JSTO in the News

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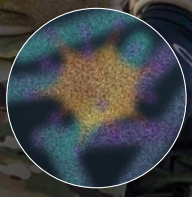
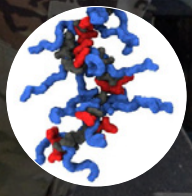
October 2023 | Vol. 13 No. 7



Widening the Diagnostic Window



Tough on Chemicals, Gentle on Gear

DTRA MISSION

DTRA provides cross-cutting solutions to enable the Department of Defense, the United States Government, and international partners to Deter strategic attack against the United States and its allies; Prevent, reduce, and counter Weapons of Mass Destruction (WMD) and emerging threats; and Prevail against WMD-armed adversaries in crisis and conflict.

CHEMICAL AND BIOLOGICAL TECHNOLOGIES DEPARTMENT MISSION

Lead DoD science and technology to enable the Joint Force, nation, and our allies to anticipate, safeguard, and defend against chemical and biological threats.

DEFENSE THREAT REDUCTION AGENCY

Research and Development Directorate
Chemical and Biological Technologies Department
Joint Science and Technology Office
for Chemical and Biological Defense

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Front cover: U.S. Air Force Airmen assigned to the 10th Expeditionary Aeromedical Evacuation Flight at Ramstein Air Base, Germany, unload a litter with a simulated patient from a C-17 Globemaster III aircraft during a training exercise. In a real-world operation, the patient would be transported to the nearest appropriate facility while the crew decontaminated the aircraft and prepared it for the next mission. The Negatively Pressurized Conex used in the training is permanently assigned to the 521st Air Mobility Operations Wing, also at Ramstein Air Base, and offers infectious disease transport capabilities to Europe and Africa. (U.S. Air Force photo by Airman 1st Class Daniel Sanchez)

Inside cover: An Oak Ridge Institute for Science and Education fellow with the Army Public Health Center (APHC) Molecular Biology Method Development Section loads sterile plasticware on the RNA extraction instrument. APHC is helping the Army maintain operational readiness by conducting rapid pool testing of soldiers who may be asymptomatic in order to ensure they can safely train and deploy with their units. (Army Public Health Center photo by Graham Snodgrass)

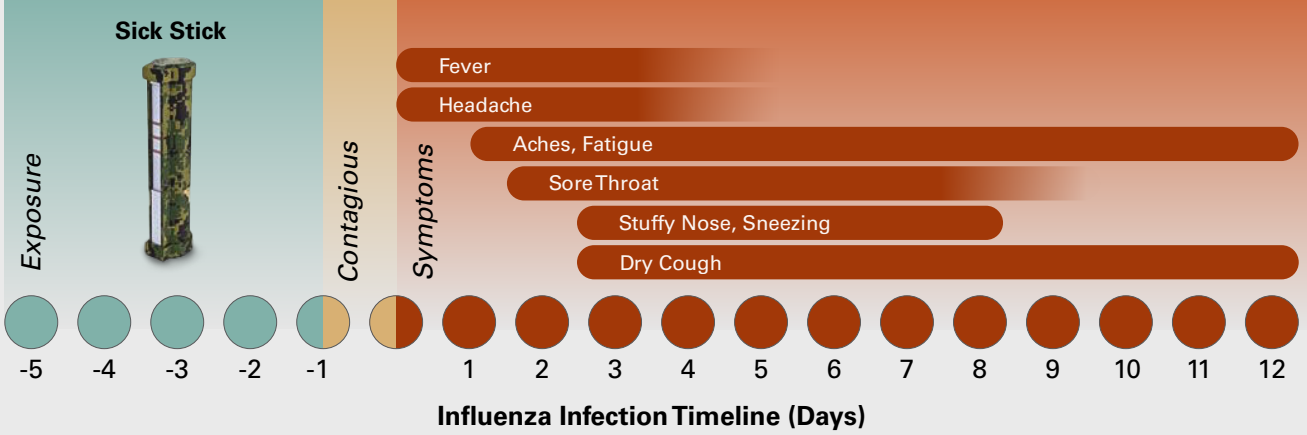
Back cover: Washington National Guard Chemical, Biological, Radiological, and Nuclear specialists with 792nd Chemical Company, 420th Chemical Battalion, 96th Troop Command conduct vehicle decontamination lanes during annual training. Contaminated vehicles could spread contaminates from the site of an attack or disaster to populated roads and supply routes if not properly neutralized. (U.S. Army National Guard photo by Staff Sgt. Adeline Witherspoon)

WIDENING THE DIAGNOSTIC WINDOW

Portable screening solutions that look for mRNA biomarkers provide effective early detection for a wide array of threats in forward deployed scenarios.

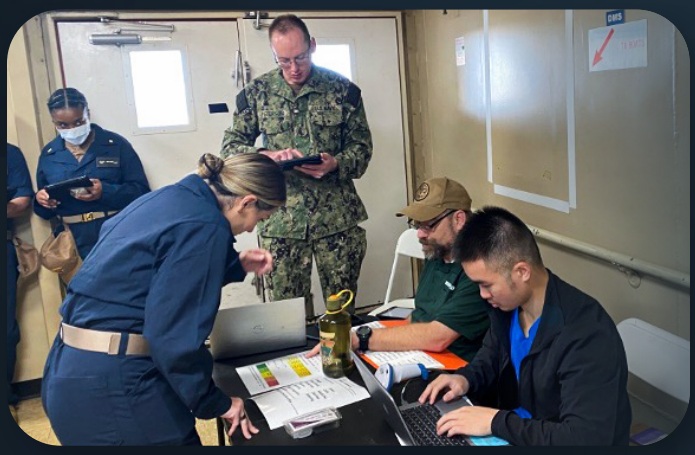
Adversarial and naturally occurring biological threats pose a great risk to warfighters on the battlefield. In field-forward scenarios, rapid diagnostic capabilities against biological warfare agents are crucial for appropriate Joint Force health-protection measures. A new screening tool called SickStick does not require specialized training to use and aims to provide sample-to-answer results in 30 minutes or less.

Traditional point-of-care diagnostic tools are often limited to specific pathogens, demand specialized equipment, and require trained personnel. In this evolving threat landscape, there is a need for portable diagnostic and screening tools that can detect infections caused by a wide array of bacterial, viral, and fungal pathogens. In addition, platforms capable of alerting if an individual is infected and contagious before symptoms develop would enhance medical countermeasures, reduce mortality, and prevent disease spread.



Visual representation of the SickStick's ability to detect an infection prior to overt flu symptoms. (Darwin Biosciences image)

The Defense Threat Reduction Agency's (DTRA) Chemical and Biological Technologies Department in its role as the Joint Science and Technology Office (JSTO) for Chemical and Biological Defense, an integral component of the Chemical and Biological Defense Program, is investing in a project with Darwin Biosciences to develop a portable, noninvasive, point-of-care diagnostic tool for presymptomatic detection of infectious diseases. This technology combines a self-collected saliva specimen, isothermal RNA biomarker amplification, and detection on a lateral flow test strip into the fully integrated SickStick.



(Top) OID contractors Collins Nguyen and Evan Stiner do a daily check-in with SickStick participants onboard USNS COMFORT (NHRC photo). (Bottom) SickStick prototypes (NHRC photo).

This approach allows for agnostic detection regardless of the causative agent and informs of an infection before symptoms develop.

Darwin Biosciences specializes in the development of saliva-based diagnostics for the early detection of infectious diseases. Leveraging the innate immune system, Darwin Biosciences developed a panel of RNA biomarkers from early immune response pathways, which are broadly activated after exposure to diverse pathogens and precedes symptom onset. This approach allows for agnostic detection regardless of the causative agent and informs of an infection before symptoms develop. This technology will provide a unique early warning capability for pre-symptomatic detection of infection enhancing medical countermeasures, and preventing contagion risks amongst troops.

As part of this effort, DTRA JSTO is investing with the Laboratory Analysis and Clinical Evaluation Program to analyze RNA biomarkers developed by Darwin Biosciences and perform operational assessments of SickStick prototypes in partnership with Operational Infectious Diseases Directorate (OID) at the Naval Health Research Center (NHRC). The shipboard study was the first of its kind and resulted in successfully collecting 728 saliva samples from 66 crewmembers on USNS Comfort while forward deployed in the United States Southern Command Area of Responsibility in 2022. A second study onboard Comfort is scheduled for October 2023. NHRC is also conducting laboratory-based testing and operational use of SickStick prototypes. This data will be invaluable to further characterize and select relevant biomarkers for the SickStick platform. DTRA JSTO continues to facilitate the development of cutting-edge technologies that will enhance battlefield readiness and protect the Joint Force, our nation, and our allies from biological warfare agents. ●

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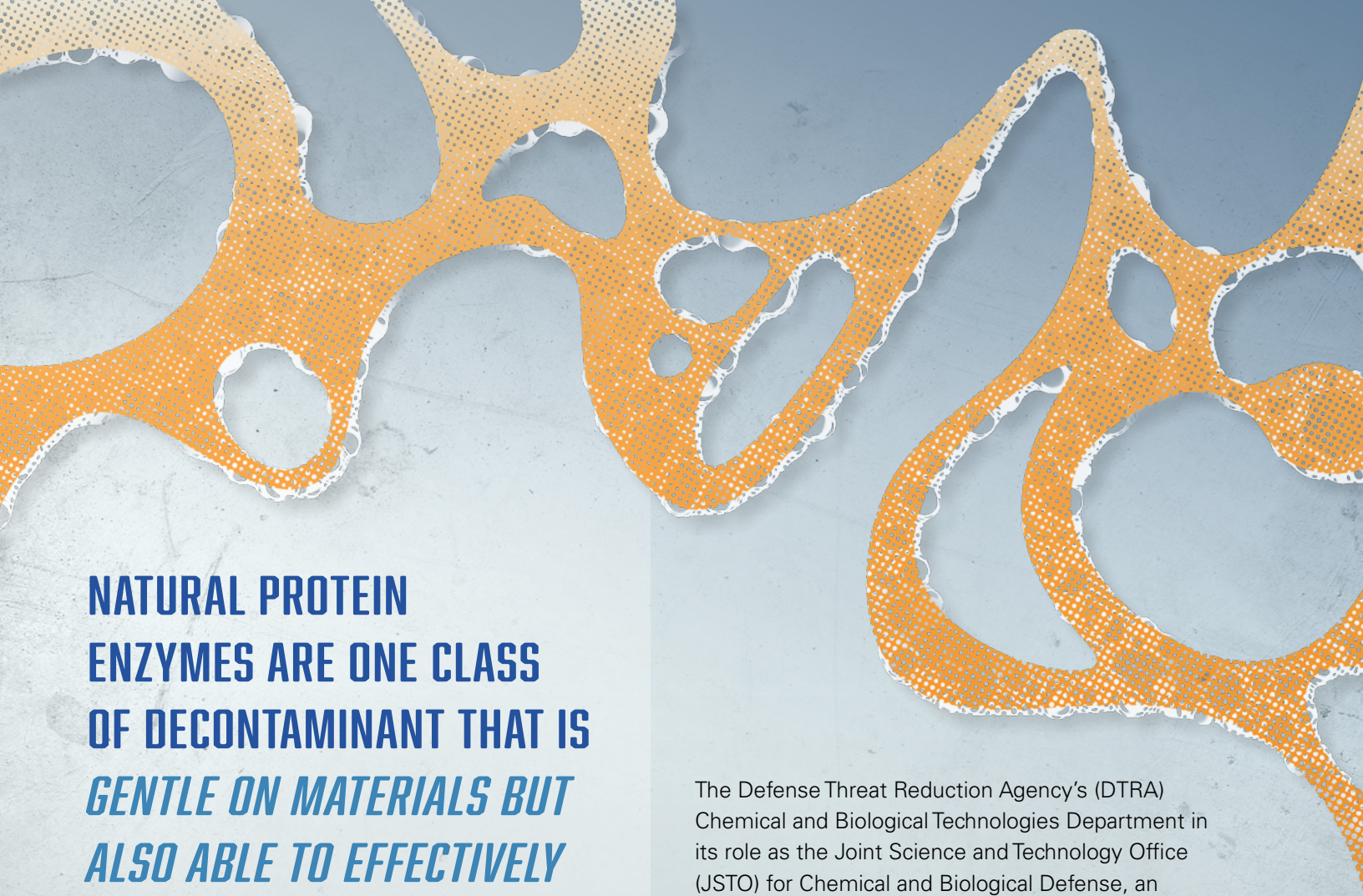
TOUGH ON CHEMICALS GENTLE ON GEAR

A new class of decontaminants can effectively neutralize chemical warfare agents without damaging military equipment.

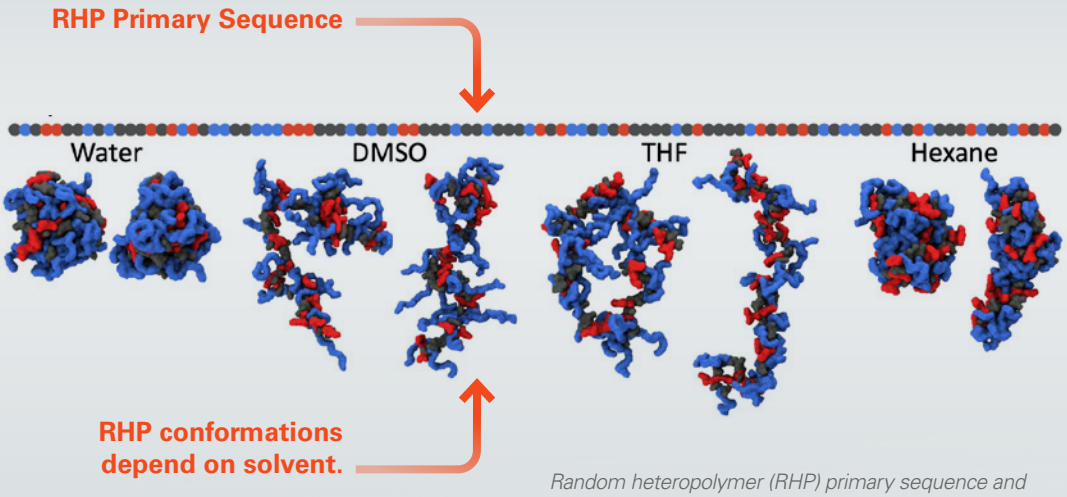
Newly developed synthetic polymer enzymes may provide the answer to harsh chemical warfare agent (CWA) decontaminants for Joint Force equipment. After military equipment is contaminated with CWAs, warfighters must rapidly and thoroughly decontaminate it to reduce Mission Oriented Protective Posture, maintain combat power, and continue their mission. Current decontamination processes use strongly reactive chemicals, such as caustics or bleach, to neutralize and destroy CWAs on equipment surfaces. While this process effectively destroys CWAs, the harsh decontaminants are not always compatible with equipment material and may cause corrosion or other damage that impacts material and mission performance. Because of this, the Joint Force seeks decontaminants that have no negative impact on equipment materials but retain the capability to effectively neutralize a broad range of CWAs.



NATURAL PROTEIN ENZYMES ARE ONE CLASS OF DECONTAMINANT THAT IS *GENTLE ON MATERIALS BUT ALSO ABLE TO EFFECTIVELY DESTROY CWAS.*

Natural protein enzymes are one class of decontaminant that is gentle on materials but also able to effectively destroy CWAs. Nature has evolved protein enzymes called organophosphatases that degrade nerve agents through catalysis, meaning one protein molecule can neutralize many agent molecules. However, to function efficiently as decontaminants, natural organophosphatases must work in environments with narrow temperature ranges (near 98.6 degrees F) and need enough water to keep the surface wet during decontamination. Natural organophosphates are poor candidates for field decontamination because nerve agents don't dissolve well in water and operational environments vary widely in temperature.

The Defense Threat Reduction Agency's (DTRA) Chemical and Biological Technologies Department in its role as the Joint Science and Technology Office (JSTO) for Chemical and Biological Defense, an integral component of the Chemical and Biological Defense Program (CBDP), invested with the University of California, Berkeley to develop novel, robust synthetic decontaminants that mimic natural biological protein enzyme structure and function. Recently, UC Berkeley developed a platform for designing biomimetic synthetic polymer enzymes that work with similar effectiveness as natural protein enzymes but function in a broader environmental and solvent range. To do this, the UC Berkeley team surveyed almost 60,000 proteins to derive and understand the common rules for protein design. Using this database, they were able to create a map of protein sequences with links to specific chemical characteristics. They then synthesized a small group of molecules similar to natural amino acids and used them to create a library of random polymers designed to mimic protein mixtures in biology. The result was a new class of molecules called random heteropolymers (RHPs) with protein-like characteristics but without some protein enzyme environmental limitations.

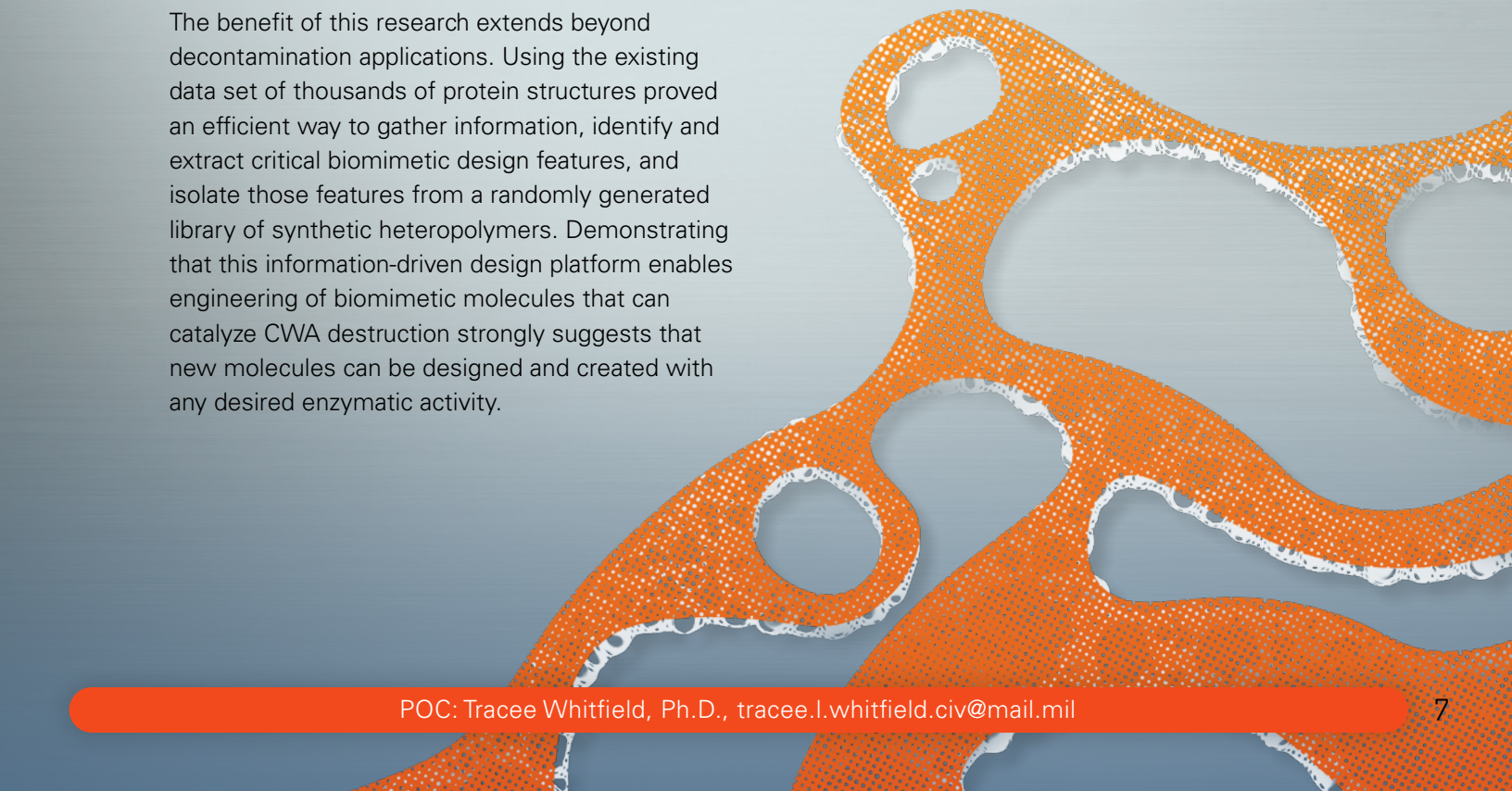


Random heteropolymer (RHP) primary sequence and predicted structure in solvent. The chemical pieces that compose the RHP are shown as colored dots in a string. Below them, computational modeling predicts RHP structure in different solvents. (UC Berkeley image)

The UC Berkeley team tested the RHPs for protein characteristics, such as the ability to interact and bind with other natural proteins and carry out enzymatic reactions. They demonstrated that stable RHPs could catalytically destroy chemical weapons agent simulants in a wide range of temperatures and in solutions containing organic solvents, like oils or alcohols, and detergents, as well as in water solutions. This is important because CWAs dissolve readily in detergents and organic solvents, which improves both removal from surfaces and neutralization.

The benefit of this research extends beyond decontamination applications. Using the existing data set of thousands of protein structures proved an efficient way to gather information, identify and extract critical biomimetic design features, and isolate those features from a randomly generated library of synthetic heteropolymers. Demonstrating that this information-driven design platform enables engineering of biomimetic molecules that can catalyze CWA destruction strongly suggests that new molecules can be designed and created with any desired enzymatic activity.

In the future, decontaminants based on RHPs will benefit the Joint Force by providing an alternative technology that won't damage materials, works in both aqueous and organic solutions, and will rapidly and catalytically neutralize CWAs without hazardous waste, and rapidly destroy CWAs at all temperatures, even below freezing. This will reduce the time, cost, and risk associated with returning equipment back to service. ●



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2024 CBD S&T Conference

SAVE THE DATE

December 2-5, 2024

FORT LAUDERDALE
FLORIDA

The 2024 CBD S&T Conference — hosted by the Defense Threat Reduction Agency's (DTRA) Chemical and Biological Technologies Department in its role as the Joint Science and Technology Office (JSTO), an integral component of the Chemical and Biological Defense Program — brings together scientists, researchers, program managers, and military personnel to defend our nation and its warfighters against the most pressing chem-bio threats of tomorrow. Hear about the latest groundbreaking research.

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CBD S&T CONFERENCE 2024

Within the Defense Threat Reduction Agency's Research and Development Directorate resides the Chemical and Biological Technologies Department performing the role of Joint Science and Technology Office for Chemical and Biological Defense, an integral component of the Chemical and Biological Defense Program. This publication highlights the department's advancements in protecting the Joint Force, our nation, and allies from chemical and biological threats through the innovative application of science and technology.

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