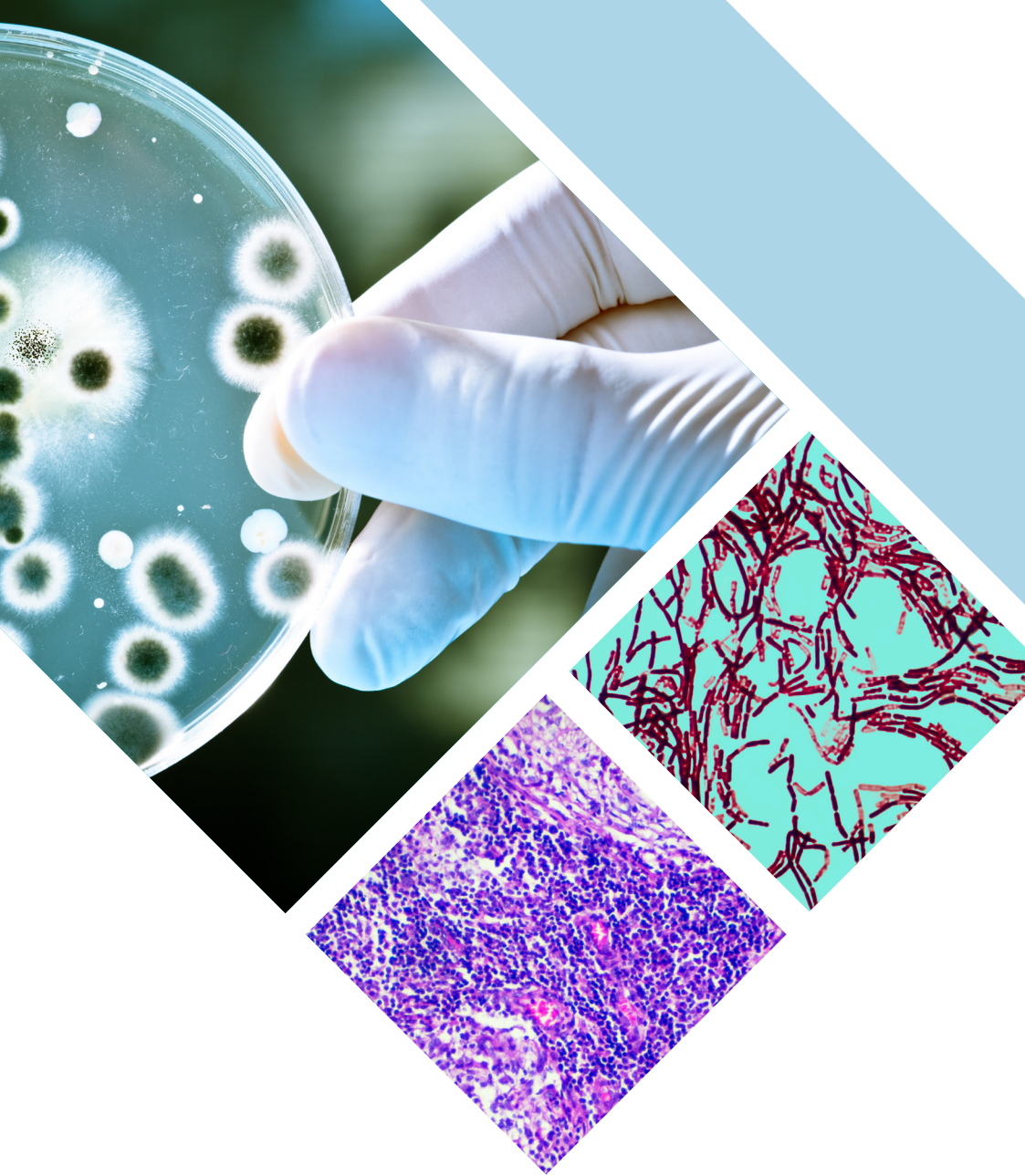




A novel nanoparticle based real-time sensor for B. anthracis and M. tuberculosis

Science for Peace and Security (SPS) Programme
Emerging Security Challenges Division



About the Project

Objectives

Tuberculosis poses extensive socioeconomic problems in many developing countries and affects a large number of people. Anthrax is a threat to domestic animals and is transferrable to humans, which makes it a likely agent for potential bioterrorist weapons. Both pathogens are endemic in Ukraine, the NATO partner country co-directing this project.

The ultimate goal of this project is to develop an innovative real-time sensor for the fast detection of dangerous pathogens. More specifically, this project will design and build a nanoparticle-based sensor platform suitable for field conditions, capable of detecting *B. anthracis* and *M. tuberculosis* in less than 60 minutes.

Deliverables

This project will produce:

- Two microwave extraction systems for fast preparation of biological samples of any type (dry or wet, solid, liquid, blood, saliva, etc.) to detect and analyze the presence of *B. anthracis* and *M. tuberculosis* in less than 30 minutes;
- Two fully disposable sample processing cassettes for safe sample handling, compatible with the microwave extraction system;
- A pathogen-specific DNA probe with fluorescent chromophore for quantitative detection of target DNA in the biological sample;
- Magnetic composite micro-nanoparticles coated with gold/silver with immobilised pathogen-specific anchor DNA probe, with shelf-life superior to one year and 100% specificity;
- An optical system to detect metal-enhanced fluorescence in the analyte;
- An automated, rapid and highly sensitive user-friendly benchtop platform for detection and quantitative analysis of biological samples for *B. anthracis* and *M. tuberculosis* in less than 60 minutes.

Impact

This new detection technology will provide fast and accurate diagnostics of tuberculosis, which has a significant health and socioeconomic effects for many low-income countries. This technology for reliable anthrax detection is also crucial in countries where this disease is endemic, posing a serious threat to domestic animal and human health. Furthermore, this technology is essential to prevent and counter the use of anthrax as a bioweapon.

Access to a cost effective, simple to use, diagnostic point of care assay would markedly reduce the impact of natural exposure to a biological agent such as *M. tuberculosis*, which affects many people around the world. In addition, fast benchtop analysers are important for preparing an efficient response to epidemic threats. The system can also be used to map the extent of biological contamination and to identify areas that require targeted decontamination.

Conceptually, this innovative sensor is not limited to detecting the two target pathogens (anthrax and tuberculosis), and can be expanded to other similar applications in healthcare and personnel protection.



Participating Institutions

Cardiff University



Cardiff University is a leading teaching and research university in the United Kingdom. Its School of Pharmacy and Pharmaceutical Sciences conducts research which encompasses the discovery, development and usage of medicines across a spectrum of disease areas including cancer, infection, musculoskeletal, cardiovascular, respiratory and neurological disorders. This work seeks to identify fundamental mechanisms of disease and new pharmacological targets, the design of novel drug candidates and diagnostics, and of innovative drug delivery systems. Complementing the laboratory investigations are workforce and practice-based studies covering areas such as the social and psychological aspects of the practitioner-patient interaction around medicines usage, pharmaco-epidemiology/-vigilance, pharmaco-economics and associated issues around medicines resource allocation. The School of Pharmacy has government-approved laboratories for bacteria handling, including attenuated strains of *B.anthraxis* and Mycobacteria.

Institute of Environmental Geochemistry (IEG)



The Institute of Environmental Geochemistry (IEG) is a Ukrainian state institution created in 1996 as a scientific centre for solving environmental problems by bringing together the most advanced departments of the Institute of Geochemistry, Mineralogy and Orgenesis of the National Academy of Sciences of Ukraine (NASU). It has become an internationally renowned institution not only for its fundamental research activities in the fields of radioecology, geochemistry and mineralogy, but also for its applied research aimed at designing novel advanced methods and instruments for remote radioecological monitoring, developing deactivation facilities, introducing nuclear waste management regulations etc. IEG actively develops new technological facilities and methodologies for radiological, ecological and biomedical monitoring. To that effect, the Institute has experimental facilities for manufacturing prototype equipment for monitoring and control of different physical, chemical and biological parameters in the environment and biological objects.

Chuiko Institute of Surface Chemistry (CISC)



The Chuiko Institute of Surface Chemistry (CISC) of the National Academy of Science of Ukraine (NASU) was created in 1986 to study fundamental and applied problems in chemistry, physics and technology of solid surfaces, highly disperse solids, functional nanomaterials and composites (including metal and metalloid oxides, metals, carbons, polymers) for medical, agricultural and industrial applications. Additionally, the Institute studies theories of chemical structure and reactivity, biomedical and biochemical problems, physical chemistry of surface and interfacial phenomena at surfaces of various nanomaterials and composites. CISC is fully equipped with major analytical and advanced modern instruments and equipment to conduct research. The Institute also organizes annual international conferences on Physics, Chemistry and Biology of Surfaces, to disseminate scientific findings and knowledge.

The Istituto Zooprofilattico Sperimentale della Puglia e Basilicata (IZSPB)



The Experimental Zooprophyllactic Institute of Puglia and Basilicata Regions (IZSPB) is a specialized Italian government funded institution mainly involved in the diagnosis and research of animal infectious and zoonotic diseases. It also takes part in the execution of prophylaxis plans for infectious diseases. IZSPB develops innovative microbiological, immunological and molecular-biological detection procedures, and takes part in the execution of prophylaxis plans for infectious diseases. IZSPB hosts the National Reference Centre for Anthrax (Ce.R.N.A.) established in 2002. It manages two laboratories dedicated to research and development of methods for the identification and genotyping of *B. anthracis*, and conducts tests for the detection of anthrax spores in suspect samples, and the pharmaceutical production of the anthrax vaccine. The main activities of Ce.R.N.A. are: the production and distribution of the anthrax vaccine for veterinary use; mapping of *B. anthracis* genotypes circulating in Italy; in suspected cases of bio-terrorism, identification of *Bacillus anthracis* spores in suspicious samples; and scientific research and international cooperation. It also distributes epidemiological information among specialists and the general public by publishing the National Epidemiological Bulletin, scientific publications and reports to decision makers at the governmental level.

The Science for Peace and Security (SPS) Programme

The Science for Peace and Security (SPS) Programme is an established brand for NATO based on four pillars: science, partnership, security, and unconventional issues (hybrid threats). It has been contributing to the core goals of the Alliance for more than six decades. Today, the SPS Programme continues to be one of the largest and most important partnership programmes addressing 21st century security challenges, particularly cyber defence, counter-terrorism, CBRN defence, energy security and advanced technologies.


The NATO Science for Peace and Security (SPS) Programme enhances security-related civil science and technology to address emerging security challenges and their impacts on international security. It connects scientists, experts and officials from NATO and Partner countries to work together to address these challenges. The SPS Programme provides funding and expert advice for security-relevant activities in the form of Multi-Year Projects (MYP), Advanced Research Workshops (ARW), Advanced Training Courses (ATC), and Advanced Study Institutes (ASI). SPS activities are always demand-driven, modular, and designed to meet the requirements of the nation(s) and end user(s). The relevance of SPS activities in response to NATO Strategic Objectives and political priorities is reinforced also via special calls, which are issued on an ad hoc basis to draw the attention of the scientific community towards current topics of interest for Allies.

Every year, approximately 2000 experts participate in SPS activities and help to build capacity in partner nations, and support NATO's security efforts.

More than 20 Nobel Laureates have been involved in the SPS Programme, a testament to the scientific excellence supported by the SPS Programme.

Young scientists are also actively supported through SPS activities, which contribute to broaden their professional network and scientific expertise.

The SPS Programme also has a high public diplomacy value for NATO, providing the Alliance with separate, non-military communication channels by bringing together experts from NATO and Partner countries, often in situations or regions where other forms of dialogue more directly focused on defence and security are difficult to establish. Accordingly, the Programme enables NATO to become actively involved in such regions, often serving as the first concrete link between NATO and a new partner.



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