Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Chemical and Biological Defense Program	Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
Total Program Element	-	46.856	44.800	43.898	-	43.898	43.004	46.107	46.226	46.220	Continuing	Continuing
LF1: *CHEMICAL/BIOLOGICAL DEFENSE - LIFE SCIENCES (BASIC RESEARCH)*	-	27.262	29.376	27.996	-	27.996	27.389	30.301	30.377	30.373	Continuing	Continuing
PS1: *CHEM/BIO DEFENSE - PHYSICAL SCIENCES (BASIC RESEARCH)*	-	19.594	15.424	15.902	-	15.902	15.615	15.806	15.849	15.847	Continuing	Continuing

A. Mission Description and Budget Item Justification

Advances fundamental knowledge and promotes theoretical and experimental research in life and physical sciences.

The projects within this BA reflect the research areas of Life Sciences (LF1) (e.g. microbiology, biochemistry, pathogenic mechanisms, cell and molecular biology, immunology, nanoscale science, and information science) which focus on fundamental efforts to understand living systems' response to biological or chemical agents, to support detection, diagnostics, protection, and medical treatment.

The projects within this BA also include efforts in Physical Sciences (PS1) (e.g. chemistry, physics, materials science, nanotechnologies, nanoscale science, and environmental science) which focus on fundamental scientific phenomena. These support investigation of physical and chemical properties and interactions for enhanced functionalities important to detection, diagnostics, protection, and decontamination.

BA1 also supports the DoD Science, Technology, Engineering, and Math (STEM) Strategy Plan to attract, inspire, and develop exceptional STEM talent across the education continuum to enrich our current and future DoD workforce to meet defense technological challenges. This includes the Joint Science and Technology Institute (JSTI) which is a 2-week residential program for high school students and teachers who conduct a research project from a STEM field with a DoD scientist. In addition, the National Research Council Research Associateship Program and the Military Internship Program provide unique opportunities for talented scientists and engineers, and promising midshipmen/cadets, to conduct research at DoD service laboratories on projects that are of interest to the Chemical and Biological Defense Program Enterprise in an effort to develop the future DoD workforce.

The projects in this PE are placed in BA1 because they are basic research efforts directed towards non-specific or non-unique military applications. Basic research technological breakthroughs support applied research (PE 0602384BP) activities.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Chemical and Biological Defense Program	Date: May 2017
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)*

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	47.761	44.800	44.311	-	44.311
Current President's Budget	46.856	44.800	43.898	-	43.898
Total Adjustments	-0.905	0.000	-0.413	-	-0.413
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	0.000	-			
• Congressional Directed Transfers	0.000	-			
• Reprogrammings	-0.905	-			
• SBIR/STTR Transfer	0.000	-			
• Other Adjustments	0.000	-	-0.413	-	-0.413

Change Summary Explanation

Funding: N/A

Schedule: N/A

Technical: N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Chemical and Biological Defense Program			Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
LF1: *CHEMICAL/BIOLOGICAL DEFENSE - LIFE SCIENCES (BASIC RESEARCH)*	-	27.262	29.376	27.996	-	27.996	27.389	30.301	30.377	30.373	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 understanding 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 2016	FY 2017	FY 2018
Title: 1) Life Sciences	27.262	29.376	27.996

Description: Focuses on fundamental efforts to understand living systems' responses to biological or chemical agents, to support detection, protection, diagnostics, and medical treatment.

FY 2016 Accomplishments:

Continued efforts to understand pathogens, novel threats and host responses. Completed genetic sequencing of a species of bats and identified novel pathways in non-human primates (NHP) and human microphage cell lines that enable filovirus infections. Continued to investigate and evaluate systemic biological responses following exposure of living systems to CB agents. Improved understanding of how polymicrobial interactions interfere with bacterial activities to influence discovery of novel antagonists for medical countermeasures. Continued to explore nano-structured materials as approaches to the needs of chemical and biological countermeasures, including behavior in biological systems and how morphology relates to biological interaction and function. Continued evaluation of the role of gene amplification and duplication in the development of multiple drug resistance in bacterial pathogens. Continued consortium approach to explore the importance of bacterial persistence and antibiotic tolerance, successfully grew mutants in vitro for understanding various resistance mechanisms. Continued to investigate the influence of glycosylation patterns on biologic stability and pharmacologic characteristics. Developed new understanding of the interaction of the blood-brain barrier with chemical and biological agent simulants and identified new brain-specific antibodies with the potential to serve as countermeasure delivery platforms. Exploited key features of natural toxin leader segments in a proof-of-concept of a new class of toxin blockers capable of dramatically reducing the translocation of exotoxin.

FY 2017 Plans:

Continue efforts to understand pathogens, novel threats, and host responses (including human and zoonotic) to prevent/minimize host injury. Continue to investigate and evaluate systemic biological responses following exposure of living systems to CB

Exhibit R-2A, RDT&E Project Justification: FY 2018 Chemical and Biological Defense Program		Date: May 2017
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 2016	FY 2017	FY 2018
agents. Improve understanding of how polymicrobial interactions interfere with bacterial activities to influence discovery of novel antagonists for medical countermeasures. Continue to explore nano- and nano-structured materials as approaches to the needs of chemical and biological countermeasures, including behavior in biological systems and how morphology relates to biological interaction and function. Continue to evaluate various global processes and mechanisms which lead to bacterial persistence and resistance. Identify biomarkers indicative of resistance and persistence. Investigate novel therapeutics developed and collected from novel sources. Investigate the influence of glycosylation patterns on biologic stability and pharmacologic characteristics. Continue evaluation of role of gene amplification and duplication in the development of multiple drug resistance in bacterial pathogens. Investigate alpha-virus glycoprotein tertiary structure and other viral immunodominant epitopes for improved development of immune assays, which will support identification of an immune correlate of protection for vaccine licensure. Examine mucosal immunity, particularly in the lung, for future development of mucosal vaccines. Investigate new transport mechanisms of the blood-brain barrier, including specific interactions regulating viral entry into the central nervous system. Investigate new biomarkers accessible in a minimally-invasive manner, characteristic of CB threats and the development of antimicrobial resistance. ***FY 2018 Plans:*** Continue efforts to understand pathogens, novel threats, and host responses (including human and zoonotic) to prevent/ minimize host injury. Complete, test, and validate primers and probes for filovirus animal model and develop in vitro and in vivo inflammatory response models. Continue to develop robust genetic control architectures for guidance of antimicrobials against bio threats. Evaluate gut-on-a-chip devices for diagnostic capability and build capacity for multiple pathogens. Validate nano-structured material drug delivery in various tissues and measure bio-distribution for optimal therapeutic delivery. Conduct in vivo validation against agent challenge to demonstrate proof of concept. Continue evaluation of role of gene amplification and duplication in the development of multiple drug resistance in bacterial pathogens. Replicate environmental factors of persistence and validate mechanism against animal models. Continue to investigate the influence of glycosylation patterns on biologic stability and begin pharmacokinetic and immunogenicity studies to validate animal model efficacy. Continue to investigate filovirus glycoprotein tertiary structure and other viral immunodominant epitopes for improved development of immune assays which will support identification of an immune correlate of protection for vaccine licensure. Begin validation of in silico transport mechanisms of the blood-brain barrier studies, in vitro, and in vivo to screen for potential therapeutic targets. Evaluate gene duplication and amplification as a specific mechanism for antimicrobial resistance and horizontal gene transfer. Begin development of a gene amplification detection system that can identify changes in antimicrobial and multidrug resistance. Investigate novel inhibitory mechanisms that circumvent efflux pumps. Explore the application of microfluidics to examine the host-immune response in the microenvironment and biomarker discover for infection onset and response to therapy. Examine the impact of modulated olfactory, respiratory, and alveolar molecular & cell population variation on uptake of inhaled particulates, progression of toxicological & pathogenic effects.			
Accomplishments/Planned Programs Subtotals	27.262	29.376	27.996

Exhibit R-2A, RDT&E Project Justification: FY 2018 Chemical and Biological Defense Program		Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
• CB2: *CHEMICAL BIOLOGICAL DEFENSE (APPLIED RESEARCH)*	50.049	56.191	71.654	-	71.654	68.631	68.636	68.816	68.806	Continuing	Continuing
• NT2: *TECHBASE NON-TRADITIONAL AGENTS DEFENSE (APPLIED RESEARCH)*	65.810	64.476	56.187	-	56.187	54.223	53.421	50.594	52.883	Continuing	Continuing
• TM2: *TECHBASE MED DEFENSE (APPLIED RESEARCH)*	86.253	68.048	73.212	-	73.212	71.624	73.597	79.610	81.898	Continuing	Continuing
• CB3: *CHEMICAL BIOLOGICAL DEFENSE (ATD)*	17.141	19.109	18.093	-	18.093	21.835	21.790	21.837	21.835	Continuing	Continuing
• NT3: *TECHBASE NON-TRADITIONAL AGENTS DEFENSE (ATD)*	20.633	17.173	23.655	-	23.655	22.893	24.347	30.490	31.291	Continuing	Continuing
• TM3: *TECHBASE MED DEFENSE (ATD)*	89.090	83.838	92.846	-	92.846	88.809	93.823	104.821	104.255	Continuing	Continuing

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Chemical and Biological Defense Program			Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
PS1: *CHEM/BIO DEFENSE - PHYSICAL SCIENCES (BASIC RESEARCH)*	-	19.594	15.424	15.902	-	15.902	15.615	15.806	15.849	15.847	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. Research results in physics, chemistry, and materials sciences that have potential application in point and standoff 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, for example, 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 2016	FY 2017	FY 2018
Title: 1) Physical Sciences	19.594	15.424	15.902
Description: Focuses on fundamental scientific phenomena including chemistry, physics, materials science, environmental science, and nanotechnology.			
FY 2016 Accomplishments: Continued exploring multifunctional material design and synthesis to identify dynamic materials that combine functionality and durability to improve CB protection by increasing protection factors and reducing physical burden. Designed and synthesized novel decontamination options that are broadly applicable to multiple chemicals or biologicals and are less harmful to equipment. Continued exploration of micro-, nano- and nanostructured materials as novel approaches to needs in chemical and biological countermeasures. Explored materials and integration of functionality that may provide adaptive materials and capabilities for CB defense countermeasures that bind, catalyze, respond to and/or mitigate threats. Continued to investigate impact of ambient surface reactivity and structure on the performance of state-of-the-art and novel CB mitigating materials. Developed new understanding of the fabrication and effect of dynamic chemical gradients on molecular transport to improve detection sensitivity.			
FY 2017 Plans: Continue to examine the impact of processing parameters in designing large scale membranes, which respond to multiple CB threats via deactivation and confirmation 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			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Chemical and Biological Defense Program		Date: May 2017
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 2016	FY 2017	FY 2018
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 exploring materials and integration of functionality that may provide adaptive materials and capabilities for CB defense countermeasures that bind, catalyze, respond and/or mitigate threats. 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. ***FY 2018 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. 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. anthraces 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.			
Accomplishments/Planned Programs Subtotals	19.594	15.424	15.902

C. Other Program Funding Summary ($ in Millions)

Line Item	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
• CB2: *CHEMICAL BIOLOGICAL DEFENSE (APPLIED RESEARCH)*	50.049	56.191	71.654	-	71.654	68.631	68.636	68.816	68.806	Continuing	Continuing
• NT2: *TECHBASE NON-TRADITIONAL AGENTS DEFENSE (APPLIED RESEARCH)*	65.810	64.476	56.187	-	56.187	54.223	53.421	50.594	52.883	Continuing	Continuing

Exhibit R-2A, RDT&E Project Justification: FY 2018 Chemical and Biological Defense Program			Date: May 2017
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)

Line Item	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
• TM2: *TECHBASE MED DEFENSE (APPLIED RESEARCH)*	86.253	68.048	73.212	-	73.212	71.624	73.597	79.610	81.898	Continuing	Continuing
• CB3: *CHEMICAL BIOLOGICAL DEFENSE (ATD)*	17.141	19.109	18.093	-	18.093	21.835	21.790	21.837	21.835	Continuing	Continuing
• NT3: *TECHBASE NON-TRADITIONAL AGENTS DEFENSE (ATD)*	20.633	17.173	23.655	-	23.655	22.893	24.347	30.490	31.291	Continuing	Continuing
• TM3: *TECHBASE MED DEFENSE (ATD)*	89.090	83.838	92.846	-	92.846	88.809	93.823	104.821	104.255	Continuing	Continuing

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A