Surface Water and Air Biocharacterization Flight Experiment

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Human presence in space, whether permanent or transient, will be accompanied by the presence of microorganisms. While most are harmless or even beneficial, several microorganisms pose a threat to crew health and spacecraft system performance. In addition to infectious disease, microorganisms can be responsible for toxin production, food spoilage, plant disease, volatile organic gases, biodegradation of spacecraft materials, and the fouling of environmental systems. Understanding the microbial ecology aboard the vehicle during flight is critical to determining and mitigating risk during long-duration missions.

Historically, spacecraft analysis techniques have used media-based methodology, which can omit many medically significant organisms such as the pathogen Legionella. Recently, the development of molecular biology techniques and instrumentation has allowed a far more comprehensive evaluation of the environment than previously possible with traditional culturing techniques. For the surface water and air biocharacterization (SWAB) experiment, these molecular techniques were selected as the basis for flight sample collection and processing. Samples of the air, surfaces, and potable water will be collected during flight, and selected techniques and chemistry will be used to preserve the DNA. The samples will be returned to Earth for processing, where a variety of techniques will be used to analyze the samples including bacterial fingerprinting, bacterial and fungal ribosomal identification, and quantitative techniques to identify and enumerate specific genes. The identification of specific genes is critical in the assessment of microorganisms for particular characteristics, including the production of microbial toxins. The samples returned from flight will also be evaluated using denaturing gradient gel electrophoresis, a molecular technique that allows identification of the bacteria without the need for growth on media. Without the limitations of microbial growth on specific media, a larger variety of organisms will be identified. Based on other studies, this technique holds the potential to multiply by 100 the number of different identified species. The results of all of these samples will be compared to the results of preflight air and surface samples taken from vehicles scheduled to dock with the Space Station and water supplies being shipped to the Space Station.

The SWAB experiment has already begun returning benefits to various NASA programs. The use of molecular identification techniques has increased the ability to identify bacterial species three times more effectively than previously accomplished by the older techniques. Accomplishments such as these are essential in incorporating advanced techniques into the risk assessment for exploration missions to protect crew health and vehicle integrity. Currently, SWAB is scheduled to fly in the fall of 2005.