Exhibit R-2, RDT&E Budget Item Justification: PB 2023 Defense Advanced Research Projects Agency	Date: April 2022
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*

COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
Total Program Element	-	238.215	308.024	352.976	-	352.976	339.904	342.618	341.522	357.240	-	-
MBT-01: *MATERIALS PROCESSING TECHNOLOGY*	-	94.338	133.326	157.652	-	157.652	165.957	166.999	177.075	176.175	-	-
MBT-02: *BIOLOGICALLY BASED MATERIALS AND DEVICES*	-	143.877	174.698	195.324	-	195.324	173.947	175.619	164.447	181.065	-	-

A. Mission Description and Budget Item Justification

The Materials and Biological Technology Program Element is budgeted in the Applied Research Budget Activity because its objective is to develop materials and biological technologies that make possible a wide range of new military capabilities. This Program Element also supports innovation and robust transition planning in the technology cycle by working with entrepreneurs to increase the likelihood that DARPA funded technologies take root in the U.S. and provide new capabilities for national defense.

The major goal of the Materials Processing Technology project is to develop novel materials, fabrication and processing techniques, models, devices and components that will lower the cost, increase the performance, and/or enable new missions for military platforms and systems. Included in this project are efforts across a wide range of technology areas including manufacturing, electronics, sensors, optics, and complex and autonomous systems.

The Biologically Based Materials and Devices project will leverage the growing application space of the biological sciences for the development of new DoD capabilities in materials development, threat detection, and warfighter performance. Contained in this project are thrusts that apply biology's unique synthesis capabilities to source DoD-relevant materials and overcome current limitations in accessing, scaling, and distributing critical microbes and resources to achieve overmatch. Programs in this project enable in situ and stand-off detection and mitigation of biological, chemical, traditional, and emerging threats against the warfighter, the food supply, DoD infrastructure, and other targets. This Project also includes efforts to develop novel biological technologies for maintaining the performance of warfighters and warfighting platforms in increasingly challenging environments. This Project supports innovation and robust transition planning in the technology cycle by working with entrepreneurs to increase the likelihood that DARPA-funded technologies take root in the U.S. and provide new capabilities for national defense.

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B. Program Change Summary ($ in Millions)	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total
Previous President's Budget	245.107	317.024	0.000	-	0.000
Current President's Budget	238.215	308.024	352.976	-	352.976
Total Adjustments	-6.892	-9.000	352.976	-	352.976
• Congressional General Reductions	0.000	-9.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	0.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	1.000	0.000			
• SBIR/STTR Transfer	-7.892	0.000			
• Adjustments to Budget Year	-	-	352.976	-	352.976

Change Summary Explanation

FY 2021: Decrease reflects SBIR/STTR transfer offset by reprogrammings.

FY 2022: Decrease reflects a reduction for Unjustified Increase.

FY 2023: FY 2023 funding increase reflects the fact that the FY 2022 President's Budget request did not include out-year funding.

Exhibit R-2A, RDT&E Project Justification: PB 2023 Defense Advanced Research Projects Agency			Date: April 2022
Appropriation/Budget Activity 0400 / 2	R-1 Program Element (Number/Name) PE 0602715E / *MATERIALS AND BIOLOGICAL TECHNOLOGY*	Project (Number/Name) MBT-01 / *MATERIALS PROCESSING TECHNOLOGY*	

COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
MBT-01: *MATERIALS PROCESSING TECHNOLOGY*	-	94.338	133.326	157.652	-	157.652	165.957	166.999	177.075	176.175	-	-

A. Mission Description and Budget Item Justification

The major goal of the Materials Processing Technology project is to develop novel materials, fabrication and processing techniques, models, devices and components that will lower the cost, increase the performance, and/or enable new missions for military platforms and systems. Included in this project are efforts across a wide range of technology areas including manufacturing, electronics, sensors, optics, and complex and autonomous systems.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Materials for Extreme Environments	36.140	55.094	57.144

Description: The Materials for Extreme Environments thrust is exploring new materials, innovative architectures, and development processes that will significantly enhance the performance and persistence of DoD platforms operating in extremely harsh environments. Materials with superior strength, functionality, and resiliency are critical for enabling DoD platforms, weapons and other components to operate and persist under conditions including, but not limited to, extremely high or low temperatures, turbulence, ionizing radiation, and/or corrosive environments. Recent developments in materials such as high entropy alloys and infiltrated carbon fiber composites hold promise for achieving material solutions for improved survivability in a wide range of harsh environment conditions. Similarly, advancements in material design, processing and manufacturing are enabling novel material architectures that can further enhance performance and resilience in structures such as leading edges, windows and apertures, propulsion systems, and space structures. Exemplar areas of research within the Materials for Extreme Environments thrust include the following: 1) high temperature materials for hypersonic platforms; 2) high temperature window and aperture materials; 3) radiation and/or electromagnetic pulse (EMP) hardened electronics for space platforms; and 4) coatings for platform survivability in corrosive environments.

FY 2022 Plans:

- Validate component level models for scaled cooled leading edge structures under high aerothermal conditions.
- Manufacture scaled architected leading edge structures with integrated cooling and demonstrate under flight relevant transient and sustained aerothermal conditions; high gravity maneuvers; and mechanical loading.
- Commission novel laboratory-scale electron transpiration cooling measurement tool.
- Develop new test capabilities for testing infrared and radio frequency performance under high temperature oxidative conditions.
- Model novel sensing capabilities suitable for hypersonic platforms under high temperature conditions.
- Identify new designs and stabilization techniques for ultra-low mass density structures suitable for on-orbit applications such as solar arrays, antennas and optical surfaces.
- Identify new on-orbit capabilities and missions enabled by larger stable structures.

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
- Perform laboratory demonstration of critical materials manufacturing steps to enable ultra-low mass density structures. - Develop system-level models that couple vehicle geometry, materials response and vehicle trajectory to project performance enhancements. ***FY 2023 Plans:*** - Conduct integration studies for scaled cooled leading edge components to facilitate technology transition. - Validate manufacturing models for scaled architected leading edge structures with integrated cooling suitable for high heat flux conditions. - Demonstrate enhanced heat flux performance from increased scale leading edge components under oxidative conditions. - Demonstrate initial proof of concept of novel sensing capabilities suitable for hypersonic platforms under high temperature conditions with selected materials. - Develop and validate manufacturing models for scaled infrared and radio frequency materials suitable for high heat flux oxidative conditions to support transition. - Develop and validate new test capabilities for testing infrared and radio frequency performance under high temperature oxidative conditions. - Develop system-level models that project improved seeking capability. - Develop and populate government use software repository and materials database to exercise system-level models to predict system performance. - Determine achievable properties of materials manufactured using processing methods applicable to lunar surface processes. - Validate material build rate for manufacturing processes based on lunar sourced materials. - Demonstrate exemplar components for solar array structures using lunar surface derived materials. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 increase is due to minor program repricing.			
Title: Functional Materials and Devices ***Description:*** The Functional Materials and Devices thrust is developing advanced materials, components and systems to improve device performance for DoD sensing, imaging and communication applications. One focus of this thrust involves development of advanced transductional materials that convert one form of energy to another for DoD-relevant applications in areas such as thermoelectrics. While promising transduction materials are known for a variety of applications, integration into devices has not been realized. Another focus area is the development of physics-based models that predict material behavior when illuminated by high peak power electromagnetic interference. A third focus area involves development of new multi-functional materials and device designs that will radically decrease the size, weight and power requirements of electron, neutron, and gamma sources for high-resolution neutron, gamma and x-ray imaging. Such devices should enable fieldable detection units for non-destructive evaluation of parts, detection of explosives and other DoD-relevant targets.	20.500	44.204	66.415

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
FY 2022 Plans: - Complete initial prototype for compact gamma ray sources that feature high intensity, tunability, and narrow bandwidth. - Conduct initial demonstrations of prototypes for compact gamma ray sources that are capable of meeting base phase performance goals for intensity and bandwidth. - Design novel techniques to extract three-dimensional information from infrared data. - Perform spectral analysis of passive thermal emissions to mathematically determine object structures. - Perform co-optimization of planar optics and materials for transduction to identify paths towards low torque night vision systems with a wide field-of-view. - Initiate research studies exploring passive and active obscurant particulates that provide asymmetric visibility. - Complete the defining of system requirements for a compact ruggedized linear accelerator.			
FY 2023 Plans: - Use optimized designs of planar optics and planar image intensifiers to develop a prototype device. - Complete testing of compact, ruggedized, electron accelerator components and validate performance consistent with overall system goals. - Finalize system design for a compact and ruggedized electron accelerator system based on demonstrated components. - Finalize components and begin system integration of a compact, high-intensity, narrow-bandwidth, and tunable gamma ray source prototype. - Finalize system demonstration that illustrates the unique capabilities of a compact, high-intensity, narrow-bandwidth, and tunable gamma ray source. - Define system requirements for compact and directional particle sources. - Create adaptive algorithms to predict parameters of sensors for high-speed driving. - Demonstrate stationary three-dimensional vision and mobile three-dimensional vision techniques for driving at speeds up to 25 mph. - Design architecture for beyond state of the art non-volatile memory density, speed, and efficiency using topological magnetic bits. - Establish concept of operations for compute in memory using topological magnetic bits. - Simulate asymmetric capabilities of novel obscurants with optical sensors and demonstrate potential to enable asymmetry on the battlefield. - Develop new methods for on-demand manipulation of obscurants, potentially creating an actively tunable asymmetric advantage.			
FY 2022 to FY 2023 Increase/Decrease Statement:			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
The FY 2023 increase is due to the transition from integrated system design to demonstration.			
Title: Chemical Processing for Force Protection	17.000	17.028	17.093
Description: Research in the Chemical Processing for Force Protection thrust is focused on the development of new chemical approaches and technologies across a broad spectrum of DoD needs. One area involves development of innovative approaches for scalable small molecule synthesis coupled with predictive tools for route design, possibly offering a new strategy to discover how to make new molecules such as pharmaceuticals and explosives. Another focus leverages advances in automation to develop safe, reproducible experimental approaches for systematic development of energetic materials. In addition, investments in this thrust will advance chemical characterization, information management and analysis, and automation. ***FY 2022 Plans:*** - Demonstrate semi-automated, reproducible experimental systems that integrate more than three explosive ingredients at scales over 10 grams per formulation with on-board sensitivity tests. - Extend semi-automated experimental systems to handle materials for propellant development, with automated integration of more than six propellant ingredients at scales over 25 grams per formulation. - Demonstrate accurate and safe determination of explosive and propellant metrics using gram-scale quantities. ***FY 2023 Plans:*** - Initiate plans for integrating the semi-automated energetics formulation platform with onboard advanced metrology to enable small-scale tests. - Assess current energetics performance requirements with respect to formulation platform capabilities to determine initial energetics discovery and system validation targets. - Initiate propellant and explosive demonstrations on an integrated, semi-automated formulation platform. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 increase is due to minor program repricing.			
Title: Reconfigurable Systems	3.000	8.000	17.000
Description: In the Reconfigurable Systems thrust, new approaches are being developed to enable more rapid and robust adaptation of defense systems and systems-of-systems to changing mission requirements and unpredictable environments. This includes development of capabilities across sensing, perception, planning and control for autonomous, high-speed operation in cluttered environments without Global Positioning System (GPS) information. This also includes development of capabilities to manipulate and control adversary sensory perception and/or situational awareness. Additional work in this thrust focuses on how sensing systems and military systems-of-systems are designed for real-time resilient response to dynamic, unexpected signals and contingencies. Research is developing a more unified view of system behavior that allows better understanding and			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
exploitation of complex interactions among components, including development of formal mathematical approaches to complex adaptive system composition and design. These capabilities will impact autonomous systems and systems-of-systems, including those that involve humans, in a variety of DoD-relevant contexts. ***FY 2022 Plans:*** - Initiate development of high-performance portable optical clock with picosecond timing precision. - Initiate design for a transportable optical clock with month-long nanosecond holdover. ***FY 2023 Plans:*** - Identify fundamental limits and associated disruptive breakthrough opportunities for electrically small transmitting and receiving antennas, and their associated non-traditional sub-circuits. - Continue development of high-performance portable optical clock with picosecond timing precision. - Continue development of transportable optical clock with month-long nanosecond holdover. - Begin engineering design of low size, weight, and power portable and transportable clocks. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 increase is due to the transition from initial component demonstration to integrated system demonstration.			
Title: Multi-Scale Modeling ***Description:*** The Multi-Scale Modeling thrust is developing advanced, multi-physics models that can predict the effect of disturbances and/or perturbations in the space environment in order to inform operational decisions based on current space environment conditions. Current space environment models are limited to predicting long term climatic averages or regularly occurring phenomena and do not fully account for coupling effects where perturbations in one region of the space environment may produce disturbances in another region. Approaches for addressing these limitations under the Multi-Scale Modeling thrust include the following: (1) development of observation driven/first-principles theory of magnetosphere-ionosphere-thermosphere coupling; (2) creation of an extensible assimilation framework for unifying space environment monitoring systems and data; and (3) non-traditional space environment measurement approaches. These developments will ensure the accuracy and spatiotemporal resolution of space weather models and is sufficient to enable prediction of operationally relevant perturbations and disturbances in the space environment. ***FY 2022 Plans:*** - Demonstrate and field test an integrated space environment forecasting capability to predict perturbation and disturbances within scale lengths as small as one hundred kilometers, every hour, within a seventy-two-hour window, and over an area representative of an operation area of responsibility. ***FY 2022 to FY 2023 Increase/Decrease Statement:***	13.198	9.000	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
The FY 2023 decrease is due to program completion.			
Title: Accelerating Discovery and Innovation ***Description:*** The Accelerating Discovery and Innovation thrust developed new approaches, tools and technologies to speed the pace of scientific discoveries and technological innovations from idea generation and fundamental research through integration of technologies into fieldable products and systems in production. The path from idea generation to a discovery is a lengthy, complex process involving many unpredictable steps, cycles and stages across fundamental and applied research and development. Research in this thrust focused on developing and implementing strategies to address many of the challenges and bottlenecks inherent along this path and to speed the rate at which an idea can be advanced into a concrete capability. Specific approaches included advanced multiplayer gaming technologies to catalyze development of new technology concepts, development of tools for data collection and visualization to accelerate fundamental and applied research, and strategies to understand how seemingly benign commercially available technologies may be converted or combined into threats to military operations, equipment or personnel.	4.500	-	-
Accomplishments/Planned Programs Subtotals	94.338	133.326	157.652

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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COST ($ in Millions)	Prior Years	FY 2021	FY 2022	FY 2023 Base	FY 2023 OCO	FY 2023 Total	FY 2024	FY 2025	FY 2026	FY 2027	Cost To Complete	Total Cost
MBT-02: *BIOLOGICALLY BASED MATERIALS AND DEVICES*	-	143.877	174.698	195.324	-	195.324	173.947	175.619	164.447	181.065	-	-

A. Mission Description and Budget Item Justification

The Biologically Based Materials and Devices project will leverage the growing application space of the biological sciences for the development of new DoD capabilities in materials development, threat detection, and warfighter performance. Contained in this project are thrusts that apply biology's unique synthesis capabilities to source DoD-relevant materials and overcome current limitations in accessing, scaling, and distributing critical microbes and resources to achieve overmatch. Programs in this project enable in situ and stand-off detection and mitigation of biological, chemical, traditional, and emerging threats against the warfighter, the food supply, DoD infrastructure, and other targets. This Project also includes efforts to develop novel biological technologies for maintaining the performance of warfighters and warfighting platforms in increasingly challenging environments. This Project supports innovation and robust transition planning in the technology cycle by working with entrepreneurs to increase the likelihood that DARPA-funded technologies take root in the U.S. and provide new capabilities for national defense.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Title: Persistent Terrestrial Living Sensors	15.195	17.172	15.140
Description: The Persistent Terrestrial Living Sensors program is developing engineered biological sensor platforms capable of detecting land-based threats (e.g., chemicals, radiation, explosives, biologics) and relaying unique signals to existing DoD ground, air, and space assets. Unlike conventional methods that monitor threats and are limited by sensor energy needs, these biological sensors are effectively energy independent, increasing the potential for wide distribution and environmental robustness. Resulting platforms will enable a variety of remote, persistent monitoring and reporting capabilities to address threat scenarios relevant for national security, including passively detecting neurotoxic chemicals and biological pathogens in outdoor environments. These sensors will provide a flexible suite to complement conventional sensor systems within the DoD. ***FY 2022 Plans:*** - Confirm plant sensor reporting phenotypes are detectable from stand-off post stimulus exposure. - Perform phenotyping of plant sensors under defined, simulated biosecurity threat scenario. - Quantify plant sensor functionality by applying trace stimuli and evaluating response for high sensor sensitivity and specificity. - Evaluate altered plant physiological properties based on understanding of molecular mechanisms. - Demonstrate protein production and analyze system for potential unexpected effects. ***FY 2023 Plans:*** - Optimize plant sensor to function consistently in enclosed environment simulating ecological stress conditions. - Perform technical integration of different molecular mechanisms of protein production in mature plants for optimized phenotype.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
- Mitigate undesired effects based on system analysis and redesign for preferred protein production outcomes. - Investigate approaches to apply plant-based genetic technologies to impart environmental resilience to unstable ecological systems. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 decrease reflects completion of proof of concept testing and shift toward optimization activities to produce a final integrated plant sensor.			
Title: Preemptive Expression of Protective Alleles and Response Elements (PREPARE)	16.261	14.585	9.241
Description: The Preemptive Expression of Protective Alleles and Response Elements (PREPARE) program is creating a transient, near immediate prophylaxis and treatment to protect military personnel and civilians against public health and national security threats. Currently, protection against Chemical, Biological, Radiological, and Nuclear (CBRN) threats relies on physical barrier technology. This program includes research to develop novel transient and reversible gene modulator therapies to bolster intrinsic host defenses. Work within this program will provide novel solutions that extend beyond the DoD's capabilities to respond to re-emerging, newly emerging, or engineered threats. ***FY 2022 Plans:*** - Refine formulations to deliver programmable gene modulators to appropriate cells and tissues with high specificity and for threat-relevant periods of time. - Refine specificity to targets, duration, and magnitude of programmable gene modulator activity in vivo. - Perform capability demonstration of programmable gene modulator platform to assess protection against a chemical, biological, or radiological threat in large animal models. - Begin collecting data for a pre-Investigational New Drug (IND) package for submission to the FDA. ***FY 2023 Plans:*** - Finalize formulations to deliver programmable gene modulators to appropriate cells and tissues with high specificity for relevant threat exposure durations. - Finalize gene targets, duration, and magnitude of programmable gene modulator activity in vivo. - Perform capability demonstration of programmable gene modulator platform to assess protection against a biological or radiological threats in second large animal model. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 decrease reflects completion of large-scale screening studies and an increased focus on specific pre-clinical studies.			
Title: Persistent Aquatic Living Sensors	25.082	26.541	20.004

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
Description: The Persistent Aquatic Living Sensors program is developing novel capabilities to sense and surveil submersibles (e.g., submarines, unmanned underwater vehicles) and divers in littoral waters using living organisms present in the environment. This effort focuses on characterizing marine biological behavior in response to targets of interest and developing the hardware, software, and algorithms that will translate organism behavior into DoD actionable information. By harnessing the unique capabilities of biology, including adaptation, response, and replication, work in this program will enable persistent dominance in contested waters. Results from this research will enhance security for maritime activities and provide DoD naval operations with new sensing paradigms to complement current sensor technologies used in traditionally challenging regions across the world. ***FY 2022 Plans:*** - Demonstrate improvements in approaches to evoke and characterize biological responses in marine organisms. - Test the accuracy of biological systems at various distances in multiple environments. - Refine system improvements and validate performance in the presence of noise and surface vessel traffic. - Demonstrate the ability of second-generation prototype to detect, process, characterize and alert the presence of manned or unmanned underwater vehicles in near shore or open water environments. ***FY 2023 Plans:*** - Demonstrate ability of underwater systems to achieve objectives in surrogate operational environment against real-world targets. - Complete transition of approaches to evoke and characterize biological responses in marine organisms under real-world conditions. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 decrease reflects initial completion of initial technology development efforts to conduct final demonstration activities.			
Title: Expanding Human Resiliency	12.862	17.773	16.890
Description: The Expanding Human Resiliency program aims to maximize warfighter resiliency by leveraging the signals of the human microbiome to improve physiology. This program will develop new technologies to control and manipulate the microbiome (e.g., to reduce attraction and feeding of disease vectors such as mosquitoes). Current state-of-the-art approaches are focused on metagenomics to inventory and categorize the microbes in a given sample. In order to have more precise and on-demand control of microbiomes, technologies will be developed to elucidate the complex interactions between the microorganisms and their host as well as the interactions between consortia of adapted and evolved microorganisms. Advances in this area will both develop novel technologies to interrogate complex microbial communities in human systems and discover ways to beneficially harness microbiomes to expand warfighter resiliency. ***FY 2022 Plans:***			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
- Test integration and stability of altered microbial strains in animal models. - Investigate methods to deliver interventions to skin to alter chemical production by the microbiome. - Down select and refine targets for chemical production by microbiomes. - Validate alterations to chemical production to reduce attraction and feeding of mosquitoes or other disease vectors within in vitro model communities. - Refine and validate physical and computational models of microbiomes based on empirical data. ***FY 2023 Plans:*** - Develop human skin microbiome-based formulation that reduces mosquito attraction and feeding, and test it in animal models. - Expand the number of distinct human skin microbiome-based models to enable testing of mosquito attraction and feeding, and utilize these models for animal model testing. - Conduct independent verification and validation (IV&V) testing of performance of human skin microbiome-based formulations using in vivo models. - Test ability of human skin microbiome-based formulations to reduce attraction and feeding by additional genera of insect vectors. - Evaluate that methods used to alter the skin microbiome are safe for human use. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 decrease reflects minor program repricing.			
Title: Restoring Cognitive Capability ***Description:*** The Restoring Cognitive Capability program is developing novel drugs to provide rapid therapy for neuropsychiatric disorders experienced by warfighters and veterans. Active duty military personnel face increased risk of acute and chronic neuropsychiatric dysfunction, limiting day-to-day function and return to duty. Current therapeutic approaches for many neuropsychiatric disorders (e.g., Post Traumatic Stress Disorder [PTSD], mood disorders, and substance abuse) rely on individual management with integrated psychiatric therapy and medication. However, most interventions approved for use in these conditions lack long-term efficacy, involve a logistical burden of treatment and/or carry a risk of serious adverse side effects. Novel drugs developed under this program will be designed to functionally interact with neuronal receptor subtypes known to play a role in these neuropsychiatric conditions, with the aim of enabling fast-acting and effective alleviation of neuropsychiatric dysfunction with single or minimal doses. Additional studies in this area seek to develop a mechanistic understanding of brain injury (UBI) resulting from blast, ultrasound, electromagnetic waves, or other directed-energy sources. ***FY 2022 Plans:*** - Evaluate in vitro signaling effects of novel drug-like molecules. - Develop and validate biosensors for assessment of drug uptake and distribution in vivo.	11.178	11.423	10.860

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
- Test novel molecules for therapeutic actions and side effects in vivo. - Document the initial biological events that take place after brain injury. ***FY 2023 Plans:*** - Evaluate novel drugs that exhibit specific signaling effects in vitro compared to existing drugs. - Use atomic-level structures and simulations of novel drugs bound to receptors, in combination with specific signaling effects, to optimize novel drug-like molecules for therapeutic effects. - Demonstrate therapeutic action of novel drugs with reduced side effects in vivo compared to existing therapeutic drugs. - Expand molecule library for novel drug discovery. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 decrease reflects minor program repricing.			
Title: Food and Feedstocks on Demand ***Description:*** The Food and Feedstocks on Demand program is developing biological technologies to support the DoD need to strengthen local resource security for the warfighter. Currently, operators in the field are burdened with transport and disposal of single-use materials. This program is using these burdensome materials as inputs and re-form the molecules for nutrition or other strategic applications. Research in this program will provide a versatile system that delivers food, water, and petroleum/oils/lubricants (POLs) so that warfighters can independently produce material support to extend mission duration and/or expand operational flexibility in resource-limited environments. ***FY 2022 Plans:*** - Breakdown plastic waste material into a biodegradable, detoxified environmentally compatible formulation. - Scale purification techniques to obtain desired products free from contaminants. - Optimize the process for product generation from increasingly complex plastic waste mixtures. - Demonstrate the capability to convert waste into usable materials in 24 hours. ***FY 2023 Plans:*** - Demonstrate breakdown techniques with realistic military waste mixtures and conditions relevant to a military operational scenario. - Deconstruct the majority of starting waste material into a biodegradable and nontoxic form. - Evaluate purification and extraction techniques conducive to novel breakdown and conversion processes for technical integration of the system. - Demonstrate scale up by converting a sufficient quantity of waste to a valuable product. ***FY 2022 to FY 2023 Increase/Decrease Statement:***	12.415	17.642	17.895

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
The FY 2023 increase reflects minor program repricing.			
Title: Gene Editor Enabled Diagnostics & Biosurveillance	13.550	18.923	18.931
Description: The Gene Editor Enabled Diagnostics & Biosurveillance program is developing fieldable, low-cost, programmable and reconfigurable diagnostic capabilities for rapid, specific, sensitive, and multiplexed detection of biological threats in military and public health scenarios. This program will investigate the design rules for diagnostic and biosurveillance targets to achieve broad-spectrum detection with high confidence diagnostic results. These design rules will inform advanced computational and machine learning approaches to scan genome data and algorithmically design probes and guides for optimal assay results. Additional work will develop assay architectures, reagents, and detection platforms to enable field-forward diagnostics at the point-of-care with the same sensitivity, and reliability tests conducted in hospital/central laboratories. ***FY 2022 Plans:*** - Establish computational tools to create diagnostic assays for a target biological signature. - Demonstrate assay utility for detection of targets in relevant clinical or environmental samples. - Develop prototype handheld devices for point-of-care and demonstrate detection of targets. - Develop prototype benchtop modules for highly multiplexed diagnostic assays and demonstrate detection of targets. ***FY 2023 Plans:*** - Refine computational tools to create novel diagnostic assays for a target biological signature. - Validate assay for detection of targets in relevant clinical or environmental samples. - Refine prototype handheld devices for point-of-care and detection of multiple targets simultaneously. - Integrate prototype benchtop modules into a functional prototype device for multiplexed diagnostic assays and demonstrate detection performance of targets. - Begin to determine disease severity through integration of host biomarker detection. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 increase reflects minor program repricing.			
Title: Unburdening the Warfighter from Chemical/Biological (CB) Defense	9.040	17.198	18.058
Description: The Unburdening the Warfighter from Chemical/Biological (CB) Defense program aims to increase warfighter survivability by developing improved personal protective equipment (PPE) and medical countermeasure (MCM) technologies to protect against CB threats. Current methods of CB protection require significant logistical burdens, including suits that are bulky and hot, which limit operational effectiveness. These burdens increase if an increased level of protection is required. The Unburdening the Warfighter from CB Defense program will investigate and design novel biological and material approaches that provide rapid protection against multiple CB agents for the warfighter. This research will innovate PPE through the discovery of			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
compounds and lightweight, durable systems designed to capture, neutralize, or repel CB agents. This novel approach will provide almost immediate and lasting protection even in austere operational settings. ***FY 2022 Plans:*** - Develop formulations and delivery methods required to provide the warfighter with biological systems capable of mitigating threats. - Begin testing the ability of the system components to protect against exposure to CB threats using special coatings, enzymes and biological approaches. - Validate system component safety in a simulated environment. ***FY 2023 Plans:*** - Test the ability of system components to protect from CB exposure by using clinically relevant experimental models. - Test the ability to rapidly reconfigure platform technologies in response to a novel threat, and protect clinically relevant models exposed to the novel CB threat using they system component of special coatings, enzymes and biological approaches. - Initiate demonstrations of material system components for weather and wear resistance and near-zero thermal burden. - Continue safety studies to ensure host compatibility for technologies, formulations, and delivery methods commensurate with FDA requirements. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 increase reflects minor program repricing.			
Title: Atmospheric Water Extraction (AWE)	9.500	13.887	13.952
Description: The Atmospheric Water Extraction (AWE) program aims to enable water harvesting directly from the atmosphere by leveraging new materials and advanced engineering and manufacturing techniques to alleviate the logistical and tactical burden of the water supply chain. Currently, the DoD relies on purification of existing water sources and/or distribution of bottled or treated water to provide the warfighter with sufficient daily hydration. State-of-the-art water-from-air generation systems are not suitable for military applications because the systems do not operate in a range of atmospheric conditions needed by our soldiers, from arid conditions (<40% relative humidity) to extremely humid, and are too energy-intensive (<7 gallons of water output per gallon of fuel). This program will deliver systems with extraordinarily low size, weight, and power (SWaP) characteristics to provide potable water to individual warfighters, and expeditionary units. Technologies developed under this program will provide strategic and tactical advantages aligned with the DoD's vision of future combat operations carried out by distributed and self-sustaining forces. ***FY 2022 Plans:*** - Optimize and refine water capture and release with developed sorbent materials. - Integrate sorbent materials with components of modeled water extraction device.			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
- Test and evaluate fabricated components of modeled water extraction device. - Demonstrate initial prototype water extraction device under program test conditions. ***FY 2023 Plans:*** - Optimize sorbent material integration with water extraction device components. - Optimize and refine sorbent material candidates for final water extraction device prototype. - Begin production of final sorbent materials at scale. - Begin optimization of components and integrated system for final water extraction device prototype. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 increase reflects minor program repricing.			
Title: Bio-Inspired Coastal Defense	-	10.990	12.002
Description: Building upon technologies discovered in the Persistent Aquatic Living Sensors (PALS) program, the Bio-Inspired Coastal Defense program will develop self-sustaining, hybrid man-made and biological reef structures to fortify and defend DoD bases in low-lying coastal regions. Military assets in these coastal regions are vulnerable to storm surges, wave action, and sea-level rise that cause erosion, degrade infrastructure, and impede operations. Innovative coastal defense will require major technological advances in (1) design, construction, and placement of manufactured reef primers, (2) accelerated recruitment and/or growth of reef species, and (3) sustained, zero-cost natural maintenance and improvement (e.g., increased durability after challenge) of the defensive reef. The primary benefit of such structures is to attenuate wave height during storm events for both established and under construction coastal facilities. ***FY 2022 Plans:*** - Model and design scaled structural components to achieve target wave energy attenuation in wave tank simulations. - Initiate tests to determine the efficacy of reef-building approaches under laboratory conditions. - Begin experiments to promote improved temperature tolerance for reef-building organisms. - Investigate novel approaches to combat DoD infrastructure degradation. ***FY 2023 Plans:*** - Characterize ecosystem organisms for reef-building systems in laboratory conditions. - Fabricate structures and perform wave tank and flume testing to retire reef platform structural development risk. - Perform temperature tolerance, growth and disease resistance tests in the laboratory. - Initiate field tests. ***FY 2022 to FY 2023 Increase/Decrease Statement:***			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
The FY 2023 increase reflects minor program repricing.			
Title: Environmental Microbes as a Bioengineering Resource (EMBER) ***Description:*** The Environmental Microbes as a Bioengineering Resource (EMBER) program aims to develop novel, bio-based technologies to overcome key challenges facing domestic supply of Rare Earth Elements (REEs) critical to the U.S. and Department of Defense (DoD). This program will leverage the diversity, specificity, and customizability of environmental microbiology to enable new domestic biomining methods for the separation, purification, and conversion of REEs into manufacturing-ready forms. Advances in this area will deliver capabilities to assure access to DoD-critical materials domestically or in operational settings. ***FY 2022 Plans:*** - Identify novel organisms, gene pathways, and microbial chemistries required for separation and purification of REEs. - Begin development of synthetic biology tools to engineer organisms (or biomolecules), or adapt current chassis, to extract REEs. - Initiate studies of microbes that operate in high temperature, acidic, and alkaline conditions. - Initiate studies on the microbial extraction of specific REEs from simulated source materials at relevant concentrations. ***FY 2023 Plans:*** - Develop and test genetically engineered microbes that can tolerate above-normal levels of REE concentrations, acidic or basic conditions and/or temperatures. - Develop and test biological components capable of specifically binding individual REEs from simulated REE source materials. - Demonstrate the ability to biologically alter the chemical form of one of more individual REEs into a form suitable for manufacturing. - Develop an assay to detect REEs associated with cells or biomolecules with high sensitivity. - Compile data for a conceptual techno-economic analysis that illustrates the potential benefits of using the proposed biomining approach. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 increase reflects minor program repricing.	-	8.564	9.200
Title: Materiel Protection through Biologics ***Description:*** Military infrastructure and systems are expected to function years beyond their original intended lifetime but are subject to degradation by environmental factors. For instance, the formation of biofilms is ubiquitous, corroding and biofouling many military systems, such as aircraft, fuel tanks, ships, medical devices, and filtration systems for water and air. These microbial communities routinely endanger warfighter health and strip years of service from critical defense assets, ultimately costing the	-	-	12.188

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
DoD billions of dollars annually. Building upon technologies investigated under the Bio-Inspired Coastal Defense program, the Materiel Protection through Biologics thrust will develop biological approaches to sustain military infrastructure and systems by developing or repurposing dynamic microbial-based biofilm communities to exhibit beneficial functions such as reducing drag or corrosion. These microbial-based interventions will protect and sustain equipment and infrastructure to reduce cost and increase the service lifetime. ***FY 2023 Plans:*** - Initiate model development to predict biofilm assembly in static conditions. - Generate testbeds that replicate specific disturbances experienced by materiel in the field and track biofilm growth. - Initiate development of a design-build-test cycle that tracks microbial community development nondestructively. - Investigate biomolecular approaches to sense and repair deficits in reinforced concrete. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 increase reflects program initiation.			
Title: Bioremediation of Battlefields	-	-	9.150
Description: The Bioremediation of Battlefields effort will address the DoD need to stabilize and remediate sites impacted by prior military activities, including contaminated combat zones, defense installations, and test ranges. This will ensure the safety of service members and local communities, and minimize the environmental impact of warfare by developing biological tools that remediate soil and groundwater contamination. This program will eliminate contaminants, and thus restore habitability, by identifying and optimizing organisms, such as microbes, fungi, and plants, that can detect toxic compounds, mitigate their impact, and report on the state of remediation. To accomplish these goals, research will be accelerated by leveraging the complex processes of biological organisms and communities. Bioremediation of Battlefields will reduce the long-term impacts of military activities and improve the overall environmental health and land use potential for contaminated sites. ***FY 2023 Plans:*** - Begin collection and characterization of microbial communities in contaminated environmental samples. - Begin high-speed screening of contaminated environmental samples for organisms that can extract, sequester, or degrade contaminants resulting from military activities. - Initiate model development to understand the spatiotemporal trajectory of a biological community or consortia in the presence of contaminants. - Begin analysis of mechanisms that enable biological indications of contaminant presence or organism activity. ***FY 2022 to FY 2023 Increase/Decrease Statement:***			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
The FY 2023 increase reflects program initiation.			
Title: Biotechnology for Challenging Environments ***Description:*** The Biotechnology for Challenging Environments program will develop novel biological solutions to enable warfighter operations in remote and extreme environmental conditions. As the DoD expands operations into previously inaccessible domains, new and unique logistical constraints imposed by extreme conditions and resource scarcity threaten force readiness. This program will develop technologies to enable new capabilities that harness microbes, biopolymers, and/or other bioprocesses to protect warfighters and maintain performance of warfighting platforms, such as electronics and infrastructure, from challenging environments. Technology advances developed in this effort will enable extended mission duration, resilient warfighting platforms, and enhanced operational capabilities for emerging domains. ***FY 2023 Plans:*** - Initiate identification and characterization of novel extremophiles and bio-inspired materials that correspond to adaptations to extreme environments. - Initiate design and engineer of microbes and other biological or bio-inspired components to produce novel materials for capabilities in extreme environments. - Initiate performance characterization of biological strains for specific endogenous functions outside of traditional laboratory settings. - Develop approaches for biologically driven low-power/self-powered remote electronics that can assess damage for self-repair in harsh environments. ***FY 2022 to FY 2023 Increase/Decrease Statement:*** The FY 2023 increase reflects program initiation.	-	-	11.813
Title: Genome Protection Technologies ***Description:*** The Genome Protection Technologies program developed a biodefense capability to control, counter, and reverse the effects of accidental or malicious misuse of gene editing technologies. This research investigated new approaches for tunable controls to enable the safe and predictable use of synthetic genes and pathways. Additional work developed measures to prevent or limit unintended genome editing or engineering and developed new tools to recall or reverse engineered changes. Advances within this program ensure that the U.S. remains at the vanguard of this widespread, advancing field that poses potential national security threats due to the large-scale democratization of gene editing technologies.	10.296	-	-
Title: Defend Against Crop System Attack ***Description:*** The Defend Against Crop System Attack program developed a platform technology aimed at increasing the speed of DoD response to state or non-state actor release of biological threats directed at our crop systems. Conventional methods	8.498	-	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2021	FY 2022	FY 2023
to defend against these threats are generally slow and ineffective. This program leveraged recent advances in molecular and synthetic biology to enable rapid delivery of gene therapies to plants for large-scale trait modification, improving resilience against adversary attack or emerging natural threats. Research within this program demonstrated an agnostic, scalable capability for protecting entire crop systems from emerging threats posed to food security by U.S. adversaries.			
Accomplishments/Planned Programs Subtotals	143.877	174.698	195.324

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A