Scientific Foundations for Countering Terrorism

Summary

The Office of Science supports a broad spectrum of activities that can advance the technologies for countering terrorism. To be effective, we must understand the context in which our science can play a role; we must be aware of critical technology gaps; and we must maintain close interactions with frontline agencies such as the National Nuclear Security Administration (NNSA) and the Department of Defense (DOD). The Office of Science can contribute significantly to a long-range basic research program for countering terrorism by virtue of its ongoing portfolio of programs.

Recent events have raised awareness of U.S. vulnerability to terrorist attacks and many new homeland security measures have been instituted to respond to these threats. The Nation's immediate responses have relied on proven technologies that can be deployed to the field now. However, the underlying problem is long term and new strategies must address increasingly sophisticated terrorist activities. Thus, the Federal government needs to initiate a plan that includes long-term, fundamental research to develop new capabilities for the detection, analysis, isolation, and interdiction of the materials that terrorists might use to attack us. Furthermore, the Nation must also prepare to deal with the aftermath of terrorist incidents by being able to detect, isolate, and mitigate the effects of toxic and infectious agents that may be released into our environment.

The Office of Science has exceptionally strong national laboratory and university programs in research that can provide technologies to detect, prevent, protect against, and respond to terrorism. For example, chemical and biological sensors, radiation detectors, chemlab on a chip, and genomic analysis could all be important to the *detection* of terrorism. *Prevention* of terrorist acts could be enhanced through improved methods for controlling and tracking radiological materials and the development of new manufacturing methods that minimize the creation of hazardous industrial chemicals.

Likewise, *protection* against terrorism could be increased through improved filters and membranes and the development of new protective fabrics. Improvements in our ability to *respond* to a terrorist event could be made by developing methods to immobilize and neutralize hazardous materials, to detect exposure to toxic or infectious agents, or to carry out rapid forensic analyses associated with attribution.

The Office of Science operates specialized facilities for materials research, centers for rapid genome sequencing and analysis, and new centers for nanoscale science that can also be applied to research for countering terrorism. A wide range of new nanophase materials will be needed as catalysts, sensors, semiconductor detectors, solid-state lasers, membranes, lightweight structures, and molecular electronic and optical materials.

Fundamental theoretical and experimental tools and models to probe molecular interactions with solid/vapor and solid/liquid interfaces will be critical to development of new selective sensors, transport, and fate models, development of improved separations chemistry and new protective barrier and catalytic materials for protective clothing and toxin neutralization.

Sensing and tracking of radiological material will require new capabilities for detection and scanning of transport vehicles and containers.

Ideally, portable, field-deployable detection equipment will be networked to provide real time data on movement. New technologies for security scanning systems will require advanced methods for detecting explosives and biological agents as well as nuclear material. Dealing with biological threats will require DNA sequencing of microbial pathogens and their genetically close relatives. DNA sequence data will need to be analyzed to identify biological targets (DNA or proteins) that could be used to detect, characterize, and analyze pathogens and to identify target proteins and their mechanisms of action in the virulence process to develop vaccines and therapies.

DNA sequence data contributes directly to DOE/NNSA work to develop DNA signatures for pathogens in conjunction with the Centers for Disease Control, the FBI, and other agencies. For example, pathogen survival, propagation, evolution, the ability to invade and grow in hosts, and the mechanisms of the disease are all mediated by genetic instructions and protein molecular machines. Fundamental genetic information is needed to understand what makes an agent a potential threat, how it can be detected, and how it can be counteracted.

Advanced computational tools will be required for dealing with the massive amounts of data that will accompany widespread sensing and analysis of potential threats. For example, the ability to compare and analyze the DNA sequences of tens to hundreds of microbes at the same time will be needed to predict the biological effects and behavior of a microbe from its DNA sequence and to organize the enormous amount of information being generated on all microbes of interest. Advanced computation can also help design and predict effects of drugs and other molecular intervention strategies aimed at defeating biothreat agents.

The Office of Science's advanced X-ray light sources, intense neutron sources, and electron microscopes are powerful tools for the analysis of materials that can be used to counter terrorism. Genomic sequencing centers and high performance computer resources are critical for the rapid analysis and modeling of biological threats. The Office of Science is a world leader in high energy and nuclear physics with the ability to greatly advance the detection and characterization of nuclear materials. The national laboratory system provides a unique environment for scientific investigation coupled with the world's most advanced facilities.

The Office of Science has a long history of close interaction with defense-related components of the DOE and the DOD. It also leads the Nation in the support of university research in the physical sciences. More than any other agency, the Office of Science is positioned to bridge the gap between unclassified basic research and classified "behind the fence" research associated with homeland security and countering terrorism.

The Office of Science, with its combination of laboratory and university research coupled with world-class facilities for scientific discovery, can assume a major role in scientific research for countering terrorism.

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