Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Chemical and Biological Defense Program	Date: March 2019
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601384BP / *CHEMICAL/BIOLOGICAL DEFENSE (BASIC RESEARCH)*

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	43.769	42.103	45.238	-	45.238	45.369	45.385	45.384	45.376	Continuing	Continuing
LF1: *CHEMICAL/BIOLOGICAL DEFENSE - LIFE SCIENCES (BASIC RESEARCH)*	-	27.312	26.815	29.730	-	29.730	29.813	29.824	29.823	29.818	Continuing	Continuing
PS1: *CHEM/BIO DEFENSE - PHYSICAL SCIENCES (BASIC RESEARCH)*	-	16.457	15.288	15.508	-	15.508	15.556	15.561	15.561	15.558	Continuing	Continuing

A. Mission Description and Budget Item Justification

The projects in this program element (PE) advance fundamental knowledge in life and physical sciences. These are basic research efforts directed at promoting theoretical and experimental research in Life and Physical Sciences.

Individual projects include:
- Life Sciences (LF1): fundamental efforts to understand living systems' response to biological or chemical agents, to support detection, diagnostics, protection, and medical treatment (e.g. microbiology, biochemistry, pathogenic mechanisms, cell and molecular biology, immunology, nanoscale science, and information science).

- Physical Sciences (PS1): fundamental scientific phenomena to support investigation of physical and chemical properties and interactions for enhanced functionalities important to detection, diagnostics, protection, and decontamination (e.g. chemistry, physics, materials science, nanotechnologies, nanoscale science, and environmental science).

B. Program Change Summary ($ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	43.898	42.103	45.311	-	45.311
Current President's Budget	43.769	42.103	45.238	-	45.238
Total Adjustments	-0.129	0.000	-0.073	-	-0.073
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	0.000	-			
• Congressional Directed Transfers	0.000	-			
• Reprogrammings	-0.129	-			
• SBIR/STTR Transfer	0.000	-			
• Other Adjustments	0.000	-	-0.073	-	-0.073

Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Chemical and Biological Defense Program	Date: March 2019
Appropriation/Budget Activity 0400: *Research, Development, Test & Evaluation, Defense-Wide* / BA 1: *Basic Research*	**R-1 Program Element (Number/Name)** PE 0601384BP / *CHEMICAL/BIOLOGICAL DEFENSE (BASIC RESEARCH)*

Change Summary Explanation

Funding: FY18 (-$0.129M): Reprogrammings to support core competencies at the U.S. Army Medical Research Institute for Infectious Diseases and CBDP Defense Finance and Accounting System transactions.

FY20 (-$0.073M): Program adjustments to balance overall portfolio efforts.

Schedule: N/A

Technical: N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Chemical and Biological Defense Program			Date: March 2019
Appropriation/Budget Activity 0400 / 1	R-1 Program Element (Number/Name) PE 0601384BP / *CHEMICAL/BIOLOGICAL DEFENSE (BASIC RESEARCH)*	Project (Number/Name) LF1 / *CHEMICAL/BIOLOGICAL DEFENSE - LIFE SCIENCES (BASIC RESEARCH)*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
LF1: *CHEMICAL/BIOLOGICAL DEFENSE - LIFE SCIENCES (BASIC RESEARCH)*	-	27.312	26.815	29.730	-	29.730	29.813	29.824	29.823	29.818	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project (LF1) focuses on fundamental efforts to understand living systems' responses to biological or chemical agents, to support detection, protection, diagnostics, and medical treatment. Research focuses on studying factors which influence the behavior of chemicals, toxins, and pathogens in relation to the host or target. Understanding of host/agent interactions can drive exploration of novel approaches to detect, diagnose or protect against threats. Research also focuses on medical countermeasures for improved efficacy against a wide array of current and future threat agents.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: 1) Life Sciences	27.312	26.815	29.730
Description: Focuses on fundamental efforts to understand living systems' responses to biological or chemical agents, to support detection, protection, diagnostics, and medical treatment. ***FY 2019 Plans:*** - Blood-brain barrier - Evaluate nanoparticle and antivirals neuro-protective agents in mice. Continue development of particle based delivery systems for transport of macromolecule antidotes across the blood-brain barrier. - Viral pathogenesis - Expand modeling of viral structures to second pathogen and begin correlation of data in mouse models. - Develop delivery molecules and begin to assess viral protein and virus like particle variants for multi-strain protective antibody. - Biomarkers - Perform optimization and evaluation of microneedle microfluidics and establish biomarker validation for various threats. - Enabling Science - Continue to characterize a family of unique double-stranded RNA molecules and begin to collect biomarkers that can indicate infection and give information on the type of infection. - Continue developing robust genetic control architectures for guidance of antimicrobials against bio threats. - Chemical scavengers - Assess the expression of lung alveoli cellular inflammatory receptors. Assess whether efflux pump inhibitors alter the access of neurological agents in the brain. Prepare antibody-targeted nanoparticles loaded with oxime. - STEM: Support Science Technology, Engineering and Math (STEM) strategic efforts to develop talent across the education continuum to enrich our current and future DoD workforce to meet defense technological challenges. Programs ending in FY19: -Reservoir host - Use developed inflammatory response models to elucidate function of filovirus proteins in bats. Transfer data to larger animal model program and conclude efforts.			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Chemical and Biological Defense Program		Date: March 2019
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601384BP / *CHEMICAL/BIOLOGICAL DEFENSE (BASIC RESEARCH)*	**Project (Number/Name)** LF1 / *CHEMICAL/BIOLOGICAL DEFENSE - LIFE SCIENCES (BASIC RESEARCH)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
- Persisters - Identify potential drug targets to enhance antibiotic efficacy from developed data. Transfer data to larger antimicrobial resistance program and conclude efforts. - In vitro glycosylation - Develop tools that can identify glycosylation patterns and corresponding therapeutic proteins for potential future therapeutics. Transfer data to larger antimicrobial resistance program and conclude efforts. - Bacterial resistance - Develop diagnostic tools for early and rapid identification of resistant pathogens based on gene amplification changes. Validate genomic patterns of resistance with secondary pathogens. ***FY 2020 Plans:*** - Blood-brain barrier - Develop a comprehensive model of the blood-brain barrier molecular antidotes to demonstrate mechanisms of transport for modulators and alphaviruses. Continue to elucidate transport vehicles in established mouse models of BBB transport. - Viral pathogenesis - Continue to expand modeling of viral structures to second pathogen and begin correlation of data in mouse models. Begin screening delivery molecules for bioavailability and immunogenicity and assess efficacy of single dose protection against multiple viral targets. - Biomarkers - Begin testing microneedles and microfluidic extraction studies in vivo and validating biomarker results against industry standards. Correlate biomarkers of various threats against different animal models to understand where further research may be needed. - Enabling Science - Complete a characterize a family of unique double-stranded RNA molecules and evaluate collected biomarkers that can indicate infection and give information on the type of infection. Continue developing robust genetic control architectures for guidance of antimicrobials against bio threats. - Chemical scavengers - Continue to assess the expression of lung alveoli cellular inflammatory receptors and test with potential therapeutic molecules. Assess how cholinergic stimulation of astrocyte networks are affected by chemical agents and therapeutics. Continue to evaluate transport of antibody-targeted nanoparticles loaded with oxime. - Animal Models - Initiate selection of animal models and threat/therapeutic classes for data validation. Characterize tissue models against known targets to assess comparability to human organ response. Begin validation of organ and animal models against clinical data. - STEM - Supporting Science Technology, Engineering and Math (STEM) strategic efforts to develop talent across the education continuum to enrich our current and future DoD workforce to meet defense technological challenges. ***FY 2019 to FY 2020 Increase/Decrease Statement:*** Increase due to change in program/project technical parameters.			
Accomplishments/Planned Programs Subtotals	27.312	26.815	29.730

Exhibit R-2A, RDT&E Project Justification: PB 2020 Chemical and Biological Defense Program			Date: March 2019
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601384BP / *CHEMICAL/BIOLOGICAL DEFENSE (BASIC RESEARCH)*	**Project (Number/Name)** LF1 / *CHEMICAL/BIOLOGICAL DEFENSE - LIFE SCIENCES (BASIC RESEARCH)*	

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
• CB2: *CHEMICAL BIOLOGICAL DEFENSE (APPLIED RESEARCH)*	74.565	67.994	77.803	-	77.803	77.799	78.285	82.463	83.596	Continuing	Continuing
• NT2: *TECHBASE NON-TRADITIONAL AGENTS DEFENSE (APPLIED RESEARCH)*	51.625	53.720	52.902	-	52.902	50.111	52.385	52.377	52.368	Continuing	Continuing
• TM2: *TECHBASE MED DEFENSE (APPLIED RESEARCH)*	73.276	70.960	71.882	-	71.882	76.953	78.329	75.839	75.928	Continuing	Continuing
• CB3: *CHEMICAL BIOLOGICAL DEFENSE (ATD)*	16.878	21.698	16.798	-	16.798	22.039	22.538	22.833	21.682	Continuing	Continuing
• NT3: *TECHBASE NON-TRADITIONAL AGENTS DEFENSE (ATD)*	20.781	22.749	24.180	-	24.180	30.295	31.085	31.076	31.071	Continuing	Continuing
• TM3: *TECHBASE MED DEFENSE (ATD)*	92.231	88.188	120.526	-	120.526	128.035	127.992	122.006	122.553	Continuing	Continuing

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2020 Chemical and Biological Defense Program			Date: March 2019
Appropriation/Budget Activity 0400 / 1	R-1 Program Element (Number/Name) PE 0601384BP / *CHEMICAL/BIOLOGICAL DEFENSE (BASIC RESEARCH)*	Project (Number/Name) PS1 / *CHEM/BIO DEFENSE - PHYSICAL SCIENCES (BASIC RESEARCH)*	

COST ($ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
PS1: *CHEM/BIO DEFENSE - PHYSICAL SCIENCES (BASIC RESEARCH)*	-	16.457	15.288	15.508	-	15.508	15.556	15.561	15.561	15.558	Continuing	Continuing

A. Mission Description and Budget Item Justification

This project (PS1) advances fundamental scientific knowledge in physical science areas that include chemistry, physics, materials science, environmental sciences, and nanotechnology that could potentially lead to transformational CB defensive capabilities enhancing Warfighter performance and safety.

Individual efforts in this project include:
- Research results in physics, chemistry, and materials sciences that have potential application in point and remote detection, diagnostics, as well as protection and decontamination.
- Surface and environmental sciences focus on the study of physical and chemical properties and phenomena of interactions, especially with regard to Non-Traditional Agents (NTAs), that seek to improve capabilities such as detection, protection, and decontamination.
- Research in nanotechnology and nanoscale sciences, such as nanoelectromechanical systems, molecular motors, nano-mechanical resonance sensing, and nano-meter imaging, has potential application across CB capability areas to provide significant enhancement by decreasing detection response times, increasing medical countermeasure effectiveness against a wider array of threat agents, and providing currently unavailable modalities like detection imbedded in fabrics.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
Title: 1) Physical Sciences	16.457	15.288	15.508
Description: Focuses on fundamental scientific phenomena including chemistry, physics, materials science, environmental science, and nanotechnology. ***FY 2019 Plans:*** - Continue to examine the impact of processing parameters in designing large scale membranes, which respond to multiple CB threats via deactivation and conformation change to enable novel means of protection and minimization of thermal burden. - Continue designing and synthesizing novel decontamination options that are broadly applicable to multiple chemicals or biologicals and are less harmful to equipment. - Continue to investigate the impact of morphology on approaches to mitigate chemical and biological threats on CB relevant substrates such as fibers and yarns. - Continue to investigate the impact of composition on structure and activity of materials to mitigate chemical and biological threats on CB relevant substrates. - Continue to study fundamental mechanisms between CB threats and surfaces at ambient pressure in order to elucidate its impact on reaction mechanisms between CB threats and state-of-the-art and novel CB mitigating surfaces.			

Exhibit R-2A, RDT&E Project Justification: PB 2020 Chemical and Biological Defense Program		Date: March 2019
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601384BP / *CHEMICAL/BIOLOGICAL DEFENSE (BASIC RESEARCH)*	**Project (Number/Name)** PS1 / *CHEM/BIO DEFENSE - PHYSICAL SCIENCES (BASIC RESEARCH)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2018	FY 2019	FY 2020
- Continue investigation of ecological and environmental drivers of Burkholderia pseudomallei virulence and persistence using multiplexed barcoded high throughput sequencing. - Continue to examine biomarkers from interstitial fluid and begin microneedle biosensor development to identify protein analytes. Optimize catalytic polyelectrolyte and metal organic framework structures for hydrolysis or oxidation of toxic agents. Evaluate and model self-decontaminating catalytic properties of materials for further testing against real agents. - Continue to assess and evaluate the efficacy of short chain fatty acids as a means of inactivating B. anthracis vegetative cells, endospores, and other microorganisms under a variety of environmental conditions and surfaces. - Continue to investigate the elementary reactions, fundamental process parameters, and material mechanisms of a new means of neutralizing chemical warfare agents using a single-step, continuous supercritical water oxidation platform. ***FY 2020 Plans:*** - Environmental Availability - Determine genetic changes that occur when bacteria enters nonculturable state. Determine conditions that resuscitate bacteria and assess virulence after resuscitation. - Photonics - Complete the design and fabrication of photonic components, including nano-scale thermal resonators, functionalized metallic nanohole arrays, and selective sensor coatings for optical resonators, and complete the proof of concept for chemical sensing using these components. - Chemical Reactivators - Determine mechanistic and structural studies of the aged reactivator complexes. - Multifunctional Materials - Reproduce synthesis to target a polymer composition containing the desired volume fraction of polymer blocks as required for successful and stable membrane generation. - Catalysts for CB Defense- Combined experimental data and modeling data to determine mechanism of the degradation. Synthesize metal organic framework (MOF) hybrids and quantify effects of interferent molecules. - Biomimetic - Evaluate molecules for bioremediation conditions that mimic field conditions. Begin to screen catalysts in libraries to validate chemistry. - Novel Destruction - Continue to optimize chemical surrogates and design modifications of lab reactor for use with threat agents. Complete system requirement for the field prototypes ***FY 2019 to FY 2020 Increase/Decrease Statement:*** Minor change due to routine program adjustments.			
Accomplishments/Planned Programs Subtotals	16.457	15.288	15.508

Exhibit R-2A, RDT&E Project Justification: PB 2020 Chemical and Biological Defense Program			Date: March 2019
Appropriation/Budget Activity 0400 / 1	**R-1 Program Element (Number/Name)** PE 0601384BP / *CHEMICAL/BIOLOGICAL DEFENSE (BASIC RESEARCH)*	**Project (Number/Name)** PS1 / *CHEM/BIO DEFENSE - PHYSICAL SCIENCES (BASIC RESEARCH)*	

C. Other Program Funding Summary ($ in Millions)

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Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A