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In Space Biomanufacturing: Establishing Scalable Point Source Production Of Critical Compounds To Counter Biological Threats Of The Future

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Point source biomanufacturing has the potential to counter biological threats in remote, extreme environment locations where supply chain logistics are limited. Space is the most extreme, remote location, and soon more DoD personnel will be entering this environment. Establishing reliable, on-demand production of critical compounds can solve future biological threats, whether that threat is from emerging pathogens, or countering environmental stressors. Rhodium Scientific has established a dedicated Biomanufacturing Program that has supported four ISS missions in the last two years. Rhodium's Program enables technologies in biomanufacturing that aid in the development of advanced chemical products, including production of countermeasures and therapeutics. These enabling technologies greatly reduce the need for stowage, cost of shipping, and risks of supply chain disruptions. For the future space warfighter, robust biomanufacturing platforms involving cellular activity in extreme environments must be assessed, ruggedized, and field-tested before scalable on-orbit manufacturing can be established.

Rhodium's Biomanufacturing Program is testing biological stressors placed upon biomanufacturing systems during transit to space, in flight operations, and return to Earth. These stressors include increased radiation and changes in gravitational forces as well as cold chain logistics and biological preservation. Rhodium Inflight Biomanufacturing (DTRA-supported) tested the capacity of three engineered microbial strains to produce five small molecules of interest to the DoD. Products are representative of operationally important molecules for in-field production within resource-limited environments on Earth and for space exploration. Rhodium Probiotic Challenge examined the potential for production of dairy-based products in space using known microbial cultures. Rhodium Synthetic Cryptobiology (DTRA-supported) and Rhodium Crystal Preservation tested different transport logistic solutions for delivery and preservation of biological material in supply chain limited environments. These two missions will reduce the need for cold stowage assets, a typically limited resource on both short and long duration space flights. Collectively, Rhodium's efforts are making great strides to establish proven processes for the expanding biomanufacturing markets.

The overall objective of this program is to establish reproducible and reliable biomanufacturing platform suitable for enabling a scalable production of targeted chemical products in space and improve production on Earth. Rhodium's central hypothesis is that genetic and transcriptomic data obtained from space-hardened biological systems can be used to identify and prioritize biological components which enhance biomanufacturing processes and reproducibly manufacture small molecules in resource-limited environments. Favorable genetic and epigenetic enhancements obtained from these missions can be further utilized to increase biomanufacturing efficiencies for products of DoD interest. While microgravity-induced mutations in the genome and alterations in gene expression have been observed, standardized methodologies to obtain such information have not been applied to ensure reproducibility and scalability of these mission critical biological processes within a biomanufacturing context. Therefore, Rhodium's Quality, Industry Compatible (QuIC) Space Process™ was utilized, providing the required quality assurances and process driven logistics to ensure the reproducibility and reliability required for space-based biomanufacturing.

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