Bacteria Survive in NASA's Clean Rooms by Eating Cleaning Products

Their abilities could make it harder to stop Earth microbes from contaminating other worlds.

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NASA's InSight spacecraftGene Blevins / Reuters

Few places are as hard for microbes to infiltrate as the clean rooms in which NASA assembles its spacecraft. Those drifting in through the air must run a gauntlet of filters. Those hitching a ride on employees find their paths barred by face masks and full-body hooded coveralls. Those that actually manage to land on a surface will find a world of famine and drought, devoid of water and nutrients. If they survive, most will be wiped off when the clean rooms' walls, floors, and contents are assiduously and repeatedly scrubbed with alcohol-based solvents.

All this is in aid of "planetary protection"—the business of stopping Earth microbes from hitching a ride on our spacecraft and contaminating other worlds. NASA is bound to this principle by international treaty, and makes every effort to uphold it. After all, stowaway microbes from Earth could confound any attempts to find actual extraterrestrial life on other planets.

But it's impossible to sterilize surfaces completely. Even NASA clean rooms have their own microbiomes—a common community of super-hardy species that somehow withstand the rigorous disinfection procedures. These communities are dominated by *Acinetobacter* bacteria, which are typically found in soil and water. While other microbes disappear during the cleaning process, *Acinetobacter* persists. Scientists have isolated strains from the surface of the Mars Odyssey orbiter, from the floors on which the Mars Phoenix lander was assembled, from the exterior of the International Space Station, and even from the station's drinking water.

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Now, a team of scientists led by Rakesh Mogul from California State Polytechnic University at Pomona has discovered one of *Acinetobacter*'s survival tricks: These microbes can eat the very cleaning products that are meant to banish them. "You can clean the rooms out and sterilize them, but microbes are still there," says Mogul. "To be a bit *Jurassic Park* about it: Life will find a way."

His team, which was mostly made up of undergraduate students, took *Acinetobacter* strains that had been recovered from clean rooms, and reared them on vanishingly low levels of nutrients. Under these extremely restrictive diets, the bacteria could grow on ethanol as their main fuel. They burned it for energy, and they used its carbon to make their own DNA, proteins, and other essential molecules.

The team found hints that *Acinetobacter* might also be able to grow on isopropyl alcohol, the main chemical used to wipe clean-room surfaces, and Kleenol 30, the detergent used to scrub the rooms' floors. Even if they can't use these substances as energy sources, they can certainly break them down. They can even withstand treatment with hydrogen peroxide, the

chemical used in bleaches, detergents, and disinfectants.

"The persistent presence of microbes in clean rooms used to assemble spacecraft has been widely recognized over the past 20 years as a vexing problem," says Lisa Pratt, NASA's planetary-protection officer. But this new study says that "disinfectant chemicals intended to kill bacteria are feeding, sustaining, and increasing the sterilization tolerance for some microorganisms."

It seems that the harsh, dry, and chemically bombarded environments of the clean rooms select for only the toughest bacteria. And *Acinetobacter* strains are unusually tough as it is. They can resist hydrogen peroxide, desiccation, radiation, high pressures, and temperatures of up to 80 degrees Celsius. Some strains can shrug off antibiotics and cause outbreaks of pneumonia in hospitals, although Mogul notes that none of the strains that he studied are known to cause disease.

Still, his study means that NASA might have to step up its planetary-protection game, especially for future missions aimed at detecting life on other worlds. They might try using different types of solvents in rotation, to avoid selecting for a community of resistant microbes. But since they need to kill the microbes without also killing the spacecraft, "there's a bottleneck of the kinds of chemicals they can use," says Mogul.

Acinetobacter's persistence should be cause for awe rather than alarm. Newspapers regularly print scaremongering headlines about the bacteria that lurk in everyday objects, from wallets to keyboards and doorknobs to phones. But there's no escaping the fact that bacteria are omnipresent. "There's no such thing as 100 percent sterility," says Mogul. "There will always be something there."

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