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**Exhibit R-2, RDT&E Budget Item Justification:** PB 2024 Defense Advanced Research Projects Agency **Date:** March 2023

<b>Appropriation/Budget Activity</b> 0400: <i>Research, Development, Test &amp; Evaluation, Defense-Wide / BA 2: Applied Research</i>	<b>R-1 Program Element (Number/Name)</b> PE 0602715E / <i>MATERIALS AND BIOLOGICAL TECHNOLOGY</i>
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COST (\$ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
Total Program Element	-	307.198	337.726	344.986	-	344.986	349.088	364.042	385.125	402.240	-	-
MBT-01: <i>MATERIALS PROCESSING TECHNOLOGY</i>	-	128.783	147.402	150.549	-	150.549	158.820	164.218	170.475	184.612	-	-
MBT-02: <i>BIOLOGICALLY BASED MATERIALS AND DEVICES</i>	-	178.415	190.324	194.437	-	194.437	190.268	199.824	214.650	217.628	-	-

**A. Mission Description and Budget Item Justification**

The efforts described in this Program Element (PE) address the Applied Research associated with the Materials and Biological Technology Program that is focused on developing materials and biological technologies that make possible a wide range of new military capabilities. This PE 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 to improve the sustainability of warfighters, and operational platforms in varied environments. This project will develop solutions for critical resource processing, materials development, threat detection and characterization, environmental remediation, and warfighter resilience to infectious disease and environmental stressors. The materials developed through this project will protect and sustain warfighters and operations in austere 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>B. Program Change Summary (\$ in Millions)</b>	<b>FY 2022</b>	<b>FY 2023</b>	<b>FY 2024 Base</b>	<b>FY 2024 OCO</b>	<b>FY 2024 Total</b>
Previous President's Budget	308.024	352.976	339.904	-	339.904
Current President's Budget	307.198	337.726	344.986	-	344.986
Total Adjustments	-0.826	-15.250	5.082	-	5.082
• Congressional General Reductions	0.000	-15.250			
• 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	9.306	0.000			
• SBIR/STTR Transfer	-10.132	0.000			
• TotalOtherAdjustments	-	-	5.082	-	5.082

**Change Summary Explanation**

FY 2022: Decrease reflects SBIR/STTR transfer offset by reprogrammings.

FY 2023: Decrease reflects a Congressional reduction to Reduce Growth.

FY 2024: Increase reflects initiation of the Turning Upcycled Waste into Novel, Sustainable Materials, Signal Processing and Communication with Biotechnology and Strengthening Resilient Emotions and Nimble Cognition Through Engineering Neuroplasticity (STRENGTHEN) programs.

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<b>Appropriation/Budget Activity</b> 0400 / 2					<b>R-1 Program Element (Number/Name)</b> PE 0602715E / MATERIALS AND BIOLOGICAL TECHNOLOGY				<b>Project (Number/Name)</b> MBT-01 / MATERIALS PROCESSING TECHNOLOGY			
COST (\$ in Millions)	Prior Years	FY 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
MBT-01: MATERIALS PROCESSING TECHNOLOGY	-	128.783	147.402	150.549	-	150.549	158.820	164.218	170.475	184.612	-	-

**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 2022	FY 2023	FY 2024
<b>Title:</b> Materials for Extreme Environments	55.094	56.352	60.509
<p><b>Description:</b> 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, superconducting materials, and infiltrated carbon fiber composites hold promise for achieving material solutions for improved survivability in a wide range of harsh environmental 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, 4) coatings for platform survivability in corrosive environments, 5) active and passive cooling methods for apertures and forward-facing vehicle features, and 6) high magnetic field and superconducting materials for undersea magnetohydrodynamic pumps.</p> <p><b>FY 2023 Plans:</b></p> <ul style="list-style-type: none"> <li>- Further scale manufacturing of thermally managed leading-edge components and validate enhanced trajectory performance through ground testing.</li> <li>- Conduct system-level platform integration studies and risk reduction ground testing to foster technology transition.</li> <li>- Assess candidate ground integration and flight demonstration options and identify viable flight demonstration platforms.</li> <li>- Maximize thermal management capability to enable use of commodity materials.</li> <li>- Conduct ground testing of thermal managed leading-edge technology integrated with vehicle.</li> </ul>			

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<b>Appropriation/Budget Activity</b> 0400 / 2	<b>R-1 Program Element (Number/Name)</b> PE 0602715E / MATERIALS AND BIOLOGICAL TECHNOLOGY	<b>Project (Number/Name)</b> MBT-01 / MATERIALS PROCESSING TECHNOLOGY		
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2022</b>	<b>FY 2023</b>	<b>FY 2024</b>
<ul style="list-style-type: none"> <li>- Demonstrate initial proof of concept of novel sensing capabilities suitable for hypersonic platforms under high temperature conditions with selected materials.</li> <li>- Develop and validate manufacturing models for scaled infrared and radio frequency materials suitable for high heat flux oxidative conditions to support transition.</li> <li>- Conduct tests with newly developed testing capabilities for determining infrared and radio frequency performance under high temperature oxidative conditions.</li> <li>- Develop system-level models that project improved seeking capability.</li> <li>- Develop and populate a government-use software repository and materials database to exercise system-level models to predict system performance.</li> <li>- Determine achievable properties of materials manufactured using processing methods applicable to lunar surface processes.</li> <li>- Validate material build rate for manufacturing processes based on lunar sourced materials.</li> <li>- Demonstrate exemplar components for solar array structures using lunar surface derived materials.</li> <li>- Identify concepts for foundational technologies to enable sustained very low Earth orbit (VLEO) operations.</li> </ul> <p><b>FY 2024 Plans:</b></p> <ul style="list-style-type: none"> <li>- Validate system-level models that couple vehicle geometry, materials response, and vehicle trajectory to performance.</li> <li>- Demonstrate increase precision of the materials and manufacturing system to enable the exemplar application of a &gt;100-meter diameter radio frequency (RF) reflector antenna.</li> <li>- Refine manufacturing and cost models based on fabrication trials of higher precision subcomponents.</li> <li>- Demonstrate ability to meet area built per mass launched metric (10 meters squared per kilogram) in a laboratory setting by testing higher precision subcomponents.</li> <li>- Demonstrate manufacturing models for large scale infrared and radio frequency apertures suitable for high heat flux oxidative conditions to support transition.</li> <li>- Conduct testing of novel infrared and radio frequency apertures suitable for hypersonic platforms under high-temperature conditions to validate performance models.</li> <li>- Prepare bench top demonstration(s) of novel technology for sustained very low Earth orbit (VLEO) operations.</li> <li>- Determine the feasibility of the novel technologies to enable sustained very low Earth orbit (VLEO) operations.</li> <li>- Conduct initial design trades for undersea magnetohydrodynamic pumps.</li> <li>- Produce conceptual point designs for undersea magnetohydrodynamic pump prototypes.</li> <li>- Generate material models based on conceptual point designs for undersea magnetohydrodynamic pump prototypes.</li> </ul> <p><b>FY 2023 to FY 2024 Increase/Decrease Statement:</b> The FY 2024 increase reflects a shift from model development to fabrication and demonstration.</p>				
<b>Title:</b> Functional Materials and Devices		45.204	52.650	52.935

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**B. Accomplishments/Planned Programs (\$ in Millions)**

**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. A fourth focus area is developing new liquid-based, large-aperture imaging systems such as telescopes. Such telescopes would break the unfavorable, exponential scaling between aperture size and cost for normal telescopes, and enable low-cost imaging platforms for ground- and space-based applications.

**FY 2023 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 high intensity (10<sup>10</sup> photons per second) and narrow bandwidth (10%).
- 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.
- 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.
- Design prototype ground- and space-based liquid-mirror telescopes with aperture sized 0.5 meters.

**FY 2024 Plans:**

- 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.
- Extended optimized night vision designs to include visual access to an additional infrared spectral band beyond the near-infrared, i.e., the short-, mid-, or long-wave infrared).

FY 2022	FY 2023	FY 2024

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2022</b>	<b>FY 2023</b>	<b>FY 2024</b>
<ul style="list-style-type: none"> <li>- Develop quantities of novel obscurant particles suitable for cubic meter-scale pilot demonstrations of passive obscurants, and lab-scale demonstrations of active obscurants, and demonstrate asymmetric visibility in both cases.</li> <li>- Develop novel material testing techniques to generate design-relevant properties 10X faster than current approaches, eliminating a major bottleneck in the development of new structural materials.</li> <li>- Explore design frameworks integrating both shape and material as concurrent degrees of freedom to unlock new optimal design balancing performance, cost, and sustainability metrics.</li> <li>- Conduct proof-of-concept manufacturing demonstrations to produce and test multi-material structural components.</li> <li>- Complete preliminary design review and critical design review of large liquid-mirror telescope.</li> <li>- Begin building lab demo of large liquid-mirror telescope, with plans to double aperture sizes.</li> </ul> <p><b>FY 2023 to FY 2024 Increase/Decrease Statement:</b> The FY2024 increase reflects minor program repricing.</p>				
<p><b>Title:</b> Chemical Processing for Force Protection</p> <p><b>Description:</b> 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.</p> <p><b>FY 2023 Plans:</b></p> <ul style="list-style-type: none"> <li>- Demonstrate formulations developed on semi-automated, reproducible experimental systems with more than six propellant ingredients at scales over 25 grams per formulation, with on-board sensitivity tests.</li> <li>- Assess current energetics performance requirements with respect to formulation platform capabilities to determine initial energetics discovery and system validation targets.</li> <li>- Initiate propellant and explosive demonstrations on an integrated, semi-automated formulation platform.</li> <li>- Initiate efforts to develop models of threat mechanisms and evolution associated with adverse genetic effects in food systems.</li> <li>- Evaluate and demonstrate fundamental limits for fractional recovery of critical elements from e-waste.</li> </ul> <p><b>FY 2024 Plans:</b></p> <ul style="list-style-type: none"> <li>- Integrate semi-automated experimental platforms into cleared, U.S. Government facilities and demonstrate system operability through a series of Government-directed demonstrations.</li> <li>- Generate systematized data sets for energetic formulation development.</li> </ul>		12.485	22.400	21.105

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2022</b>	<b>FY 2023</b>	<b>FY 2024</b>
<p>- Initiate efforts to detect and characterize adverse genetic effects by developing initial indicators consistent with an attack in food systems</p> <p><b>FY 2023 to FY 2024 Increase/Decrease Statement:</b> The FY2024 decrease reflects a shift from system development and test to technology transfer and data refinement.</p>				
<p><b>Title:</b> Reconfigurable Systems</p> <p><b>Description:</b> 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 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.</p> <p><b>FY 2023 Plans:</b></p> <ul style="list-style-type: none"> <li>- Continue development of high-performance portable optical clock with picosecond timing precision.</li> <li>- Continue development of transportable optical clock with month-long nanosecond holdover.</li> <li>- Begin engineering design of low size, weight, and power portable and transportable clocks.</li> </ul> <p><b>FY 2024 Plans:</b></p> <ul style="list-style-type: none"> <li>- Initiate integration of critical components into a high-performance, environmentally-robust portable optical clock device with picosecond timing precision.</li> <li>- Initiate integration of critical components into a high-performance, environmentally-robust transportable optical clock with month-long nanosecond holdover.</li> </ul>		7.000	16.000	16.000
<p><b>Title:</b> Multi-Scale Modeling</p> <p><b>Description:</b> The Multi-Scale Modeling thrust developed advanced, multi-physics models to predict the effect of disturbances and/or perturbations in the space environment in order to inform operational decisions based on current space environment conditions. Space environment models were limited to predicting long term climatic averages or regularly occurring phenomena and did 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 included the following: (1)</p>		9.000	-	-

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>	<b>FY 2022</b>	<b>FY 2023</b>	<b>FY 2024</b>
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 helped to ensure the accuracy and spatiotemporal resolution of space weather models and were sufficient to enable prediction of operationally relevant perturbations and disturbances in the space environment.			
<b>Accomplishments/Planned Programs Subtotals</b>	128.783	147.402	150.549

**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 2022	FY 2023	FY 2024 Base	FY 2024 OCO	FY 2024 Total	FY 2025	FY 2026	FY 2027	FY 2028	Cost To Complete	Total Cost
MBT-02: <i>BIOLOGICALLY BASED MATERIALS AND DEVICES</i>	-	178.415	190.324	194.437	-	194.437	190.268	199.824	214.650	217.628	-	-

**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 to improve the sustainability of warfighters, and operational platforms in varied environments. This project will develop solutions for critical resource processing, materials development, threat detection and characterization, environmental remediation, and warfighter resilience to infectious disease and environmental stressors. The materials developed through this project will protect and sustain warfighters and operations in austere 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 2022	FY 2023	FY 2024
<p><b>Title:</b> Persistent Terrestrial Living Sensors</p> <p><b>Description:</b> 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.</p> <p><b>FY 2023 Plans:</b></p> <ul style="list-style-type: none"> <li>- Optimize plant sensor to function consistently in enclosed environment simulating ecological stress conditions.</li> <li>- Perform technical integration of different molecular mechanisms of protein production in mature plants for optimized phenotype.</li> <li>- Optimize desired effects based on system analysis and redesign for preferred protein production outcomes.</li> </ul> <p><b>FY 2024 Plans:</b></p> <ul style="list-style-type: none"> <li>- Quantify plant phenotype changes in relevant environments to determine and optimize functional molecular characteristics.</li> <li>- Integrate technical approaches for plant molecular responses to environmental stimuli and functional protein production.</li> <li>- Investigate the potential for additional plant phenotypes as an outcome of protein production.</li> </ul> <p><b>FY 2023 to FY 2024 Increase/Decrease Statement:</b></p>	17.172	15.140	14.384

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2022</b>	<b>FY 2023</b>	<b>FY 2024</b>
The FY 2024 decrease reflects minor program repricing.				
<p><b>Title:</b> Persistent Aquatic Living Sensors</p> <p><b>Description:</b> 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.</p> <p><b>FY 2023 Plans:</b></p> <ul style="list-style-type: none"> <li>- Expand the toolbox of underwater systems to demonstrate objectives in surrogate operational environments.</li> <li>- Conduct hardware testing and refine the hardware designs based on the end-user's feedback.</li> </ul> <p><b>FY 2024 Plans:</b></p> <ul style="list-style-type: none"> <li>- Complete development of system prototype.</li> <li>- Complete the transition of approaches to evoke and characterize biological responses in marine organisms under real-world conditions.</li> </ul> <p><b>FY 2023 to FY 2024 Increase/Decrease Statement:</b> The FY 2024 decrease reflects shift from technology development to final demonstration activities.</p>		26.541	18.004	6.466
<p><b>Title:</b> Expanding Human Resiliency</p> <p><b>Description:</b> 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, expanding on current state-of-the-art approaches to have more precise and on-demand control of microbiomes. Technologies in this effort 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.</p> <p><b>FY 2023 Plans:</b></p> <ul style="list-style-type: none"> <li>- Develop human skin microbiome-based formulations that reduce mosquito attraction and feeding, and test in animal models.</li> <li>- Initiate independent verification and validation (IV&amp;V) testing to assess performance of human skin microbiome-based formulations using an animal model.</li> </ul>		17.773	14.890	8.074

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2022</b>	<b>FY 2023</b>	<b>FY 2024</b>
<ul style="list-style-type: none"> <li>- Design human skin microbiome-based formulations to reduce attraction and feeding by additional insect vectors (e.g., sandflies).</li> <li>- Develop methods and conduct studies to address safety, and removal or deactivation of applied skin microbiome formulation, to support the regulatory approval process.</li> </ul> <p><b>FY 2024 Plans:</b></p> <ul style="list-style-type: none"> <li>- Demonstrate ability to engineer microbes that modulate volatile chemical production to reduce attraction and feeding of sandflies.</li> <li>- Develop and test engineered microbial community strategies for functional performance (e.g., repelling target organisms) with an animal model.</li> <li>- Initiate process to obtain regulatory approval to assess safety and efficacy of human skin microbiome formulations.</li> <li>- Complete IV&amp;V testing to assess efficacy of engineered skin microbial formulations to reduce landings by mosquitoes using an animal model.</li> </ul> <p><b>FY 2023 to FY 2024 Increase/Decrease Statement:</b> The FY 2024 decrease reflects a reduction of research activities to conduct verification and validation studies of candidate microbiome formulations.</p>				
<p><b>Title:</b> Restoring Cognitive Capability</p> <p><b>Description:</b> 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.</p> <p><b>FY 2023 Plans:</b></p> <ul style="list-style-type: none"> <li>- Evaluate novel drugs that exhibit specific signaling effects in vitro compared to existing drugs.</li> <li>- 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.</li> <li>- Demonstrate therapeutic action of novel drugs with reduced side effects in vivo compared to existing therapeutic drugs.</li> </ul>		11.423	10.860	10.318

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<b>Appropriation/Budget Activity</b> 0400 / 2	<b>R-1 Program Element (Number/Name)</b> PE 0602715E / MATERIALS AND BIOLOGICAL TECHNOLOGY	<b>Project (Number/Name)</b> MBT-02 / BIOLOGICALLY BASED MATERIALS AND DEVICES		
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2022</b>	<b>FY 2023</b>	<b>FY 2024</b>
<p>- Demonstrate engagement of multiple targets by molecules identified through billion-molecule library screening.</p> <p><b>FY 2024 Plans:</b></p> <ul style="list-style-type: none"> <li>- Optimize novel compounds for pharmacokinetic and adsorption, distribution, metabolism, and excretion (ADME) properties and validate with in vivo models.</li> <li>- Perform full dose-response and time-course studies with candidate compounds in vivo.</li> <li>- Confirm mechanism of action in vivo by verifying transcriptional and proteomic biomarkers.</li> <li>- Demonstrate preclinical therapeutic efficacy and lack of adverse effects in vivo.</li> </ul> <p><b>FY 2023 to FY 2024 Increase/Decrease Statement:</b> The FY 2024 decrease reflects minor program repricing.</p>				
<p><b>Title:</b> Food and Feedstocks on Demand</p> <p><b>Description:</b> 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.</p> <p><b>FY 2023 Plans:</b></p> <ul style="list-style-type: none"> <li>- Demonstrate breakdown techniques with realistic military waste mixtures and conditions relevant to a military operational scenario.</li> <li>- Deconstruct the majority of plastic waste material into a biodegradable and nontoxic form.</li> <li>- Evaluate purification and extraction techniques conducive to novel breakdown and conversion processes for technical integration of the system.</li> <li>- Demonstrate scale up by converting a sufficient quantity of waste to a valuable product.</li> </ul> <p><b>FY 2024 Plans:</b></p> <ul style="list-style-type: none"> <li>- Design and engineer deconstruction methods and waste breakdown systems to align with relevant military scenarios and waste types.</li> <li>- Evaluate modular systems for additional military use cases.</li> <li>- Pressure test robustness and system integration between waste deconstruction platforms and bioreactor systems.</li> <li>- Provide preliminary analyses that products are within desired specifications.</li> </ul> <p><b>FY 2023 to FY 2024 Increase/Decrease Statement:</b></p>		17.642	17.395	17.002

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2022</b>	<b>FY 2023</b>	<b>FY 2024</b>
The FY 2024 decrease reflects minor program repricing.				
<p><b>Title:</b> Gene Editor Enabled Diagnostics &amp; Biosurveillance</p> <p><b>Description:</b> The Gene Editor Enabled Diagnostics &amp; Biosurveillance program aims to develop fieldable, low-cost, programmable and reconfigurable diagnostic capabilities for rapid, specific, sensitive, and multiplexed detection and characterization of biological threats in military and public health scenarios. This program will investigate the design rules for high confidence diagnostic biosurveillance as well as develop agnostic pathogen detection and characterization platform technology for overall threat assessment. These design rules will inform advanced computational and machine learning approaches to scan genome data, algorithmically design probes and guides for optimal assay results, and characterize previously unknown organisms or threats. Additional work will develop assay architectures, reagents, and detection platforms to enable field-forward diagnostics and threat assessment characterization either at the point-of-care or in other areas of interest. Technology will have the same sensitivity, and reliability as tests conducted in hospital/central laboratories.</p> <p><b>FY 2023 Plans:</b></p> <ul style="list-style-type: none"> <li>- Refine computational tools to create novel diagnostic assays for a target biological signature.</li> <li>- Validate assay for detection of targets in relevant clinical or environmental samples.</li> <li>- Refine prototype handheld devices for point-of-care and detection of multiple targets simultaneously.</li> <li>- Integrate prototype benchtop modules into a functional prototype device for multiplexed diagnostic assays and demonstrate detection performance of targets.</li> <li>- Begin to determine disease severity through integration of host biomarker detection.</li> </ul> <p><b>FY 2024 Plans:</b></p> <ul style="list-style-type: none"> <li>- Complete assay and component integration into ruggedized field-forward devices.</li> <li>- Evaluate program performance through independent verification and validation (IV&amp;V) studies with government partners.</li> <li>- Assess progress towards manufacturing and distribution goals of devices and disposable components.</li> <li>- Evaluate durability of prototype devices in simulated field conditions.</li> <li>- Initiate technology development to support in-field, agnostic detection, characterization, and threat assessment of potential pathogens.</li> </ul> <p><b>FY 2023 to FY 2024 Increase/Decrease Statement:</b> The FY 2024 decrease reflects a shift from point-of-need assay chemistry development to component integration and testing.</p>		18.003	18.931	12.158
<p><b>Title:</b> Unburdening the Warfighter from Chemical/Biological (CB) Defense</p> <p><b>Description:</b> 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</p>		17.198	17.558	17.157

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2022</b>	<b>FY 2023</b>	<b>FY 2024</b>
<p>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 additional levels of protection are 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 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.</p> <p><b>FY 2023 Plans:</b></p> <ul style="list-style-type: none"> <li>- Test the ability of system components to protect from CB exposure by using clinically relevant experimental models.</li> <li>- 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.</li> <li>- Continue safety studies to ensure host compatibility for technologies, formulations, and delivery methods commensurate with FDA requirements.</li> </ul> <p><b>FY 2024 Plans:</b></p> <ul style="list-style-type: none"> <li>- Develop clinically relevant, large animal models to test safety and efficacy of platform technologies.</li> <li>- Scale up protection requirements while maintaining adherence to safety and burden requirements.</li> <li>- Initiate safety and toxicity testing of system components in large animal experimental model.</li> </ul> <p><b>FY 2023 to FY 2024 Increase/Decrease Statement:</b> The FY 2024 decrease reflects minor program repricing.</p>				
<p><b>Title:</b> Atmospheric Water Extraction (AWE)</p> <p><b>Description:</b> 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 logistical and tactical burdens. 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 (&lt;40% relative humidity) to extremely humid, and are too energy-intensive (&lt;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 and will provide insights into how new materials can help the warfighter overcome existing material challenges. 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.</p> <p><b>FY 2023 Plans:</b></p>		13.887	13.952	13.257

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2022</b>	<b>FY 2023</b>	<b>FY 2024</b>
<ul style="list-style-type: none"> <li>- Optimize sorbent material integration with water extraction device components.</li> <li>- Identify new approaches to the synthesis of molecularly engineered material architectures.</li> <li>- Optimize and refine sorbent material candidates for final water extraction device prototype.</li> <li>- Begin production of final sorbent materials at scale.</li> <li>- Begin optimization of components and integrated system for final water extraction device prototype.</li> </ul> <p><b>FY 2024 Plans:</b></p> <ul style="list-style-type: none"> <li>- Select final scaled sorbent material candidates for integration into device prototype.</li> <li>- Integrate sorbent materials with final components of water extraction device.</li> <li>- Test and evaluate final fabricated components of water extraction device.</li> <li>- Demonstrate final prototype water extraction device under program test conditions.</li> </ul> <p><b>FY 2023 to FY 2024 Increase/Decrease Statement:</b> The FY 2024 decrease reflects minor program repricing.</p>				
<p><b>Title:</b> Bio-Inspired Coastal Defense</p> <p><b>Description:</b> 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.</p> <p><b>FY 2023 Plans:</b></p> <ul style="list-style-type: none"> <li>- Characterize ecosystem organisms for reef-building systems in laboratory conditions.</li> <li>- Fabricate structures and perform wave tank and flume testing to mitigate reef platform structural development risk.</li> <li>- Perform temperature tolerance, growth and disease resistance tests in the laboratory.</li> </ul> <p><b>FY 2024 Plans:</b></p> <ul style="list-style-type: none"> <li>- Initiate field tests for ecosystem engineers to achieve improved coral and oyster growth.</li> <li>- Deploy test structure in the field and measure attenuation.</li> <li>- Continue to optimize temperature tolerance for corals.</li> </ul>		15.627	12.002	11.413

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2022</b>	<b>FY 2023</b>	<b>FY 2024</b>
<ul style="list-style-type: none"> <li>- Optimize oyster growth to achieve disease tolerance in the lab and in the field.</li> </ul> <p><b>FY 2023 to FY 2024 Increase/Decrease Statement:</b> The FY 2024 decrease reflects minor program repricing.</p>				
<p><b>Title:</b> Environmental Microbes as a Bioengineering Resource (EMBER)</p> <p><b>Description:</b> 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.</p> <p><b>FY 2023 Plans:</b></p> <ul style="list-style-type: none"> <li>- Develop and test genetically engineered microbes that can tolerate above-normal levels of REE concentrations, acidic or basic conditions and/or temperatures.</li> <li>- Develop and test biological components capable of specifically binding individual REEs from simulated REE source materials.</li> <li>- Demonstrate the ability to biologically alter the chemical form of one of more individual REEs into a form suitable for manufacturing.</li> <li>- Develop an assay to detect REEs associated with cells or biomolecules with high sensitivity.</li> <li>- Compile data for a conceptual techno-economic analysis that illustrates the potential benefits of using the proposed biomining approach.</li> </ul> <p><b>FY 2024 Plans:</b></p> <ul style="list-style-type: none"> <li>- Design, build, and test survival and functionality of multiple, engineered environmental microbe strains under biomining-relevant conditions.</li> <li>- Demonstrate the ability to utilize a bio-based approach to bind several individual REEs with high specificity and to recover a single target REE from complex mixtures.</li> <li>- Utilize a biological approach to convert at least two REEs from one chemical form into another at high yield.</li> <li>- Refine bio-based REE purification pipeline to reflect compatibility with domestic source material as well as any containment strategies for living genetically engineered organisms used in the pipeline.</li> </ul> <p><b>FY 2023 to FY 2024 Increase/Decrease Statement:</b> The FY 2024 increase reflects minor program repricing.</p>		8.564	9.200	9.659
<p><b>Title:</b> Preemptive Expression of Protective Alleles and Response Elements (PREPARE)</p>		14.585	9.241	3.208

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>	<b>FY 2022</b>	<b>FY 2023</b>	<b>FY 2024</b>
<p><b>Description:</b> 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.</p> <p><b>FY 2023 Plans:</b></p> <ul style="list-style-type: none"> <li>- Finalize formulations to deliver programmable gene modulators to appropriate cells and tissues with high specificity for relevant threat exposure durations.</li> <li>- Finalize gene targets, duration, and magnitude of programmable gene modulator activity in vivo.</li> <li>- Perform capability demonstration of programmable gene modulator platform to assess transient, reversible, effective protection against biological or radiological threats in a second large animal model.</li> </ul> <p><b>FY 2024 Plans:</b></p> <ul style="list-style-type: none"> <li>- Demonstrate the efficacy of programmable gene modulators against multiple viral targets in vivo or in vitro.</li> <li>- Demonstrate the utility of using programmable gene modulators to combat chemical threats.</li> <li>- Demonstrate the use of programmable gene modulators to combat viral threats in a large animal model of infection.</li> </ul> <p><b>FY 2023 to FY 2024 Increase/Decrease Statement:</b> The FY 2024 decrease reflects completion of drug characterization and formulation to focus on final testing.</p>			
<p><b>Title:</b> Materiel Protection through Biologics</p> <p><b>Description:</b> 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. In another example, critical defense assets such as missile silos and naval piers rely on aging concrete infrastructure, ultimately costing the DoD billions of dollars annually to repair and maintain. Building upon technologies investigated under the Bio-Inspired Coastal Defense program, the Materiel Protection through Biologics thrust will develop approaches to sustain military infrastructure and systems by developing biological or bio-inspired technologies to imbue beneficial functions into existing systems, resulting in benefits such as, but not limited to, reducing drag, mitigating corrosion, or repairing concrete. These bio-inspired interventions will protect and sustain equipment and infrastructure, reducing operation costs and increasing service lifetime.</p> <p><b>FY 2023 Plans:</b></p> <ul style="list-style-type: none"> <li>- Initiate model development to predict biofilm assembly in static conditions.</li> </ul>	-	15.188	20.093

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2022</b>	<b>FY 2023</b>	<b>FY 2024</b>
<ul style="list-style-type: none"> <li>- Generate testbeds that replicate specific disturbances experienced by materiel in the field and track biofilm growth.</li> <li>- Initiate development of a design-build-test cycle that tracks microbial community development nondestructively.</li> <li>- Investigate biomolecular approaches to sense and repair deficits in reinforced concrete.</li> <li>- Identify bio-inspired strategies to support crack repair in concrete.</li> <li>- Adapt non-destructive evaluation methods to detect bio-inspired structures embedded in concrete.</li> </ul> <p><b>FY 2024 Plans:</b></p> <ul style="list-style-type: none"> <li>- Adapt accelerated-aging methods and testbeds to assess the long-term performance of self-repairing concrete.</li> <li>- Develop tools to apply and maintain function of self-repairing treatments to concrete prisms and cylinders.</li> <li>- Integrate diagnostic data from non-destructive evaluation and accelerated aging testbeds into material-scale models of crack healing in concrete.</li> <li>- Generate models that predict assembling biofilms in static conditions using high-throughput testbeds.</li> <li>- Engineer communities that are resilient to disturbances while simultaneously generating target function.</li> </ul> <p><b>FY 2023 to FY 2024 Increase/Decrease Statement:</b> The FY 2024 increase reflects major research activities coinciding with multiple testing events for self-healing concrete and biofilm technologies for applicability to multiple DoD platform applications.</p>				
<p><b>Title:</b> Bioremediation of Battlefields</p> <p><b>Description:</b> 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. 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.</p> <p><b>FY 2023 Plans:</b></p> <ul style="list-style-type: none"> <li>- Begin collection of microbial communities in contaminated environmental samples.</li> <li>- Begin high-speed screening of contaminated environmental samples for organisms that can extract, sequester, or degrade contaminants resulting from military activities.</li> <li>- Initiate model development to understand the spatiotemporal trajectory of a biological community in the presence of contaminants.</li> </ul>		-	6.150	12.229

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2022</b>	<b>FY 2023</b>	<b>FY 2024</b>
<p>- Investigate technologies for biologically or biochemically-based field forward, rapid semi-quantitative sampling and sensing technologies for select contaminants in soil.</p> <p><b>FY 2024 Plans:</b></p> <ul style="list-style-type: none"> <li>- Characterize biochemically-based approaches to biodegrade soil contaminants.</li> <li>- Establish high-throughput testbeds for studying bioremediation activity in complex soil environments.</li> <li>- Develop and test potential mechanisms for enabling overt signaling of soil contamination state.</li> <li>- Develop potential strategies for ecological containment of the plant and microbial species.</li> </ul> <p><b>FY 2023 to FY 2024 Increase/Decrease Statement:</b> The FY 2024 increase reflects the cost of running comparative tests between engineered and native communities for bioremediation.</p>				
<p><b>Title:</b> Biotechnology for Challenging Environments</p> <p><b>Description:</b> 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 warfighter and warfighting platform readiness. This program will develop technologies using biological approaches to protect and maintain performance of warfighters and warfighting platforms, such as electronics and infrastructure, from challenging environments. Technology advances developed in this effort will extend mission duration and enhance operational capabilities in emerging domains.</p> <p><b>FY 2023 Plans:</b></p> <ul style="list-style-type: none"> <li>- Initiate identification and characterization of novel biological and bio-inspired materials that correspond to adaptations to extreme environments.</li> <li>- Initiate design and engineer of microbes and other biological or bio-inspired components to produce novel materials for capabilities in extreme environments.</li> <li>- Initiate performance characterization of biological candidates for specific endogenous functions outside of traditional laboratory settings.</li> </ul> <p><b>FY 2024 Plans:</b></p> <ul style="list-style-type: none"> <li>- Down-select candidate molecules from libraries of biologically sourced or inspired molecules with potential ice modulation activity for DoD applications.</li> <li>- Assess performance of molecules with demonstrated ice modulation properties using a quantitative testbed.</li> </ul>		-	11.813	13.659

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2022</b>	<b>FY 2023</b>	<b>FY 2024</b>
- Begin optimizing high performing molecules to enhance material properties and increase performance.				
<b>FY 2023 to FY 2024 Increase/Decrease Statement:</b> The FY 2024 increase reflects program scale up of candidate screening and testbed validation activities.				
<b>Title:</b> Turning Upcycled Waste into Novel, Sustainable Materials		-	-	7.332
<b>Description:</b> Currently the DoD relies on critical materials, such as rubber- and wood-derived products, which are needed to protect and provide mobility to our warfighters in an austere, expeditionary setting. Unfortunately, providing these materials to our warfighters suffers from vulnerabilities such as fragile supply chains, foreign sourcing, or costly shipping to points of need. These critical materials also contribute to DoD waste streams with no further value, while also creating environmental and logistical challenges. To address this, the Turning Upcycled Waste into Novel, Sustainable Materials program will investigate the feasibility of converting abundant DoD waste stream products (e.g., tires, scrap wood, and paper) into durable, and sustainable materials when supplies are limited in expeditionary operations. Approaches will be investigated to develop materials with enhanced mechanical properties suitable for use in applications ranging from contingency construction materials to military tires.				
<b>FY 2024 Plans:</b>				
- Begin characterization and experimental optimization of alternative synthetic approaches to produce rubber polymers.				
- Initiate research on scalable approaches for functionalizing monomers to enable polymerization by alternative synthetic approaches.				
- Establish experimental approaches to generate datasets for multi-scale models of macroscopic material properties that can be used to design and optimize precision elastomer synthesis.				
- Initiate research into the pre-processing of wood/paper waste stream feedstocks and synthesis of DoD-relevant materials.				
<b>FY 2023 to FY 2024 Increase/Decrease Statement:</b> The FY 2024 increase reflects program initiation.				
<b>Title:</b> Signal Processing and Communication with Biotechnology		-	-	9.028
<b>Description:</b> The DoD requires the ability to monitor complex operating environments with sufficient resolution and confidence to inform missions, and protect personnel and platforms against various physical and chemical threats. The Signal Processing and Communication with Biotechnology program will develop a new customizable sensing methodology using a novel microbe-based, platform technology capable of detecting a variety of input signals, internal information processing, and generating multiple output signal types in diverse operational environments. Technology developed in this program will offer signal processing and transmission methodologies with logistical advantages and reliable operability in contested environments.				
<b>FY 2024 Plans:</b>				

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2022</b>	<b>FY 2023</b>	<b>FY 2024</b>
<ul style="list-style-type: none"> <li>- Initiate development of living, microbial distributed sensing systems that respond to multiple input signal types (e.g., chemicals, magnetic fields, light) and produce signals that are detectable by electronic/photonic devices.</li> <li>- Assess living microbial sensors for user-defined multi-channel input signal processing, response time, sensitivity, and durability under conditions that mimic operational environments.</li> <li>- Fabricate and test interface architectures to enable data exfiltration from, or communication between, living microbial sensors and conventional electronic/photonic instruments.</li> </ul> <p><b>FY 2023 to FY 2024 Increase/Decrease Statement:</b> The FY 2024 increase reflects program initiation.</p>				
<p><b>Title:</b> Strengthening Resilient Emotions and Nimble Cognition Through Engineering Neuroplasticity (STRENGTHEN)</p> <p><b>Description:</b> The Strengthening Resilient Emotions and Nimble Cognition Through Engineering Neuroplasticity (STRENGTHEN) program, building upon efforts started under the Human Social Systems program in PE 0601101E, Project CCS-02, aims to overcome the limitations of focusing on descriptions of individual disease effects and suicide risk factors by adopting a transdiagnostic approach that addresses the mechanisms (i.e., predictors or causes) of mental health and wellbeing. STRENGTHEN will optimize the brain networks essential for Cognitive Flexibility and Emotional Regulation, establishing dose response, time-to-onset, and duration-of-effect curves to quantify the impact of change in Cognitive Flexibility and Emotional Regulation on validated measures of suicidality, behavioral health, and wellbeing within DoD.</p> <p><b>FY 2024 Plans:</b></p> <ul style="list-style-type: none"> <li>- Develop individualized neurobehavioral response models of Cognitive Flexibility and Emotional Regulation.</li> <li>- Design individualized multimodal multidimensional neuroplastic interventions to optimize Cognitive Flexibility and Emotional Regulation.</li> <li>- Develop suite of interventions to optimize Cognitive Flexibility and Emotional Regulation in populations at low risk, at risk, and high risk of suicide to maximize well-being and minimize suffering from mental illness, substance abuse, and suicidality.</li> <li>- Commence development of a mechanistic understanding of mental health for transdiagnostic treatment.</li> <li>- Assess and select hybrid interventions designed to increase mental health resiliency.</li> </ul> <p><b>FY 2023 to FY 2024 Increase/Decrease Statement:</b> The FY 2024 increase reflects program initiation.</p>		-	-	9.000
<b>Accomplishments/Planned Programs Subtotals</b>		178.415	190.324	194.437
<b>C. Other Program Funding Summary (\$ in Millions)</b>				
N/A				

**UNCLASSIFIED**

<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2024 Defense Advanced Research Projects Agency		<b>Date:</b> March 2023
<b>Appropriation/Budget Activity</b> 0400 / 2	<b>R-1 Program Element (Number/Name)</b> PE 0602715E / MATERIALS AND BIOLOGICAL TECHNOLOGY	<b>Project (Number/Name)</b> MBT-02 / BIOLOGICALLY BASED MATERIALS AND DEVICES

**C. Other Program Funding Summary (\$ in Millions)**

**Remarks**

**D. Acquisition Strategy**

N/A