DETECTION OF THE BIOHAZARDS OF LIVING MARTIAN ORGANISMS

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Introduction: Over the last 20 years there have been significant steps to create a system, which allows researchers to study Martian samples that are returned to Earth while accurately assessing the presence of biohazards. A draft test protocol developed in 2002 provides steps to assess the biohazards of possible living Martian organisms returned from Mars missions [1]. Following the release of this document, NASA published an article that outlined plans for a Mars Sample Receiving Facility [2]. However, the protocol has not been re-evaluated since 2002, despite advances in technology and biology since then [3]. In addition, the plans for a Mars Sample Receiving Facility require development in specific areas in the future [2]. Our objective was to analyze the approach taken to detect biohazards of living Martian organisms.

Analysis: In the draft protocol, biohazard testing included genetic, molecular, pathogenicity, and biological tests [1]. Other tests include exposing Martian samples to unicellular or multicellular terrestrial organisms and introducing the samples to terrestrial ecosystems [1]. The goal of these tests was to examine the effect that unfamiliar living Martian organisms had on terrestrial biological systems [1]. However, the protocol only included general guidelines for testing as opposed to specific test methods. Rummel et. al suggested enforcing fixed guidelines only in the final protocol to account for evolving practices within toxicogenomics [1]. Indeed, the field of toxicogenomics is still evolving today, and development in artificial intelligence and machine learning may potentially influence this field in the near future [4]. Molecular and cellular tests have also replaced the need to use plant and animal in-vivo testing, however, it is still required as per the protocol [2]. This makes it more difficult to plan a Mars Sample Receiving facility [2]. As a result, the draft protocol should be revised.

The plans for a Mars Sample Receiving Facility as suggested by Beaty et. al present three specific approaches to creating a Mars Sample Receiving Facility: The Flad and Associates (FLAD) approach, the Lord, Aeck, Sargent (LAS) approach, and the Industrial Design and Construction (IDC) approach [2]. The teams that produced these designs operated independently of one another, and each approach had a different area to test for biohazards depending on the design of the Sample Receiving Facility [2]. However, specific methods to test for biohazards were not included in these plans. The three plans also required development in a couple of areas, including: Sample preservation, equipment for sample analysis, robotics, and techniques for decontamination [2].

Recommendations: The draft protocol should be reviewed to account for technological and biological advancements, as well as development in the field of toxicogenomics. The review should also include the implementation of specific biohazard testing techniques that are in accordance with modern technologies and techniques. The new protocol will allow NASA to implement simpler techniques of biohazard testing within the Mars Sample Receiving Facility plans [2]. These changes will be applicable for planning a Mars Sample Return Mission, as well as detecting biohazards in Martian meteorites.

Conclusion: The draft protocol and plans for a Mars Sample Receiving Facility provide a good review of biohazard testing and can be revised to provide more specific methods to test living Martian organisms. By accounting for the advancements in biology and technology since 2002, more detailed plans can be implemented to test for biohazards and preserve the Earth's biodiversity.

References: [1] Rummel J.D. et al. 2002. NASA/CP-2002-211842. [2] Beaty D. W. et al. 2009. *Astrobiology* 9:745-758. [3] Rummel J.D. and Kminek G. 2018. *Astrobiology* 18:377-380. [4] Liu Z. et al. 2019. *Trends in Pharmacological Sciences* 40:92-103.

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