CONFERENCE 2024

Sessions

Focus Area – Approaches to Characterizing the Threat from Chemical and Biological Agents

Re-aerosolization of Hazardous Materials: What Goes Down, Can Go Back Up Again

DTRA Session Chairs: Dr. Sara Peacock and Mr. Rick Fry

There is a general lack of understanding of the various re-aerosolization potentials that characterize the remaining hazard posed by persistent agents (chemical, biological or radiological) affecting the spread of these potential hazards within an operational environment. There is a great need to understand on the science behind the re-aerosolization of stable agents (often particulates) that have previously been deposited. This is less a chemical or biological issue but more of a physics issue.

This session will be an opportunity to summarize the available information and research from government, academia and industry to refine our understanding of the process of re-aerosolization, and identify tools that would enhance ability to understand the operational impact of persistent agents.

Many historical analyses have been focused on biological organisms, such as spores or other bioaerosols, but the physics will apply across the threat space. We need to work to enhance our understanding of this component to the lingering hazard of persistent chemical and biological threats for response and operations.

Some of the relevant material properties for consideration but not limited to: particle size, particle shape, particle size distributions, agglomeration characteristics, ionization potentials, ionic charges, electrostatic interactions, material compositions, surface area concentrations, surface roughness, humidity, droplet sizes, other environmental conditions, etc. We are also concerned about the energy/effort required to re-aerosolize (how easy is it). We need to know, essentially, the physics behind, the re-aerosolization of persistent agents.

Focus Area – Approaches to Characterizing the Threat from Chemical and Biological Agents using WMD Simulants

Threat Agent Defeat Modeling and Testing using WMD Simulants

DTRA Session Chair: Mr. Bruce Hinds

This session will focus on a range of advances within the Chemical and Biological Threat realm to include diagnostic instrumentation, novel or emerging capabilities in testing environments, and the use of test data for the development and continued validation and improvement of modeling and simulation tools.

Focus Area – Developing Medical Countermeasures Against Chemical Threats

AI/ML-assisted Redesign of Native Proteins

DTRA Session Chairs: Dr. Sweta Batni and Dr. Kenneth Frey

Advances in Artificial Intelligence/Machine Learning (AI/ML) are converging into scientific biological research. For example, recent advances in both protein structure predictions and deep-learning models have enabled generation of large numbers of idealized protein domains as well as the sequences that encode them. AI/ML-assisted re-design and fabrication of native proteins can lead to more robust proteins that can positively impact assay and product development in ways that can affect the CBDP. This session seeks to provide a snapshot of the latest advances, opportunities, and limitations of the technology.

Medical Prophylaxis to Mitigate Chemical Threats

DTRA Session Chair: Dr. David Pena

Chemical threats span a wide variety of molecules that affect the nervous system, respiratory system, skin and mucous membranes, and metabolic processes to quickly incapacitate and/or kill. As the ultimate protective defense, a medical prophylactic product (vaccine or medication) that will prevent or limit the negative impacts to the Warfighter when the causative agent has yet to be identified or is an unknown threat agent is needed.

This session will focus on identification and proof of concept demonstration of:

- Medical products that offer broad-spectrum prophylactic protection against multiple threats;
- Medical prophylactic products that limit or contain agents' effects; and
- FDA-approved products that demonstrate protective efficacy against chemical agents.

Products must be able to be administered to large numbers of people, be effective for 10 days or more, and be logistically supportable (e.g., stored at room temperature).

Revolutionizing Biomedical Research: Integrating Cutting-edge AI/ML to Unleash Innovation in Drug Discovery and Therapeutics Development

DTRA Session Chair: Dr. Stephen Becker

The Joint Science and Technology Office for Chemical and Biological Defense (JSTO-CBD) preserves Warfighter readiness by developing and fielding countermeasures to mitigate exposure to CB hazards. For decades we have seen the use of a variety of computational tools to understand and develop countermeasures against the adverse effects of chemical and biological threat agents. Recent advances in cutting-edge generative AI and deep machine learning systems (e.g., Large Language Models (LLMs), Graph Neural Networks (GNNs), Mixture of Experts (MoE) architectures, synthetic data, etc.) have the power to reshape the landscape of medical countermeasure research by accelerating drug discovery, optimizing targets for therapeutics development, and pharmacology/toxicology studies. These new approaches will allow us to understand host response to agents and develop novel medical countermeasures or repurpose existing medical countermeasures while reducing or eliminating the need for animal models, resulting in the faster and more efficient development of safer and more effective therapeutic interventions.

This session aims to bring together researchers, industry professionals, and policymakers to foster dialogue and share insights through the application of cutting-edge AI to DoD-relevant biomedical research. Participants will provide a snapshot of the latest advancements, challenges, and opportunities at the intersection of AI and drug discovery, and attendees will gain valuable insights into the practical applications of AI in biomedical sciences, fostering a deeper understanding of how these innovations are reshaping the future of pharmaceutical research.

Key Topics:

- Target Identification and Validation:
    - Implementing AI-driven virtual screening methods for the identification and validation of novel drug targets and efficient identification of lead compounds
    - Optimizing chemical structures using deep learning models to understand Structure activity relationships, improve drug efficacy and reduce off-target effects
    - Predictive modeling to prioritize potential therapeutic targets based on biological, genetic, and omics data
- Pharmacology and Toxicology Studies:
    - Early identification of potential toxicological concerns through AI-based analysis of safety data.
    - Augmentation of microphysiological systems (MPS) and animal studies to extrapolate human toxicity and assist in human endpoint prediction
    - Integration of AI in predicting pharmacokinetics and pharmacodynamics to guide dosage and administration
- Preclinical/Clinical Trials Optimization:
    - Application of AI in designing and analyzing preclinical trials for quicker and more accurate assessment of drug candidates
    - Identification of biomarkers using AI techniques to facilitate early detection of efficacy and safety signals
    - Utilizing AI for patient stratification and selection in clinical trials to enhance trial efficiency
    - Predictive analytics for optimizing trial design, monitoring patient responses, and predicting treatment outcomes

Focus Area – Envisioning the Future of CB Detection and Diagnostics

AI-powered Diagnostics

DTRA Session Chair: Ms. Jacqueline Crossler

Artificial Intelligence (AI)-powered diagnostics are rapidly transforming the research and development domain of health care to speed up development timelines and provide diagnostics at a faster pace than ever before. By using AI algorithms that are tested, trusted, and validated to analyze vast amounts of data to generate predictive analytics, diagnostic capabilities can be developed with improved accuracy, speed, and efficiency. For Chemical and Biological Defense, this can be leveraged as an invaluable tool to quickly respond to an unknown threat and develop diagnostics assays that detect disease before symptoms occur and transform how we respond to an unknown threat.

AI can revolutionize diagnostic development processes in several ways; examples include:

1. Pattern recognition: AI can recognize patterns in large datasets, such as genomic or proteomic data, to identify biomarkers or genetic variations associated with specific diseases and support personalized medicine and targeted treatment approaches.
2. Diagnostic Decision Support: AI systems can offer to healthcare professionals by considering symptoms, patient history, and test results. This can help in differential diagnosis and reduce the chances of errors.
3. Rapid Screening: AI-powered tools can rapidly analyze large volume of diagnostic tests, expediting the screening process. This is particularly beneficial in situations where quick identification of conditions, such as infectious diseases, is crucial.
4. Predictive Analytics: AI models can predict the likelihood of certain diseases or conditions based on historical patient data, enabling preventive measures and early interventions.

This session delves into the capabilities of AI/ML in diagnostics development, especially in responding to chemical and biological threats. Innovative responses are sought that showcase how AI can enhance the precision, speed, and efficiency of diagnostics, and considers the future trajectory of AI applications in this field.

Innovating Cross-domain Solutions to Detect Emerging Biological Threats

DTRA Session Chairs: Dr. Jennifer Soliz and Dr. Bao Tran

The Biological Detection portfolio supports the DoD's modernization goal to deliver biological threat detection capabilities. Organizations must be equipped with biodetection technologies that can provide detection against the ever-changing threat landscape and integrate early-warning detection capabilities for bio-threats, whether of natural origin, engineered accidentally, or deliberately released. JSTO CBA-Detection is interested in harnessing knowledge, resources, technology, and/or methodologies across disparate fields and domains to innovate detection solutions for the expansion and advancement of detection capabilities for future biothreats (i.e., engineered pathogens, toxins, emerging bio-threats) in the operational field.

Concepts for cross-domain applications may include, but are not limited to:

- Cross-domain synergistic technologies: merging technologies and/or research advancements from disparate fields (biomimicry, engineering, autonomy/robotics, data science/information technologies, aerospace, material science, etc.) to innovate unconventional detection modalities and solutions for future biothreats. Examples may include:
    - Digital computational tools that can address the digital paradigm, including artificial intelligence, machine learning, deep learning, modeling, etc.

    - Detector that can detect a range of chemical and biological threats
    - Advancements in material science, multi-functional materials, data storage, transmittance/signaling capabilities, syn-bio, microsensors, microcontroller, etc.
    - Novel solutions through enhanced communication/data-sharing networks among multi-sectorial and multi-lateral partnerships for advancing early warning detection capabilities for future threats
    - Disruptive low SWaP-C technology trends for innovative and novel biological detection
- Cross-domain transfer learning: leveraging information, methodologies, principles in other fields/domains to expand detection capabilities ahead of the occurrence (i.e., deep learning, data analytics, environmental monitoring, etc.). Examples may include:
    - Integration of neural networks for continuous learning to advance the detection capabilities over time
    - Extended reality for machine learning for improved accuracy and performance
    - Data harmonization and integration for multiomic signatures of threats
- Cross-domain data harvesting: creating FAIR compliant data sharing networks with other established institutions (e.g., data streaming transfer, repository hubs, etc.) to refine current/developing fieldable environmental detection technologies. Examples may include:
    - Collaboration on a network for data transfers across various data hubs to enhance and inform quality data collection among partners

Microphysiological Systems as Tools for Non-invasive Diagnostics

DTRA Session Chair: Dr. Lalena Wallace

Microphysiological Systems (MPS), also called “Organs-on-a-chip”, are a novel technology that combines in vitro cell culture with a microfluidics platform to replicate human tissues in their physiological environment. MPS are gaining traction as a valuable tool that can replace animals as a model system for many types of experiments. MPS models of disease pathology have also provided insight into disease progression and cellular responses, with the most recent examples focusing on SARS-CoV-2 infection and relating data to human clinical samples. While animal studies persist as a necessary step before drug testing can occur in human trials, MPS present a new option with the potential to provide a more accurate picture of the human physiological response and the ability for high throughput screening.

There are ongoing efforts to characterize MPS potential to provide prospective information about pre-symptomatic indicators and serve as novel diagnostic prognosticators.

This session seeks to explore the capabilities of microphysiological systems as tools for discovering diagnostic biomarkers of exposure to biological and chemical agents. Our primary interest is developing diagnostics that utilize non-invasive sampling. Moreover, MPS that mimic the skin and oral cavity are of particular interest as they can provide biomarker data that can be utilized for diagnostics for non-invasive sampling. We believe the maturation of this technology will provide the necessary tools to respond quickly and efficiently to hazards which may arise in contested environments.

Quantum Technologies, Metamaterials, and the Future of CB Sensing

DTRA Session Chair: Mr. Tyler Miller

As the threat landscape continues to evolve, it's necessary for the science and technology community to pursue new and novel approaches to chemical and biological sensing that not only provides higher-fidelity measurements to detect and identify an increasing number of threats, but also reduces the size, weight, power, and cost (SWaP-C) of fielded capabilities to reduce the Warfighter's burden.

Quantum information science and technology (QIST) is a technological paradigm based on exploiting the fundamental properties of matter and energy at atomic scales. As we enter the second quantum revolution, where the ability to control quantum systems is being realized, QIST is poised to provide significant capabilities for Chemical and Biological Defense. Similarly, metamaterials, or nanostructured composite materials that exhibit unique electromagnetic properties, have emerged as another promising technology for detection due to recent advancements in modeling and nanoscale device patterning.

Quantum technologies and metamaterials can be employed for chemical and biological detection in many ways, including:

- Molecular-level insight from quantum metrology approaches such as optically detected magnetic resonance may allow for the identification of novel and emerging threats with ultrafine resolution, enabling the possibility of agnostic chemical and biological sensing capabilities.
- Non-line-of-sight threat detection to detect airborne hazards, even when obscured.
- Development of optical metamaterials (meta optics) for low SWaP-C remote sensing that do not rely on cryogenic cooling or traditional optics.

This session is focused on exploring the potential of metamaterials, QIST, and other emerging technologies for the next generation of chemical and biological threat detection. Innovative responses are sought that demonstrate how quantum technologies or metamaterials can improve the sensitivity and selectivity or drastically reduce the size, weight, and power of biological and chemical sensors.

Focus Area - Innovations to Make Hard Decisions Easier - Generating Actionable Information in the Digital Battlespace

eXtended Reality and Humanoid Robotics: NextGen Assets for Remote CB Response and Operation

DTRA Session Chairs: Dr. Christopher Kiley and Dr. Chia-Wei Tsai

Human machine interface (HMI) technologies such as extended reality (XR) and brain-computer interfaces (BCI) have demonstrated significant advancements as evident with the launch of end-user commercial devices and platforms such as Quest, HoloLens, and NextMind. These advances have help move these technologies from laboratory and medical settings to broader, recreational uses by the general population. In parallel, developments in unmanned platforms are advancing from air and ground vehicles to humanoid robots. The availability of these systems allow access to remote, harsh, or denied areas.

Within the Chemical and Biological Defense Program, the applications of these technologies focus on situational awareness head-up displays, training, and sensor deployment. To promote the advancement of science and technology (S&T), this topic aims to expand beyond current applications of traditional unmanned systems and the recreational use of BCI and XR technologies toward supporting remote CB response and operations.

This session seeks presentations highlighting efforts that:

- Generate digital twins and associated models to support remote sensor maintenance and operation
- Generate digital twins to support modeling and simulation to inform CB response and/or acquisition strategy
- Combine XR and robotics for telepresence
- Develop humanoid robots for operating in harsh or contaminated environments

Innovative Approaches to Elucidate Optimal Deployment of CB Sensing Assets

DTRA Session Chairs: Mr. Edward Argenta

Transformative advances in computing, sensing, and data are building the conditions needed to advance real time sensor fusion and optimization for chemical and biological defenses. Innovations in computational hardware technology such as synaptic transistors1 and quantum computing will revolutionize how models and data can interact. Software computational advancements are occurring weekly with new machine learning and artificial intelligence (i.e. Large Language Models) being announced and applied to unique problems. These technologies continue to mature and will become available for use on the battlefield either in situ or remotely in the future. Currently, edge computing and connectivity are being leveraged to provide increased situational awareness.

Sensors, and thus data, capabilities are also rapidly advancing. Sensors are becoming more ubiquitous, mobile, taskable, and sensing unique data beyond the classical environmental air and ground sampling. Monitoring of the individual soldier via non or minimal invasive technology, low SWAP environmental sensors, or wide area scanning detectors allow for a more localized situational picture than before. Each sensor has unique sensitivities, specificities, availability (number of sensors), readiness, range of effectiveness, ruggedness, and cost, and others features which all factor in to how they could be optimal used to provide overall situational awareness. As the military battlefield connects these data, the ability to fuse sensors with different levels of capability to make informed decisions will be vital.

The CB threat landscape is ever evolving, and a one-size fits all approach is unlikely to be provide desired results. Battlespace intelligence and actions may require changes in sensing strategies to meet the commander's intent and risk. Technology will be needed to provide guidance, during planning and in real-time, on how and when to utilize various sensing modalities for a specific end point (i.e. early warning, reduced false alarms, elimination of false negatives). Efforts to explain the reasoning behind the optimization for commander's understanding will be critically important.

This topic seeks talks highlighting efforts that are capable of leveraging next generation computing to perform sensor optimization. Efforts should demonstrate how fusing of information provides a quantifiable change in specific end points while minimizing resource utilization to include costs. Tools should allow for trade-off assessments and user modifications. Efforts will need to effectively model CB threats, both traditional and emerging, as well as CB alerting assets such as environmental sensors, physiological monitors, and diagnostics. The goal is to identify ways to improve end points (i.e. early warning, reduced false alarms, elimination of false negatives) by smartly coupling and fusing disparate capabilities and understand how different threat types (characteristics?) impact these deployment optimization strategy.

1 https://www.nature.com/articles/s41586-023-06791-1

Localizing Chemical and Biological Threat Detection

DTRA Session Chairs: Mr. Edward Argenta

Historically, chemical and biological sensors have been stationary, limited in supply, and disconnected. Sensors were built for specific threats, required complicated calibrations to ensure effectiveness, and provided minimal data. JSTO has been striving towards sensor technologies that significantly reduce size, weight, and power and are those that are multi-functional. Through these efforts and commercial advancements detection technologies have matured to become more person-worn, robotics mounted, and human focused. Recent advancements have operationally demonstrated that monitoring of human physiological data and sensing individual biomarkers can be used as inputs into detection algorithms. These advancements bring about highly localized or individual situational awareness like no one has experienced before. With these advancements, the commander's knowledge of the battlespace will improve.

This topic seeks to explore all things "wearable." Technologies should be person centric and provide localized information about the threats in the area. Technologies should demonstrate broad capabilities and provide operationally relevant data. These capabilities should illustrate how their information nests into a layered defense paradigm and provide potential operational concepts of employment. This can include how the technology could replace currently fielded equipment. Technologies should highlight achievements in SWAP that reduce the burden on the user while maintaining or enhancing detection capability.

Minds in Sync: Exploring the Nexus of Humans on a Chip and Wearable Technologies on Cognitive Measures of Human Performance

DTRA Session Chairs: Dr. Sweta Batni and Dr. Chia-Wei Tsai

Recent advancements in human organ-on-a-chip (OoC) technologies, specifically organoids that can accurately mimic the human biomechanics and physiology of essential system organs, has enabled researchers to develop minimally invasive means to extract and measure electrophysiological/electrochemical signal data from organoid devices. Organoid-bioelectronic signals can in turn be analyzed to determine potential adverse cognitive health effects of chemical and biological (CB) exposures on essential human organs such as the brain and correlated with real time continuous monitoring data from minimally invasive brain wearable devices to provide dynamic measurements of adverse human operational performance on the battlefield. When combined with novel computational tools in the domains of artificial intelligence and machine learning (AI/ML), researchers could classify and reconstruct high fidelity organoid data and brain computer interface technologies to develop ML algorithms to predict high fidelity cognitive health effects responses within a human system.

This session is focused on exploring novel capability areas at the nexus of experimental human organ-on-a-chip, specifically brain, and related minimally invasive wearable technologies and computational advanced analytic methods that can be applied by the Joint Science and Technology Office (JSTO) to develop high fidelity AI/ML algorithms to predict cognitive human health effects and human performance in response to a CB exposure in an operationally relevant environment.

Topic areas of interest within this session include:

- Next generation (3D) culture models of essential human systems, such as central nervous brain tissue or human cardiac muscle tissue models, that include minimally invasive electrophysiological or electrochemical functional analysis techniques for dynamic, continuous monitoring of human organoid systems following CB threat agent exposure
- Human organs-on-a-chip (HOC) models measuring electrophysiological activity for continuous monitoring of, and correlations to, human operational performance indicators in complex or CB contested environments

- Minimally invasive wearable brain devices
- Brain-computer interface technologies for continuous monitoring of human performance and promoting human-machine teaming

Next Generation CB Hazard Prediction and Consequence Assessment with Multi-echelon Decision Support Applications

DTRA Session Chair: Mr. Rick Fry

Chemical and biological (CB) modeling and simulation (M&S) capabilities are critical to provide an understanding of the hazard environment, the operational impact, and potential mitigation strategies. Accurate M&S of CB agent releases often requires the coupling of multiple models at varying degrees of fidelity. Representative examples include source term models that characterize the initial dissemination; transport and dispersion (T&D) models that predict hazard area dosages and deposition; and models that account for secondary evaporation. Furthermore, human health effects models are necessary to translate the contamination into easily interpretable operational impacts. The location and potential health effects of CB threats are often depicted in static plots and tables that must be deciphered by trained specialists before proposed mitigation steps can be considered. This topic seeks talks highlighting next generation advances in modeling tools that utilize the latest computing technologies, dynamically update the impact of CB threats as new information is acquired, provides unique visualizations, and disseminates specific guidance on how to minimize mission impact(s). Potential guidance could include recommendations for personal protection levels, countermeasure employment strategies, routing options and more.

This session is focused on the future of chemical/biological threat assessment for situational awareness and decision support. It seeks to highlight the following:

- Advancements in hazard prediction and leveraging state-of-the-art modeling techniques and modern hardware solutions.
- Improvements towards an automated end-to-end CB decision support process from early detection to mitigation in order to unencumber users.
- Advancements in modeling and simulation outputs to assess threat agent risk, MCM risk/benefit, and operational fielding risks for real time advanced casualty estimation and layered medical decision support.

Focus Area - Medical Countermeasures

Combatting Future Biological Threats – Host-Directed Interventions to Emerging Threats for Rapid Response

DTRA Session Chairs: Dr. Robert Webb and Dr. Eric Stavale

The topic area focuses on the development of therapeutic medical countermeasures (MCMs)against emerging biological threats. The development of host-directed prophylactic therapies allows for the potential for broad-spectrum capabilities due to common motifs within the host required for infection or intoxication. The use of these therapeutics during a rapid response will allow for the treatment of the warfighter at risk of exposure to a biological agent of unknown origin and will fortify preparedness in safeguarding against evolving and unpredictable material threats. This alternative approach to agent-specific therapeutics potentially includes targeting common elements in the pathogen infective/intoxication pathway to counter a wider class of pathogens. Host-directed therapies can improve host cellular responses to pathogens/biologicals, target disease-causing virulence factors, and activate innate and adaptive immune responses and immunological memory. These efforts may be defined as any product that can proactively attenuate the host pathogen response leading to improved clinical treatment outcomes as shown by reduced morbidity, mortality, end-organ damage, and long-term functional recovery.

Topics of interest include but are not limited to:

- Prioritize host targets to counter groups of viruses considered to be material threats.
- Prioritize host targets for broad-spectrum anti-toxin strategies targeting novel toxins. This includes small, circular peptide toxins with specific internal structural architecture (conotoxins), large chemical-based toxins (palytoxins) and other marine based toxins including but not limited to tetrodotoxins and saxitoxins.
- Prioritize host targets to counter groups of bacteria considered to be material threats.
- Elucidate the roles of several key targets that modulate the immune response to limit disease of above biologics.

Comparing Animal Models to Organoids (CAMO) – Testing Medical Countermeasures with Microphysiological Systems and Comparing to Traditional Animal Models and Clinical Trials

DTRA Session Chairs: Dr. Julie Barbaras and Ms. Margaret King

Microphysiological systems can enable rapid approval by accelerating discovery and validation of medical countermeasures, both vaccines and therapeutics. This topic area focuses on the use of established microphysiological systems (MPS) to test the effectiveness of medical countermeasures with comparison to traditional animal model or clinical trial results. Included in this topic, is the demonstration of the system to accurately reproduce infection dynamics comparable to traditional animal models.

The second portion of the CAMO program is standardizing the data received from each MPS into parameters that are directly comparable to data produced by animal models and clinical trials. Standardization of MPS data will also assist in the comparison of individual microphysiological systems to observe whether the systems are producing similar results and if not, work toward this goal.

Topics of interest include but are not limited to:

- Increase understanding of challenges faced when testing MCMs in MPS, and potential solutions
- Prioritize data points that should be collected in MPS to ensure results are comparable to traditional models
- Standardize procedures for testing medical countermeasures using MPS
- MCM efficacy testing using MPS

Development of Immune Microphysiological Systems (Immune Systems on a Chip) for MCM Testing

DTRA Session Chairs: Dr. Traci Pals and Ms. Mary Zoepfl

The ability of the human immune system to elicit protective immunity to both vaccines and naturally occurring pathogenic infections is critical to the development of medical countermeasures (MCMs). Research on the immune system has traditionally been limited to either two-dimensional tissue culture or animal models. However, these systems do not fully capture the complexity of the human immune response and the significant differences between animal and human immune systems further complicate results. Human tissue-based microphysiological systems (i.e. organs on a chip) have been faithful and useful models of organs such as lungs, liver, and heart but these systems often utilize limited tissue types and do not incorporate a functional immune system that could accurately demonstrate the impact of a pathogen or MCM on a complete immune system. Development of an immune-based microphysiological system will be more complex, but its use and importance in future MCM and vaccine development cannot be understated as it could speed development, lessen the need for animal models, and decrease the cost.

Topics of interest include but are not limited to:

- Development and characterization of comprehensive immune microphysiological systems
- Mucosal vs systemic microphysiological immune systems
- Comparison of microphysiological immune systems to animal study data
- Perfusion of whole blood to more accurately mimic immune system dynamics rather than immune cells in culture media or buffer
- Addition of tissue-resident immune cells, including cells from both myeloid and lymphoid lineages.
- Integration of multiple immune components into more complex system and then incorporation with other organs into a multi-organ system

The Use of AI and Advanced Computer Systems to Develop Drugs Against New Emerging Threats

DTRA Session Chairs: Dr. Revell Phillips and Ms. Annette von dem Bussche

The medical futures branch is interested in fundamental research on technologies for improved rapid Medical Counter Measure (MCM) development.

Topics of interest include, but are not limited to the following:

- AI/ML for drug discovery and development: Considering the timeline to develop an effective medical countermeasure (MCM) against biological threats, several efforts are underway to streamline and accelerate the process of discovering, designing, and developing therapeutics against biological threats. In this regard integrating computer-aided drug development (CADD) techniques like computational modeling, complex algorithms, will enhance the development of an effective and rapid medical countermeasure (MCM).
- Also of interest are High Throughput Screening technologies, especially those that allow the collection of large quantities of data relevant to MCM development in a short amount of time – as this data is of particular importance for training future AI/ML development for MCMs.

Toxin Medical Countermeasures – Development of Novel, Broad-Spectrum Countermeasures for Toxin Exposure

DTRA Session Chairs: Dr. Daphne Stanley and Dr. Katherine Brittingham

Toxins encompass a highly diverse group of agents that can be utilized by adversaries to induce morbidity, mortality, and impede the effectiveness of missions. Presently, there are no medical countermeasures approved by the FDA to mitigate intoxication resulting from various marine toxins. Considering their potency, global prevalence, and the potential aerosol danger they pose, toxins represent a potential threat to the Warfighters.

The session seeks prophylactic and therapeutic medical countermeasures for exposure to naturally occurring, synthetic and/or aerosolized toxins (excluding botulinum and ricin). Discussion topics should aim to focus on advancing the discovery of:

- Enabling capabilities for activity (i.e. potency) and characterization assays, animal models and related hurtles in development
- Identification of toxin and/or host-based targets common to toxin families
- Platforms for discovery and evaluation of broad-spectrum countermeasures focused on targeting mechanism of action
- MCM strategies for unusual toxins, including small circular peptides with significant internal structure (i.e. cysteine binding as in some conotoxins) or the huge chemical-like structure in toxins like palytoxin
- Toxin inhibition by channel blockage
- Leveraging machine learning concepts and tools for discovery and/or structural validation of toxin inhibitors

Focus Area – Mitigating CB Hazards for the Joint Forces and Mission

Mitigation - Science and Technology Advances for Chemical and Biological Hazard Mitigation

DTRA Session Chairs: Dr. Bernadette Higgins and Dr. Glenn Lawson

This topic area seeks presentations on fundamental and applied science and technology that improves hazard mitigation systems (chemistry, formulation, and application). Systems may be for personnel, equipment, or critical area decontaminants, material coatings, and destruction of chemical and biological (CB) threats. Research and data should assess how technologies enhance Joint Force survival through increased effectiveness and responsiveness of decontamination. Technologies should render CB threats harmless without harming personnel or materiel, demonstrate improved efficacy across a broad range of CB threats, and reduce water and logistics needs. Presentations should also describe how technologies may sustain the Joint Forces and mission by limiting the spread of contamination to promote rapid reduction in Mission Oriented Protective Posture (MOPP) levels.

Presentations may include research and supporting data on, but not limited to:

- Reduced or eliminating CB contamination of personnel and personal effects as well as sensitive and non-sensitive equipment
- Improved decontaminant efficiency to return equipment to normal unprotected use with reduced time and logistics requirements
- Improved or new CB contamination mapping technologies to reduce logistics requirements of decontamination and ensure mitigation effectiveness
- Autonomous methods and systems for equipment decontamination that reduce troop-to-task for contamination mitigation operations to visualize and manage hazards across battlespace
- Improved coatings, including bio-inspired coatings, that reduce CB contamination retention to facilitate decontamination
- Methodologies with improved ability to characterize, verify, and validate performance of decontamination materials and systems that incorporate operational relevance and improved testing cost and time

Focus Area – Protecting the Joint Forces from CB Threats

Protection - Science and Technology Advances for Chemical and Biological Protection

DTRA Session Chairs: Dr. Kendra McCoy and Ms. Wendy Mills

This topic area seeks presentations on fundamental and applied science and technology for development and characterization of advanced materials and systems for chemical and biological (CB) protection. Research and data should assess how technologies prevent exposure of skin, eyes, or lungs to liquid, vapor, and aerosol hazards. Technologies should be lighter, cooler, smarter, and effectively integrate into physical protection to enable Joint Forces to fully complete the mission. Presentations should also describe how technologies may contribute to the Joint Force layered protection paradigm by enhancing individual survival and unencumbering the Joint Forces.

Presentations may include research and supporting data on, but not limited to:

- Improved technology usability and encumbrance (i.e., improved functionality [mobility, vision], customization, and decreased physical burden or logistical requirements)
- Improved technology integration and interoperability with current and developmental combat systems
- Improved technologies that reduce the cost of individual and collective protection as well as the operational impact of contaminated environments
- Technology protecting against the full spectrum of threats that supports the full range of military operations, with scalable manufacturing processes
- Dynamic, multifunctional materials for protective garments that are chemically/biologically responsive, bio-mimetic, antimicrobial, or have the capability to repel (without PFAS), absorb, or destroy contamination
- Multifunctional catalytic materials that inactivate all threats, individual or collective protection air filtration with increased capacity, engineering standards, and guidelines e.g., high-efficacy filters or temporary filtration systems able to better protect DoD facilities against CB threats, with lower lifecycle costs
- New, enhanced protective equipment characterization, verification, and validation methodologies that improve operationally relevant testing of materials and systems as well as the cost and time of testing
- Leveraging surface chemistry in operando methods to study real-time behavior of agents in simulated operationally relevant environments