Fiscal Year:	FY 2020	**Task Last Updated:**	FY 07/23/2020
PI Name:	Howell, David Ph.D.		
Project Title:	Immobilization and Stabilization of Biocatalysts for Efficient Pharmaceutical Manufacturing		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:	TRISH--TRISH		
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	None		
Human Research Program Risks:	None		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Zip Code:	77845	**Congressional District:**	17
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	2020 TRISH BRASH1901: Translational Research Institute for Space Health (TRISH) Biomedical Research Advances for Space Health
Start Date:	04/01/2020	**End Date:**	03/31/2022
No. of Post Docs:		**No. of PhD Degrees:**	
No. of PhD Candidates:		**No. of Master' Degrees:**	
No. of Master's Candidates:		**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:		**Monitoring Center:**	TRISH
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Bondos, Sarah Ph.D. (Texas A&M University)		
Grant/Contract No.:	NNX16AO69A-T0503		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	The significant resources, facilities, and toxic waste produced from traditional chemical synthesis makes production of medicines during long term space exploration impossible. To increase efficiency and environmental safety, the multi-billion dollar biocatalysis industry leverages enzymes to produce fine chemicals, pharmaceuticals, and other industrially relevant compounds. Enzymes are efficient and highly selective reusable biocatalysts that can significantly accelerate the rate of chemical reactions. Biocatalysis offers higher yields, fewer side reactions, elimination of protection and de-protection steps, purer products, easier recovery and separation, and reduced waste. The drawbacks to using enzymes as biocatalysts are that enzymes are costly to produce, easily degraded or inactivated, and difficult to store. Despite the great potential of enzymes in pharmaceutical manufacturing, current approaches to solve the enzyme stability problem are insufficient. Bondwell Technologies has developed a low-cost platform approach to immobilize and stabilize a wide array of enzymes without a time-consuming optimization process. Our biomaterial platform can uniquely incorporate active large, complex proteins via protein fusion, eliminating the need for crosslinkers. Biocatalysis requires both an enzyme, and a mechanism to physically separate the enzyme from product, usually a solid support. In our approach, both of these factors are produced in a single molecule. This rapid, single-pot, single-component approach dramatically reduces the cost of materials synthesis while simultaneously increasing the process' reliability and scalability. This same process can be used for a wide variety of enzymes, eliminating the time-consuming and difficult optimization process required by all other stabilization / immobilization techniques. For systems that chemically cross-link a protein to a surface, one concern is that the protein could leach from the materials if the cross-linked bond is degradable. In contrast, our approach connects enzymes to materials through a stable peptide bond without damaging the enzyme. Additionally, many proteins lose activity when stored dry or at room temperature; however, Bondwell materials can be stored dry at room temperature for nearly 10 years and remain active. Proteins fused to our materials are a million-fold more active than the same protein trapped in hydrogel, and have 1,000-times the binding capacity of protein cross linked to resin beads. We have successfully demonstrated that enzymes remain active when fused to our materials. In this proposal we will demonstrate the unique ability of this technology to manufacturing drugs under storage/use conditions suitable for deep space exploration missions. The proposed plan will produce materials with the ability to produce amoxicillin, cephalosporin, and melatonin. In addition, we will test enzyme efficacy in our system and performance after storage. Our long-term goal is to combine the efficiency, specificity, and broad applicability of biocatalysis with telescoping in a sealed reactor flow chemistry system. Most natural therapies can be catalyzed by enzymes, and enzymologists are using directed evolution and artificial intelligence to rapidly create enzymes that catalyze novel reactions. We envision using each enzyme-material fusion to create a mesh of fibers shaped like a disc ~1 cm diameter. The drug is manufactured by placing the correct discs (enzymes) with reagents in the telescoping system and allowing the reaction to occur. Each disk can be rinsed, dried, and re-used as needed to manufacture one or more drugs. This unique system has the potential to produce chemicals, manufacture drugs, prepare food, or even generate biofuels from a small number of precursors.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	
Task Progress:	New project for FY2020.
Bibliography Type:	Description: (Last Updated:)