Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Chemical and Biological Defense Program

Date: February 2018

Appropriation/Budget Activity

R-1 Program Element (Number/Name)

0400: Research, Development, Test & Evaluation, Defense-Wide I BA 1: Basic PE 0601384BP I CHEMICAL/BIOLOGICAL DEFENSE (BASIC RESEARCH)

Research

1 100001												
COST (\$ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
Total Program Element	-	43.750	43.898	42.103	-	42.103	45.311	45.449	45.487	45.490	Continuing	Continuing
LF1: CHEMICAL/BIOLOGICAL DEFENSE - LIFE SCIENCES (BASIC RESEARCH)	-	29.502	27.996	26.815	-	26.815	29.778	29.866	29.891	29.893	Continuing	Continuing
PS1: CHEM/BIO DEFENSE - PHYSICAL SCIENCES (BASIC RESEARCH)	-	14.248	15.902	15.288	-	15.288	15.533	15.583	15.596	15.597	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) Strategic 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.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Chemical and Biological Defense Program

R-1 Program Element (Number/Name)

0400: Research, Development, Test & Evaluation, Defense-Wide I BA 1: Basic PE 0601384BP I CHEMICAL/BIOLOGICAL DEFENSE (BASIC RESEARCH)

Date: February 2018

Research

B. Program Change Summary (\$ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	44.800	43.898	43.004	-	43.004
Current President's Budget	43.750	43.898	42.103	-	42.103
Total Adjustments	-1.050	0.000	-0.901	-	-0.901
 Congressional General Reductions 	-	-			
 Congressional Directed Reductions 	-	-			
 Congressional Rescissions 	-	-			
 Congressional Adds 	0.000	-			
 Congressional Directed Transfers 	0.000	-			
 Reprogrammings 	0.293	-			
SBIR/STTR Transfer	-1.343	-			
Other Adjustments	0.000	-	-0.901	-	-0.901

Change Summary Explanation

Funding: FY17 (+\$0.293M): Reprogramming to support core competencies at the U.S. Army Medical Research Institute for Infectious Diseases.

FY17 (-\$1.343M): Transfer of funding to support Small Business Innovative Research/Small Business Technology Transfer efforts.

FY19 (-\$0.901M): Application of revised inflation guidance.

Schedule: N/A

Appropriation/Budget Activity

Technical: N/A

Exhibit R-2A, RDT&E Project Ju	stification	: PB 2019 C	Chemical an	d Biologica	l Defense P	Date: February 2018						
Appropriation/Budget Activity 0400 / 1					PE 060138		t (Number/ MICAL/BIO ESEARCH)	•		MICAL/BIO	ne) LOGICAL D SIC RESEA	
COST (\$ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
LF1: CHEMICAL/BIOLOGICAL DEFENSE - LIFE SCIENCES (BASIC RESEARCH)	-	29.502	27.996	26.815	-	26.815	29.778	29.866	29.891	29.893	Continuing	Continuing

A. Mission Description and Budget Item Justification

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

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.

Title: 1) Life Sciences	29.502	27.996	26.815
Description: Focuses on fundamental efforts to understand living systems' responses to biological or chemical agents, to support detection, protection, diagnostics, and medical treatment.			
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 nanostructured 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 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			

FY 2017

FY 2018

FY 2019

Exhibit R-2A, RDT&E Project Justif											
	fication: PB 2	2019 Chemi	cal and Biol	ogical Defen	se Program				Date: Fe	bruary 2018	}
Appropriation/Budget Activity 0400 / 1	Project (Number/Name) LF1 / CHEMICAL/BIOLOGICAL DEFENSE LIFE SCIENCES (BASIC RESEARCH)										
B. Accomplishments/Planned Prog	ırams (\$ in M	lillions)							FY 2017	FY 2018	FY 2019
modulated olfactory, respiratory, and of toxicological & pathogenic effects.	alveolar mole	ecular & cell	population	variation on	uptake of inl	naled particul	ates, progres	ssion			
minimize host injury. Complete, test, vivo inflammatory response models. against bio threats. Evaluate gut-on-evaluation of role of gene amplification Replicate environmental factors of perinfluence of glycosylation patterns on animal model efficacy. Continue to infor improved development of immune licensure. Continue validation of in significant potential therapeutic targets. Evaluate and horizontal gene transfer. Continuation	Continue to ca-chip device on and duplica ersistence and biologic stab eventual biologic stab eventual eventual biologic stab eventual eve	develop robins for diagnostion in the control of a diagnostic for a diagno	ust genetic of petic capabilic capabilic development echanism agotinue pharmorotein tertial ort identifications of the bloom amplification echanism mechanications of the bloom development amplification of the peticony mechanic echanism mechanic echanism mechanic echanism mechanic echanism echanism mechanism echanism	control archit ity and build tof multiple of gainst anima nacokinetic ary structure aron of an immod-brain barrion as a specion detection inisms that c	ectures for g capacity for drug resistar I models. C nd immunog and other vir nune correla- rier studies, cific mechan system that ircumvent ef	nuidance of a multiple path nce in bacteri ontinue to inv genicity studie al immunodo ate of protecti in vitro, and i iism for antim can identify of fflux pumps.	ntimicrobials ogens. Confal pathogens yestigate the es to validate minant epitor on for vaccing vivo to screticrobial resischanges in Explore the	pes e een			
application of microfluidics to examine onset and response to therapy. Exar	e the host-imi nine the impa	ct of modul	ated olfactor	ry, respirator	y, and alveo						
variation on uptake of inhaled particul FY 2018 to FY 2019 Increase/Decre	e the host-imi mine the impa lates, progres ease Stateme	ict of modul ssion of toxi ent:	ated olfactor	ry, respirator	y, and alveo						
application of microfluidics to examine onset and response to therapy. Exar variation on uptake of inhaled particular par	e the host-imi mine the impa lates, progres ease Stateme	ict of modul ssion of toxi ent:	ated olfactor	ry, respirator pathogenic e	y, and alveo		· & cell popul	ation	29.502	27.996	26.81
application of microfluidics to examine onset and response to therapy. Exar variation on uptake of inhaled particular FY 2018 to FY 2019 Increase/Decree	e the host-imine the impa lates, progres ease Statements adjustments	act of modul ssion of toxi ent:	ated olfactor cological & p	ry, respirator pathogenic e Accon	y, and alveo ffects. nplishments	lar molecular	· & cell popul	ation	29.502		
application of microfluidics to examine onset and response to therapy. Example variation on uptake of inhaled particular and the second of the	e the host-imine the impa lates, progres ease Statements adjustments	act of modul ssion of toxi ent:	ated olfactor	ry, respirator pathogenic e	y, and alveo	lar molecular	· & cell popul	ation	FY 2023	27.996 Cost To Complete Continuing	o Total Cos

PE 0601384BP: CHEMICAL/BIOLOGICAL DEFENSE (BASIC RESEA... Chemical and Biological Defense Program

Exhibit R-2A, RDT&E Project Justif	fication: PB	2019 Chem	cal and Biolo	ogical Defen	se Program				Date: Fel	oruary 2018		
Appropriation/Budget Activity 0400 / 1	400 / 1						R-1 Program Element (Number/Name) PE 0601384BP I CHEMICAL/BIOLOGICAL DEFENSE (BASIC RESEARCH) Project (N LF1 I CHE LIFE SCIE					
C. Other Program Funding Summa	ry (\$ in Milli	ons)										
			FY 2019	FY 2019	FY 2019					Cost To		
Line Item	FY 2017	FY 2018	Base	OCO	<u>Total</u>	FY 2020	FY 2021	FY 2022	FY 2023	Complete	Total Cost	
• TM2: TECHBASE MED	73.096	73.212	70.960	-	70.960	72.997	78.989	81.306	79.218	Continuing	Continuing	
DEFENSE (APPLIED RESEARCH)												
• CB3: CHEMICAL	18.584	18.093	21.698	-	21.698	21.675	21.735	21.740	21.737	Continuing	Continuing	
BIOLOGICAL DEFENSE (ATD)												
• NT3: TECHBASE	16.055	23.655	22.749	-	22.749	24.219	30.349	31.155	31.150	Continuing	Continuing	
NON-TRADITIONAL												
AGENTS DEFENSE (ATD)												
• TM3: TECHBASE	88.629	92.846	88.188	-	88.188	93.271	104.285	103.753	97.215	Continuing	Continuing	
MED DEFENSE (ATD)												

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Ju	Exhibit R-2A, RDT&E Project Justification: PB 2019 Chemical and Biological Defense Program											Date: February 2018		
Appropriation/Budget Activity 0400 / 1 R-1 Program Element (Number/Name) PE 0601384BP / CHEMICAL/BIOLOGICAL DEFENSE (BASIC RESEARCH) PS1 / CHEM/BIO DEFENSE - F SCIENCES (BASIC RESEARCH)									ENSE - PH					
COST (\$ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost		
PS1: CHEM/BIO DEFENSE - PHYSICAL SCIENCES (BASIC RESEARCH)	-	14.248	15.902	15.288	-	15.288	15.533	15.583	15.596	15.597	Continuing	Continuing		

A. Mission Description and Budget Item Justification

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

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.

Title: 1) Physical Sciences	14.248	15.902	15.288
Description: Focuses on fundamental scientific phenomena including chemistry, physics, materials science, environmental science, and nanotechnology.			
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,			

FY 2017

FY 2018

FY 2019

Exhibit R-2A, RDT&E Project Just	fication: PB	2019 Chemi	ical and Biolo	ogical Defen	se Program				Date: Fe	ebruary 2018	3		
Appropriation/Budget Activity 0400 / 1				PE 06	01384BP <i>I</i> (nent (Numb CHEMICAL/E CRESEARC	BIOLOGIĆAL	. PS1/0	Project (Number/Name) PS1 / CHEM/BIO DEFENSE - PHYSICAL SCIENCES (BASIC RESEARCH)				
B. Accomplishments/Planned Pro	grams (\$ in N	<u>/lillions)</u>							FY 2017	FY 2018	FY 2019		
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threats via deactivation and conform Continue designing and synthesizing biologicals and are less harmful to e chemical and biological threats on C composition on structure and activity to study fundamental mechanisms b	g novel decon quipment. Co B relevant su of materials	tamination on ontinue to invibstrates suc to mitigate c	options that a vestigate the ch as fibers a chemical and	are broadly a e impact of mand yarns. C I biological th	applicable to norphology of Continue to in nreats on CE	multiple che in approache investigate the B relevant su	micals or es to mitigate e impact of bstrates. Co	e ontinue					
reaction mechanisms between CB the ecological and environmental drivers throughput sequencing. Continue to identify protein analytes. Optimize toxic agents. Evaluate and model se Continue to assess and evaluate the endospores, and other microorganise elementary reactions, fundamental payarfare agents using a single-step, of the endospores of the endospores. FY 2018 to FY 2019 Increase/Decr Minor change due to routine program	nreats and states of Burkholdes of Burkholdes of Examine bioratalytic polyelelf-decontamine efficacy of states of the continuous success paramocontinuous success Statemeters of Burkholder of the continuous success Statemeters of Burkholder of Statemeters of Burkholder	ate-of-the-art eria pseudon markers fron lectrolyte an nating cataly nort chain fa ariety of env neters, and r percritical w	t and novel C nallei virulen n interstitial f d metal orga tic propertie tty acids as a ironmental c material mec	CB mitigating ce and persifluid and beganic frameworks of material a means of item of the conditions and thanisms of a	y surfaces. (istence using gin micronee ork structure: Is for further nactivating E Id surfaces.	Continue inveg multiplexed dle biosenso for hydrolystesting agains. anthracis	estigation of distribution of developments or oxidationst real agent vegetative of investigate to	nigh ent to on of its. ells,					
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ecological and environmental drivers throughput sequencing. Continue to identify protein analytes. Optimize of toxic agents. Evaluate and model so Continue to assess and evaluate the endospores, and other microorganiselementary reactions, fundamental pwarfare agents using a single-step, or FY 2018 to FY 2019 Increase/Decre	nreats and sta s of Burkholde examine bion atalytic polyelelf-decontamine efficacy of shims under a value process paramicontinuous su ease Statements	ate-of-the-arteria pseudon markers from lectrolyte an nating cataly nort chain fariety of envineters, and repercritical went:	t and novel C mallei virulen m interstitial f d metal orga /tic propertie: tty acids as a ironmental c material mec rater oxidatio	CB mitigating ce and persifluid and beganic frameworks of material a means of it conditions and chanisms of a n platform. Accon	y surfaces. (istence using in micronee ork structure is for further nactivating E id surfaces. a new mean	Continue inveg multiplexed dle biosenso s for hydrolys testing agains. anthracis Continue to s of neutraliz	estigation of d barcoded had barcoded had barcoded had been been been been been been been bee	nigh ent to on of ats. ells, the	14.248		<u> </u>		
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PE 0601384BP: CHEMICAL/BIOLOGICAL DEFENSE (BASIC RESEA... Chemical and Biological Defense Program

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Appropriation/Budget Activity					•	nent (Numb	,		Number/Na	,	
0400 / 1				PE 06	01384BP <i>I (</i>	CHEMICAL/E	BIOLOGICAL	PS1 I CHEM/BIO DEFENSE - PHYSICAL			
				DEFE	NSE (BASIC	RESEARC	' 1)	SCIENCE	ES (BASIC I	RESEARCH)
C. Other Program Funding Summa	ry (\$ in Milli	ons)									
			FY 2019	FY 2019	FY 2019					Cost To	
<u>Line Item</u>	FY 2017	FY 2018	Base	OCO	<u>Total</u>	FY 2020	FY 2021	FY 2022	FY 2023	Complete	Total Cost
• TM2: TECHBASE MED	73.096	73.212	70.960	-	70.960	72.997	78.989	81.306	79.218	Continuing	Continuing
DEFENSE (APPLIED RESEARCH)											
• CB3: CHEMICAL	18.584	18.093	21.698	-	21.698	21.675	21.735	21.740	21.737	Continuing	Continuing
BIOLOGICAL DEFENSE (ATD)											
• NT3: <i>TECHBASE</i>	16.055	23.655	22.749	-	22.749	24.219	30.349	31.155	31.150	Continuing	Continuing
NON-TRADITIONAL											
AGENTS DEFENSE (ATD)											
• TM3: TECHBASE	88.629	92.846	88.188	-	88.188	93.271	104.285	103.753	97.215	Continuing	Continuing
MED DEFENSE (ATD)											

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Chemical and Biological Defense Program

Date: February 2018