtained using the rover's coring and regolith-collecting bits. Some of those tubes will serve as witness blanks to keep track of terrestrial contamination. These tubes and other parts of the rover's sampling system that contact Mars samples directly will undergo several special cleaning processes. For example, before assembly, this hardware will be heated to 302°F (150 °C) for 24 hours and then protected from subsequent contamination.

To keep the sampling system clean, engineers will integrate its critical parts into the rover only after the spacecraft arrives at Kennedy Space Center for final processing shortly before launch. The sample caching elements will be enclosed behind a door under the rover's belly that will unseal and detach only after landing. An additional barrier behind this door will limit the flow of unwanted material into the parts that will touch the sample and should remain clean.

Mars 2020 will collect and cache Mars samples; the task of potentially returning these tubes to Earth lies with future missions to the Red Planet. This approach should result in the most pristine, well-documented planetary samples ever obtained, ready for imaging and analysis in advanced laboratories and study by scientific specialists from around the world.



Mission hardware is cleaned using techniques that have proven effective on many previous missions. Image credit: NASA/JPL-Caltech

For more information about Mars 2020 and NASA's Mars exploration program, visit: **mars.nasa.gov/mars2020**