

NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCES (NIEHS)

The mission of the National Institute of Environmental Health Sciences www.niehs.nih.gov is to discover how the environment affects people in order to promote healthier lives, with a vision of providing global leadership for innovative research that improves public health by preventing disease and disability. NIEHS achieves its mission and vision through a multidisciplinary biomedical research program, prevention and intervention efforts, and a communication strategy that encompasses training, education, technology transfer and community outreach. www.niehs.nih.gov/sbir

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I. Exposure Assessment Tools

<http://www.niehs.nih.gov/research/supported/dert/programs/exposure/> The NIEHS Exposure Biology and Exposome Program studies the totality of the exposures that a person experiences from conception to death along with the associated biological responses. Validated tools are needed that measure, analyze, and predict a substantial range of internal and external exposures and health outcomes across diverse geographic populations. These tools should be designed fit for purpose in collaboration with the purchasers and end-user populations (e.g., community outreach programs, citizen scientists, disaster response personnel, population-based epidemiologists, or clinical researchers). Examples include:

- Integrated systems and/or computational models that leverage information from existing databases (e.g., EPA ExpoCast) and devices (sensors, biomonitors, satellites, etc.) linking exposure at the point of contact, internal dose, and biological response, where the cumulative personal exposures can be used to simulate and predict population-scale effects. Individual personal privacy protection must be addressed.
- Sensors
 - Technologies to assess personal exposure in population studies using networks of fixed site and wearable monitors
 - Personal, wearable, real-time detection measurements across multiple stressors and scales (e.g., time, space, route of exposures, distribution), with emphasis on high sensitivity and specificity and/or low cost devices
- Biomonitoring
 - Personal monitoring technologies that can detect multiple toxicants in biospecimens using non- or minimally invasive approaches
 - Devices that can continuously monitor and report exposures in real-time

New strategies for detecting analytes not currently measured in CDC NHANES, including replacement chemicals or emerging chemicals

- Technologies that can assess multiple exposures in archived biological samples
- New approaches to integrate smart device technologies into exposure assessment
- Untargeted discovery or annotation of environmental analytes in metabolomics studies

II. Nano Environmental Health and Safety

<http://www.niehs.nih.gov/research/supported/dert/programs/nanohealth/> The NIEHS Nano Environmental Health and Safety (Nano EHS) program is interested in the detection of engineered nanomaterials in the environment, in products, and in biological samples; and technologies that can predict toxicity potential. High priority engineered nanomaterials of interest are those with a potential for human exposure.

Examples include:

- Sensors that can detect engineered nanomaterials in air, water, and consumer products, and provide a contextual assessment on the toxicological potential

- Biomonitoring technologies that can detect engineered nanomaterials for personal monitoring of biospecimens using non- or minimally invasive approaches
- *In vitro* assays to evaluate biological responses to engineered nanomaterials, beyond cytotoxicity

III. **Toxicity Screening, Testing, and Modeling**

The National Toxicology Program <http://ntp.niehs.nih.gov/> at NIEHS is interested in technologies to improve predictivity in toxicology testing to support the goals and initiatives of Tox21 <http://ntp.niehs.nih.gov/results/hts/index.html>. Phase III of Tox21 is focused on expanding biological endpoints and human relevance with increased focus through the following efforts:

Improved or expanded testing methods for toxicity screening

These should include the development of physiologically relevant cell-based systems or phylogenetically lower order animal models. *In vitro* approaches should reflect *in vivo* effects in animals and humans, and may be used to reduce or replace *in vivo* animal use. High priority areas are the development of metabolically competent *in vitro* screening systems that are predictive of xenobiotic metabolism in humans, and the incorporation of genetic variation in *in vitro* or animal models to understand susceptibilities. Examples include:

- Data rich *in vitro* approaches that incorporate mid- to high-throughput -omics or high content imaging
- Enhanced lower organism models (e.g., zebrafish or *C. elegans*) for mid- throughput toxicant screening
- Stem cell assays (both embryonic and iPS cells) for effects of toxicants on cell differentiation, with multiple functional endpoints
- Screening systems that incorporate genetic diversity into toxicology testing (e.g., panels of human iPS cells or rodent models for genetic diversity)
- Improved human organotypic models that more accurately predict *in vivo* function, which may include microfluidic approaches. Specifically, mid-throughput systems to evaluate the effects of xenobiotics on functional endpoints or pathway changes in liver, kidney, gastro-intestinal, lung or brain tissue. Other target tissues are also acceptable.
- *In vitro* assays to model inflammatory responses to xenobiotics
- Short-term tests, assays, or systems that reduce or replace animal studies, or increase predictivity of *in vivo* animal models of acute toxicity (oral or inhalation), reproductive or developmental toxicity (e.g., from endocrine-disrupting xenobiotics), carcinogenicity, or ocular toxicity
- Improved identification and characterization methods for untargeted, high-throughput metabolomics analysis of xenobiotics

Computational approaches for predictive toxicology

- New computational systems and tools for integrating toxicity data that analyzes and visualizes data across different screening systems, as well as *in vivo* data
- Improved experimental and computational tools for *in vitro* to *in vivo* extrapolation of xenobiotic exposures across a range of assay types
- Technologies for pre-market identification of problem xenobiotics through *in vitro* and computational tools (e.g., development of an integrated testing strategy for green chemistry)
- Computational tools for modeling detoxification and metabolic activation

Other technologies for enhanced toxicology testing

- High-throughput, low cost approach to measure global gene expression in a cell simultaneously

- Improved methods for fixing and preserving tissues that maintain cellular structure for histopathology while minimizing degradation of nucleic acids (RNA, miRNA, DNA, methylated DNA) so that archival tissue blocks can be better used for molecular analysis.
- Alternatives or improvements to formalin fixation, paraffin embedding (FFPE) of tissues are sought for improved molecular or genome-wide analysis for better use of tissue archives.
- *In vivo*, real-time, and tissue-specific detection of oxygen radicals in experimental animals

IV. **Biomarkers**

NIEHS supports the development and validation of biomarkers that can distinguish reversible from irreversible changes in target organs of toxicity as a result of individual responses to environmental stressors (*e.g.*, air pollution components, pesticides, toxic metals, endocrine-disrupting compounds, and other industrial chemicals).

Biological pathways of interest include:

- Oxidative stress
- Inflammation
- DNA damage response
- Immune function
- Mitochondrial function
- Epigenetic regulation

High priority human biomarkers include, but are not limited to:

- Inflammation biomarkers
- Plasma or serum-based markers using altered RNA or protein expression or altered metabolite profiles to determine response to environmental exposures
- Markers developed in exhaled breath, buccal cells, or other easily accessible, non-invasive biological samples that characterize alterations in key pathways associated with environmental stressors
- Urinary biomarkers for DNA adducts, metabolites, or other cellular markers
- miRNA or exosome biomarkers for exposure assessment to environmental toxicants (*e.g.*, drug induced liver injury)

V. **Superfund Research Program**

<http://www.niehs.nih.gov/research/supported/dert/programs/srp/> The NIEHS Superfund Research Program (SRP) is interested in applying new engineering, bioengineering, and biotechnology approaches to develop novel strategies to characterize, monitor, and remediate hazardous substances at contaminated sites.

Topics of interest include, but are not limited to:

Monitoring, Detection, and Site Characterization

- Real-time, on-site monitoring: soil, surface water, groundwater, subsurface, sediments, air (such as volatile releases from sites) etc.
- Nanotechnology-based sensors and probes, biosensors, and miniaturized analytical probes
- Non-targeted or multi-analyte field sampling tools or kits
- Products that allow for rapid sample clean-up/preparation for analysis of environmental samples
- Devices to detect chemical mixtures in environmental media
- Self-contained miniaturized toxicity-screening kits for detecting contamination hotspots
- Assays or devices to determine the extent to which a contaminant is bioavailable

- High throughput assays or toxicity screening products for use in ecological risk assessments

Examples of specific environmental monitoring, detection, and site characterization needs:

- Devices to detect and measure vapor intrusion or to detect non-aqueous phase liquids (NAPLs) and dense non-aqueous phase liquids (DNAPLs) in the subsurface
- Site characterization techniques and strategies for complex geology (fractured, karst and heterogeneous layered deposits)
- Short-duration tests or methods to improve identification of reasonable worst case vapor intrusion condition in a building
- Technologies for rapid extraction or processing of soil for incremental sampling methodologies (ISM)
- Technologies for automated fiber counting for asbestos samples

Remediation

- Novel technologies for *in situ* remediation of contaminated sediments, soils, and groundwater
- Technologies to remediate chemical mixtures in environmental media
- Portable adsorption systems for removing chlorinated VOCs from indoor air to achieve risk-based indoor air standards
- Nano-enabled structures, electrochemical methods, photocatalytic processes, thermal treatments, or filtration-based methods of remediation.
- Bioremediation and phytoremediation technologies including development and culturing/propagation of plants, bacterial strains, or fungal species optimized for bioremediation.
- New strategies for delivery of reagents for groundwater remediation: *in situ* chemical oxidation (ISCO), zero valent iron (ZVI), and hydraulic fracturing (note: this excludes gas exploration)
- New strategies for delivery of reagents for recovery/extraction of contaminants in groundwater

Information Technology to Support Monitoring and Remediation

- Computational, geographical information system-based, or modeling products for predicting fate and transport of contaminants, rates of remediation, or for identifying contamination sources
- Miniaturized data analysis tools

SRP encourages applicants to develop green / sustainable detection technologies and remediation approaches that improve energy efficiency and reduce waste generation. Proposals must demonstrate that the proposed detection and remediation technologies are relevant to Superfund. For [more information about the types of hazardous substances found at Superfund sites](#): <http://www.niehs.nih.gov/research/supported/dert/programs/srp/hwaerp/index.cfm>

VI. Education/Outreach

<http://www.niehs.nih.gov/research/supported/dert/programs/peph/> As part of its Partnerships for Environmental Public Health (PEPH) Program, NIEHS is interested in developing tools that build capacity, improve environmental health literacy, and support citizen science endeavors. These approaches or resources should be fit for purpose to meet the needs of the following audiences: community members, health care and public health professionals, educators, and students of all ages. Approaches may include:

- Mobile applications that contextualize environmental health information about exposures of concern in food, air, water, or consumer products

- Devices for collecting and reporting information on exposures in environmental samples for educational purposes in schools or communities
- Systems that can utilize public and voluntary population data from sensors, activity trackers, GIS enabled devices, social communications, and surveillance cameras; for example, to assist disaster response and communication
- STEM education resources related to environmental health in school settings or community education programs
- Continuing medical education classes related to environmental health
- Documentaries, short films, and television shows on environmental health science topics with accompanying discussion guides, lessons, or activities to facilitate broader use of the programming

VII. **Worker Training Program**

http://www.niehs.nih.gov/careers/hazmat/about_wetp/

The NIEHS Worker Training Program (WTP) is interested in Advanced Training Technology (ATT) products for the health and safety training of hazardous materials (HAZMAT) workers, skilled support personnel, and emergency responders in biosafety response and cleanup, community and citizen preparation and resiliency, and for ATT tools to assist in research into the acute and long-term health effects of environmental disasters. ATT as defined by WTP includes, but is not limited to, online training, virtual reality, serious gaming, and tools that complement all aspects of training from development to evaluation including advance technologies that enhance, supplement, improve, and provide health and safety training for hazardous materials workers. WTP accepts solicitations via requests for applications (RFA). Please contact Kathy Ahlmark ahlmark@niehs.nih.gov for information on the next solicitation date, which differs from the standard receipt dates of this NIH omnibus.

VIII. **NIEHS DOES NOT Fund**

- × Technologies for the detection and remediation of pathogens in the environment - contact EPA or DoD for information on SBIR funding opportunities for this topic

IX. **Other Topics within the Mission of the Institute**

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