1. Briefly describe the project you worked on this summer, including the project objectives

For the study entitled “Assessment of Bacterial Spores in Solid Materials,” I assisted in the continuing development of efficient and sensitive procedures for detecting bacterial spores embedded in solids. Historically, it has been difficult to determine the quantity of bacterial spores that are embedded in the solid materials used to build spacecraft and spacecraft instrumentation. In order to avoid accidental transfer of Earth life to other solar system bodies, evaluation of the microbial bioburden found in common spacecraft materials is important.

This summer, we quantified the release, by cryogenic grinding at liquid nitrogen temperatures, of microbes present in 4 different spacecraft solids: epoxy 9309, epoxy 9394, epoxy 9396, and a silicone coating. Three different samples of each material were prepared: aseptically prepared solid material, powdered material inoculated with a known spore count of Bacillus atrophaeus, and solid material artificially embedded with a known spore count of Bacillus atrophaeus. Samples were cryogenically ground as needed, and the powders were directly cultured to determine the number of microbial survivors per gram of material. Recovery rates were found to be highly material-dependent, varying from 0.2 to 50% for inoculated material surfaces and 0.002 to 0.5% for embedded spores. A study of the spore survival rate versus total grinding time was also performed, with results indicating that longer grinding time decreases recovery rates of viable spores.

2. Describe what you have learned

Since my field is inorganic photochemistry, this was my first time working on a microbiology project. Therefore, besides the results of the project as described in item #1, almost every experimental procedure utilized this summer was completely new to me. I had no experience with bacterial spores, so I learned about this rugged and dormant phase displayed by some bacteria.
Since we were quantifying the amounts of bacterial spores found in various materials, I initially learned how to work in the laboratory to ensure aseptic conditions. Preventing contamination from ambient microbes meant that most laboratory work was conducted in a biohood, while tools and glassware were pre-sterilized by autoclaving, flame-sterilization, or the use of isopropyl alcohol or bleach.

As a predominantly solution-state chemist, working with solids was also new to me. This summer, I learned, mostly through trial-and-error, how to best prepare various 2-part solid materials from their precursors to obtain pellets with maximum uniformity. I learned the proper procedures to degrade these pellets into fine powders by cryogrinding, and how to inoculate the powders with known amounts of bacterial spores. Every material had its own particular combination of properties, which was one of the challenges of the project.

Determining the amount of viable spores in various powered materials meant that I need to learn how to prepare sterile agar plates (solid growth medium-containing Petri dishes used to culture microorganisms). Assuming that each observed bacterial colony that grew was the result of a single viable spore in the original solution, I was able to quantify the original amount of spores per gram of material. Since it was unknown beforehand what concentration of spores would be countable, I most often wound up doing a dilution series on the original liquid culture.

In addition, I obtained experience with various other laboratory equipment and techniques, either directly or indirectly. I used microscopes to visualize solids and bacteria, I read about the theory behind flow cytometry and polymerase chain reactions (PCR), and also observed people performing DNA extractions, PCR, and quantitative PCR (qPCR) measurements.

Finally, simply being physically present at JPL during the summer has allowed me to learn much new information about the NASA’s space program. Although my group was involved specifically with Planetary Protection, I had time to attend several seminars and tours given by various JPL employees.

### 3. How will you apply this to your instructional area for improvement and enhancement?

As an instructor of preparatory and general chemistry courses, there is certainly not any flexibility with respect to the content of my classes. However, the more experience one obtains with actually doing science, the better a science teacher he or she will inevitably be. At the very least, undergoing any scientific endeavor gives a person solid experience with investigating something unknown, and with the
mistakes inherent in such a process. This is extremely valuable to an instructor, who becomes so familiar with the course content that they can forget what it is like for a student, for whom the material is new and unknown.

In addition, students have a very real interest in the practical aspects of a career in science, and appreciate hearing how the course materials they are learning are actually used in a laboratory setting. I now have additional experience designing and carrying out scientific inquiry in a real research laboratory, and can report how many course concepts (such as the scientific method, solutions, concentration calculations, and dilutions) are important to learn for more than just a chemistry class.

My experience participating in a microbiology project was also valuable. Chemistry is the central science, so I certainly teach more than just chemistry majors. In fact, modern science is increasingly interdisciplinary. Most cutting-edge science is found in fields closer to biochemistry, so it was nice to strengthen my background in the biological sciences.

4. How will you share this information with colleagues, students, and professional groups?

I plan on giving a talk about the results from this study to my colleagues during a future SMC flex-day. The results of this study will also very likely appear in a poster or talk at a future microbiology conference.

5. How will this assist students and counselors with information in your field leading to employment and/or transfer to a four-year university?

My summer experience has given me additional contacts and knowledge that I can share with students.

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