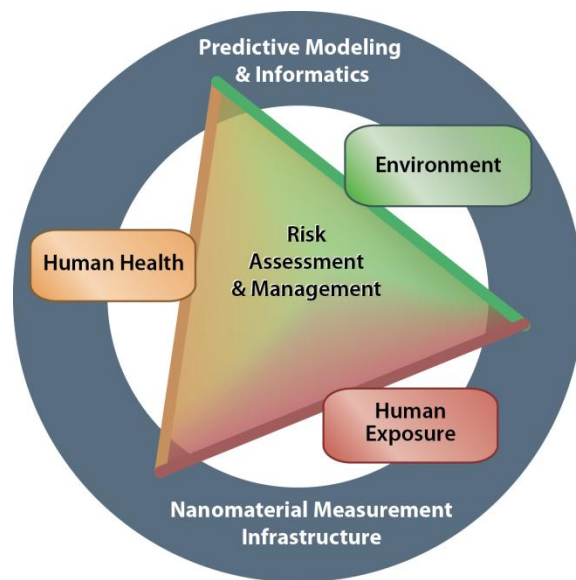
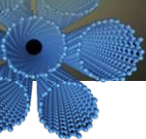


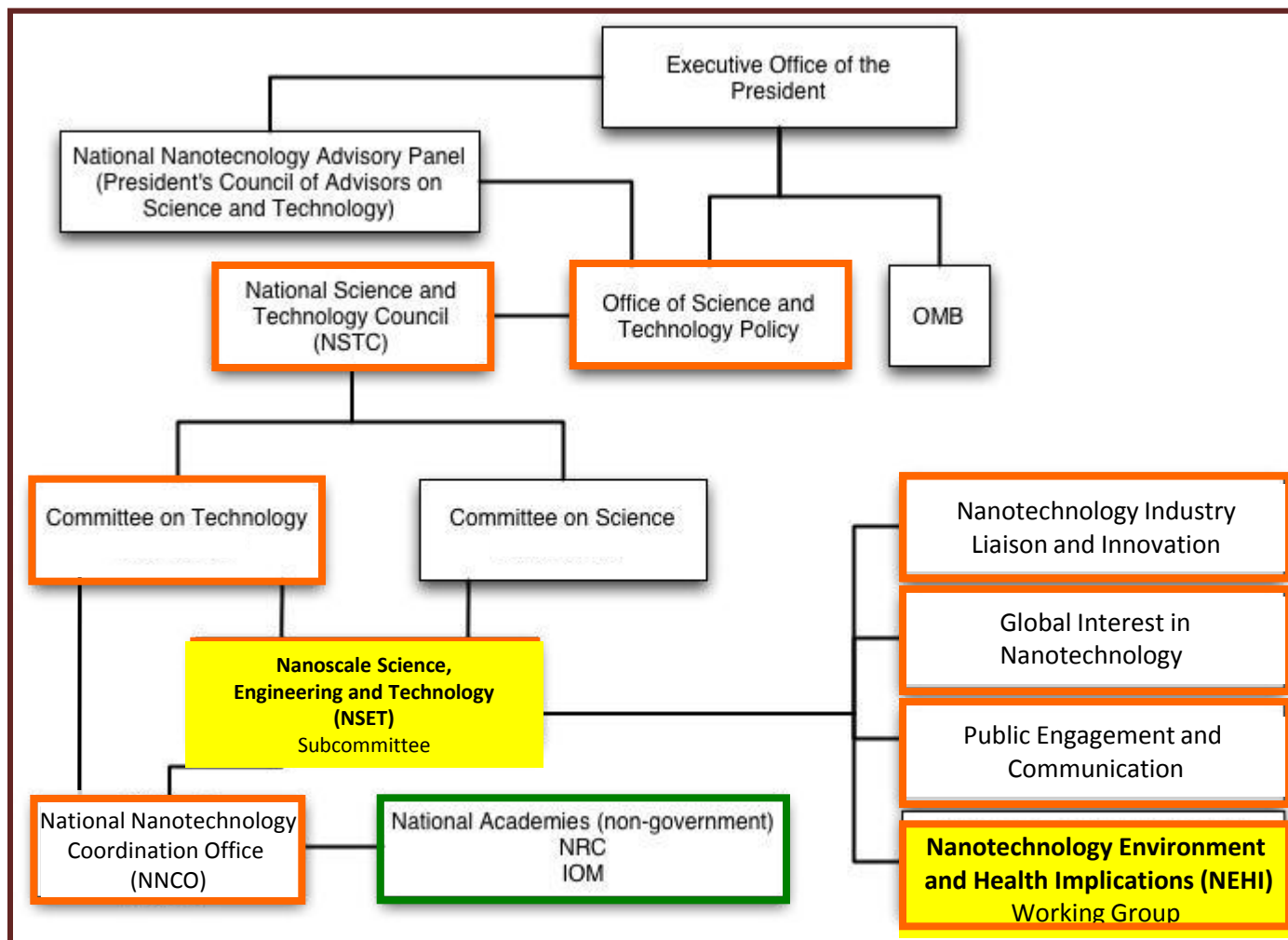
2011 NNI Environment, Health, and Safety Research Strategy

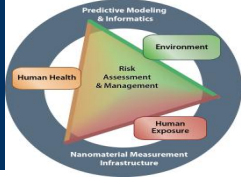
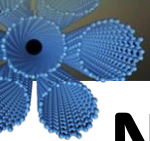


Trey A. Thomas, Ph.D.
**Co-chair, Nanotechnology Environment and Health
Implications Working Group**
**Nanoscale Science, Engineering, and Technology
Subcommittee**



Organizational Structure





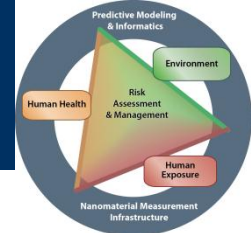
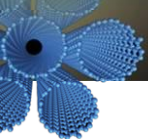
NNI Environmental, Health, and Safety Research Strategy

NNI Environmental Health and Safety Mission

- Protect public health and the environment
- Employ science-based risk analysis and risk management
- Foster technological advancements that benefit society

Provides guidance to Federal agencies

- EHS research priorities
- 2011 NNI EHS research strategy replaces the 2008 document



Highlights from the NNI EHS Research Strategy

Process

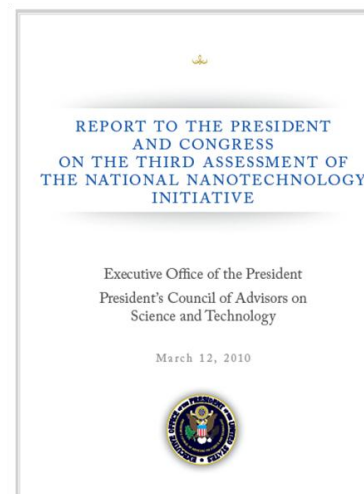
- Reviews of 2008 strategy
- Workshops with stakeholder engagement
- Assessment of strengths and weaknesses
- Writing Process

Structure

- Vision, mission
- Research framework
- Core chapters
- Path forward

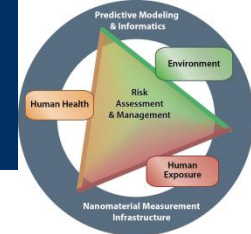
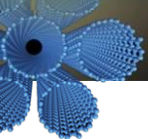
What's New

- Informatics and predictive modeling
- Key concepts for targeting and accelerating research
- Best practices for coordination and implementation of research

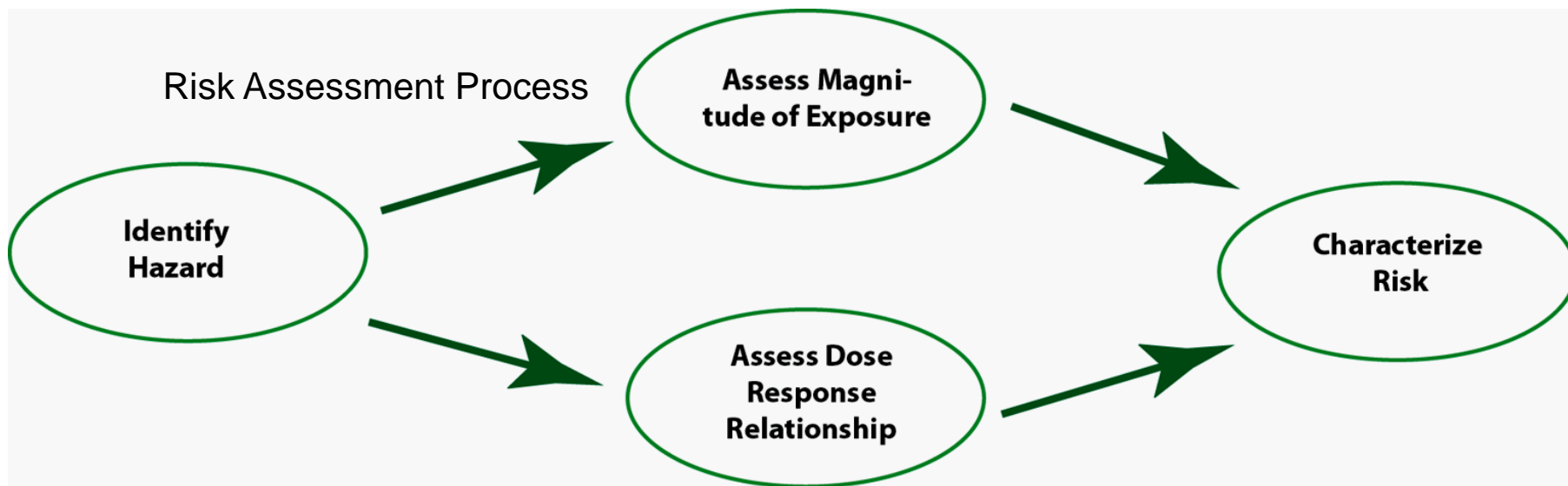


Review of the Federal
Strategy for
Nanotechnology-Related
Environmental,
Health and Safety Research



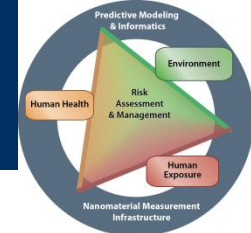
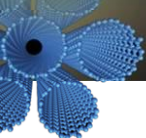


Framing the Research Strategy

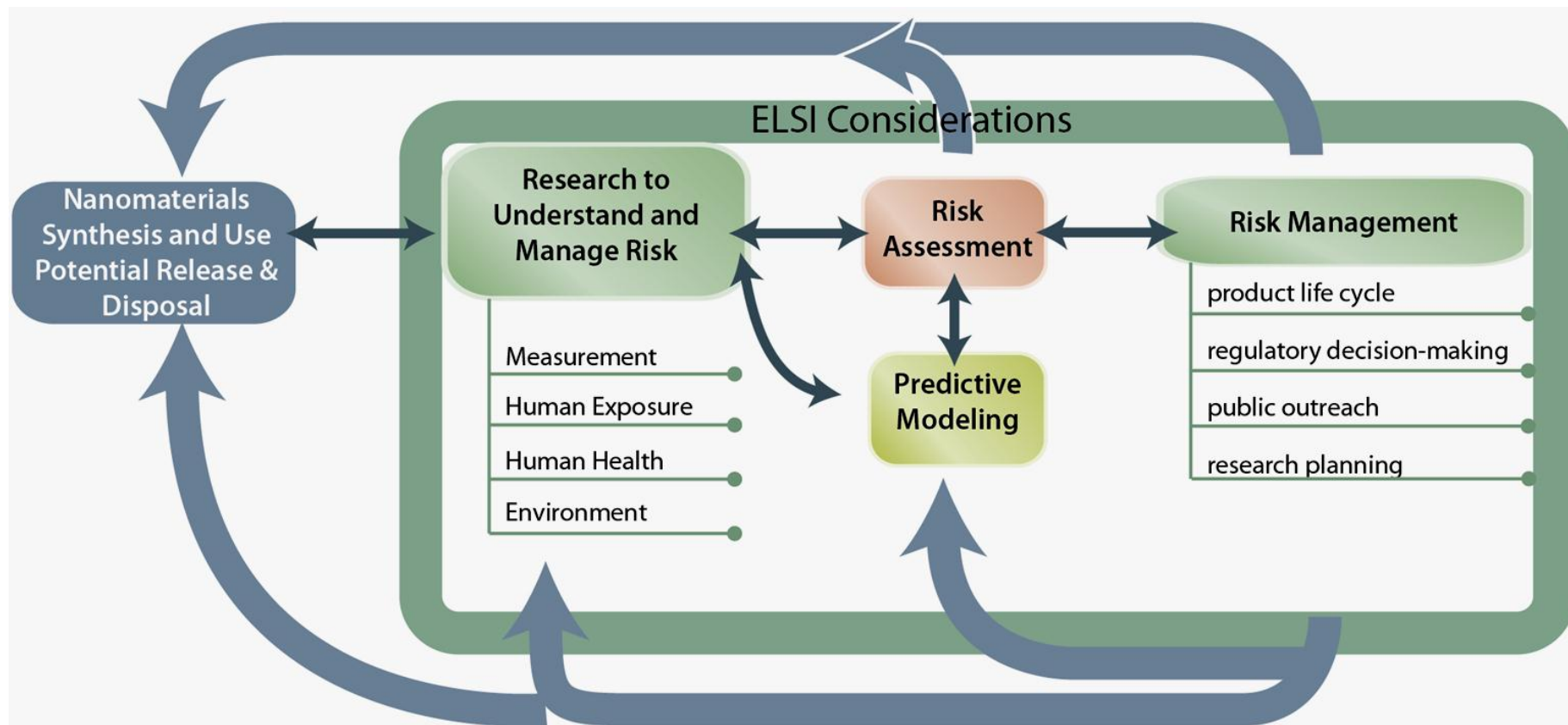


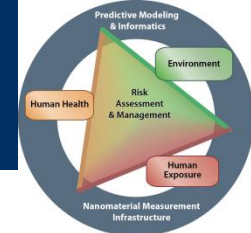
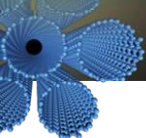
Core research areas include

- Nanomaterial measurement infrastructure
- Human exposure assessment
- Human health
- Environment
- Risk assessment and management methods

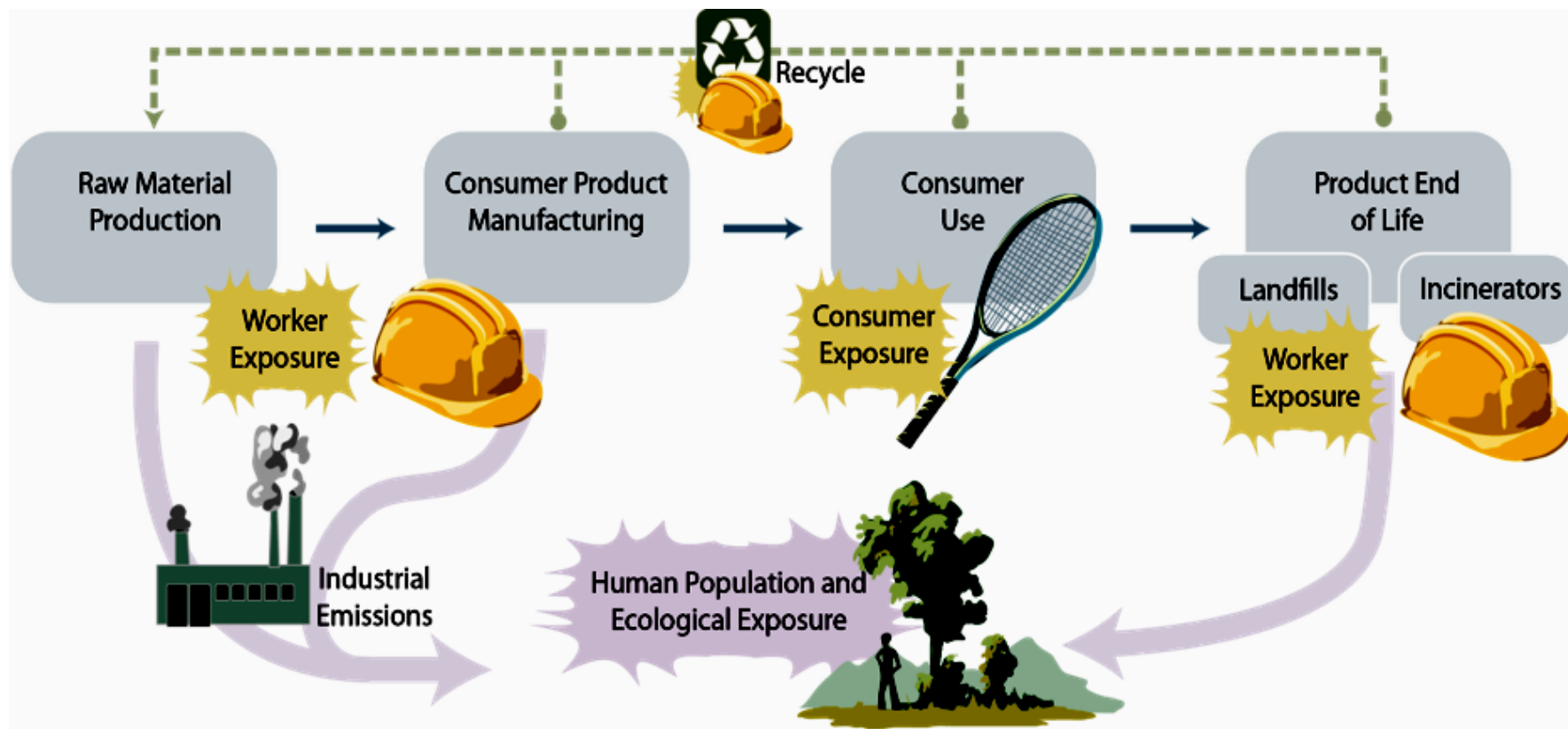


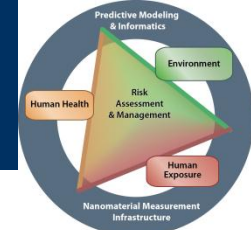
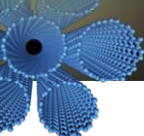
Risk Management Research Framework





Product Life Cycle Stages





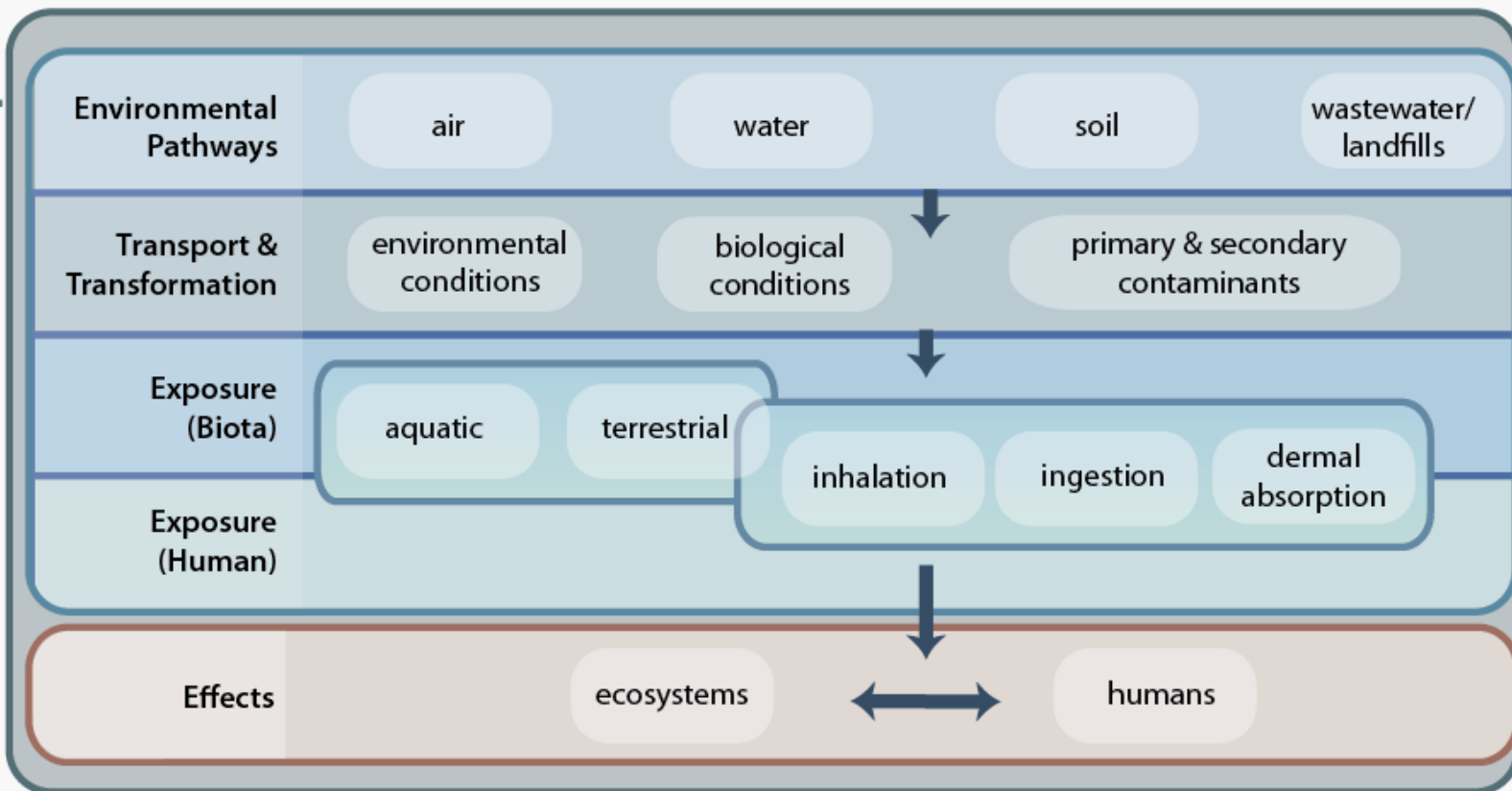
Product Life Cycle Stages

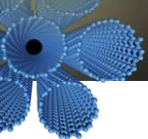


Risk Assessment Paradigm

Exposure Assessment
Transport/
Transform
Concentration
in Env.
External Dose

Hazard ID
Internal Dose
& Response

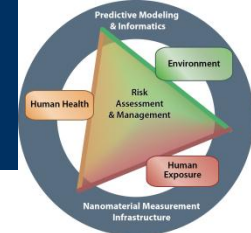




Measurement Research Needs

- Develop measurement tools for :
 - Physico-chemical properties of ENMs
 - Detection and monitoring of ENMs in realistic exposure media and conditions
 - Transformations of ENMs and NEPs
 - Biological responses to ENMS and NEPs
 - Release mechanisms

Nanomaterials Measurement Infrastructure: Enabling the Human Health and Environment Research



2008 Strategy

IMA Research Need #1
Develop methods to **detect** nanomaterials in biological matrices, the environment, and the workplace

IMA Research Need #2
Understand how **chemical and physical modifications** affect the properties of nanomaterials

IMA Research Need #3
Develop methods for standardizing assessment of **particle size, size distribution, shape, structure, and surface area**

IMA Research Need #4
Develop **certified reference materials** for chemical and physical characterization of nanomaterials

IMA Research Need #5
Develop methods to characterize a nanomaterial's **spatio-chemical composition, purity, and heterogeneity**

HH Research Need #2
Develop methods to quantify and characterize exposure to nanomaterials and **methods to characterize nanomaterials in biological matrices**

HH Research Need #3
Identify or develop **appropriate in vitro and in vivo assays/models** to predict in vivo human responses to nanomaterial exposure

2011 Strategy

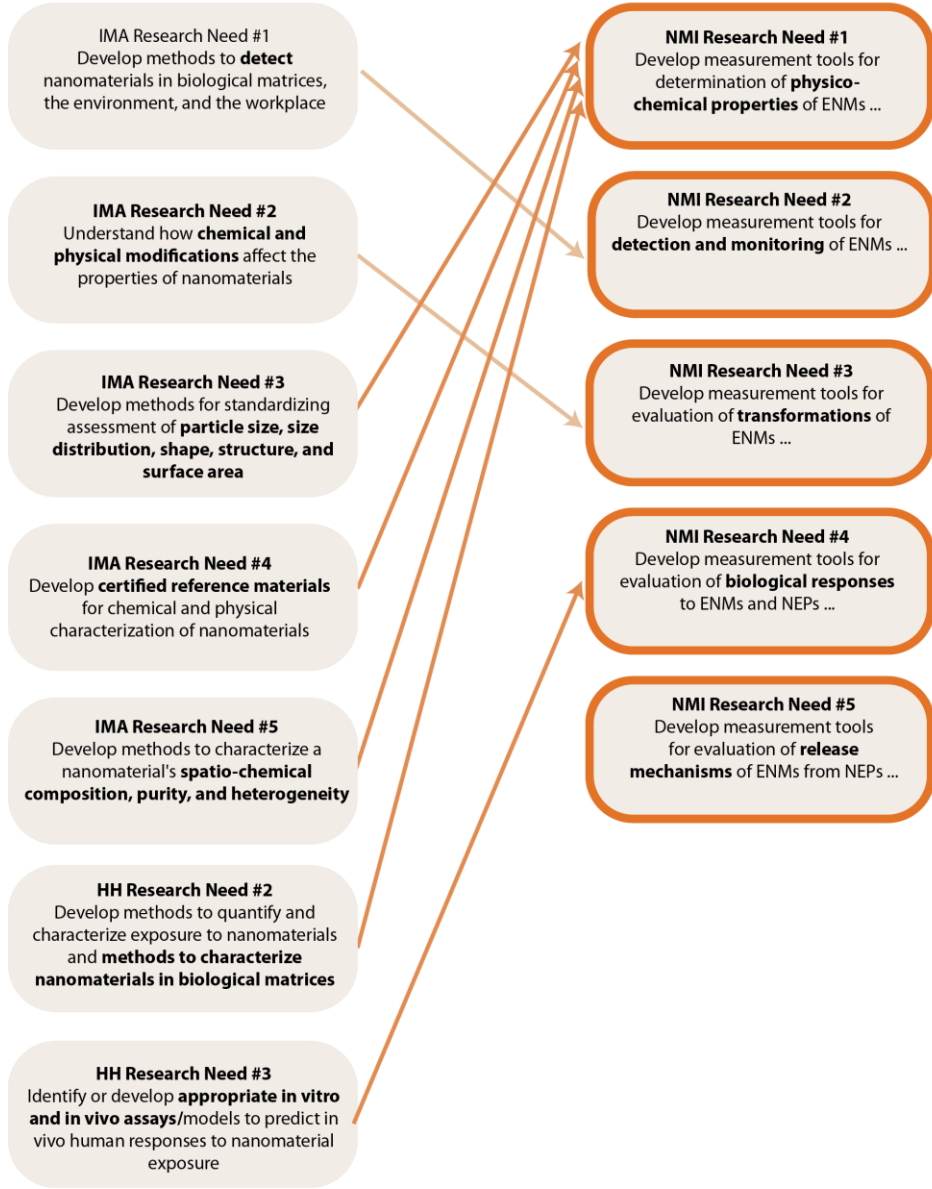
NMI Research Need #1
Develop measurement tools for determination of **physico-chemical properties** of ENMs ...

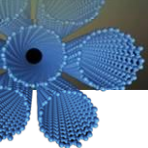
NMI Research Need #2
Develop measurement tools for **detection and monitoring** of ENMs ...

NMI Research Need #3
Develop measurement tools for evaluation of **transformations** of ENMs ...

NMI Research Need #4
Develop measurement tools for evaluation of **biological responses** to ENMs and NEPs ...

NMI Research Need #5
Develop measurement tools for evaluation of **release mechanisms** of ENMs from NEPs ...





Measurement Definitions

Protocols

- well-defined procedures, methods, or assays that may require the use of reference materials and controls, as well as methods for data analysis.

Standards

- internationally recognized reference materials and certified reference materials, developed by organizations such as NIST, and consensus-based documentary standards published by national and international standards development organizations such as ISO and ASTM International.

Instruments

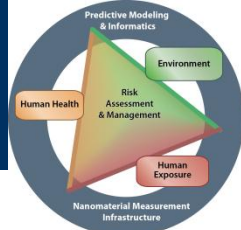
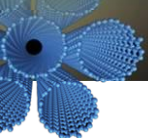
- new or improved measurement apparatuses that may be broadly transferred to and adopted by other organizations.

Models

- representations that support interpretation and structure and other properties.

Data

- “benchmark” data that have been measured using validated protocols and reference materials (if relevant) or other well-characterized test materials.



Informatics and Modeling for NanoEHS Research

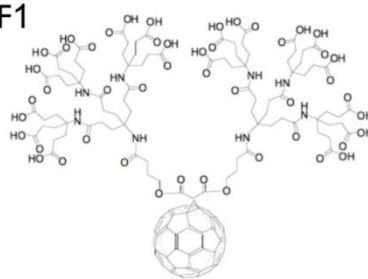
- Aid development, analysis, organization, archiving, sharing, and use of data that is acquired in nanoEHS research projects in the core research.
- Effectively manage reliable, high-quality data to support advanced modeling and simulation.

- **Sections:**

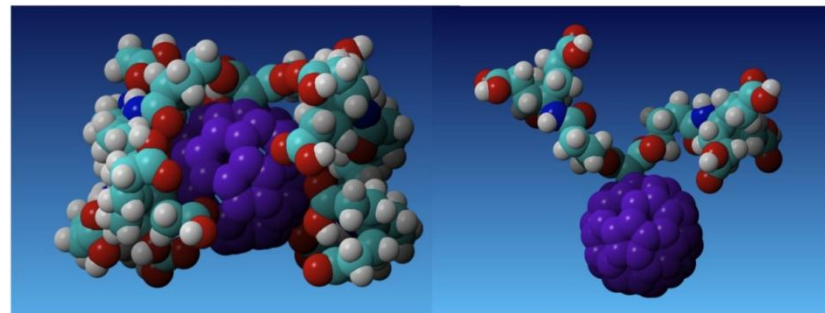
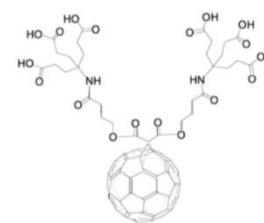
- Data acquisition, analysis, sharing
- Structural models
- Predictive models and simulations
- Collaborative informatics infrastructure

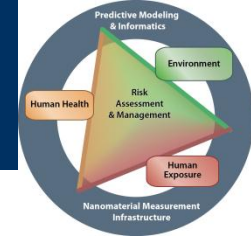
- **New research need**

DF1



DF1-mini

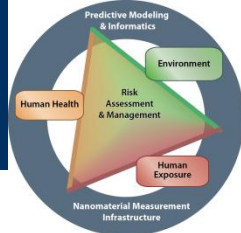
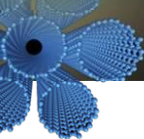




Targeting and Accelerating Research

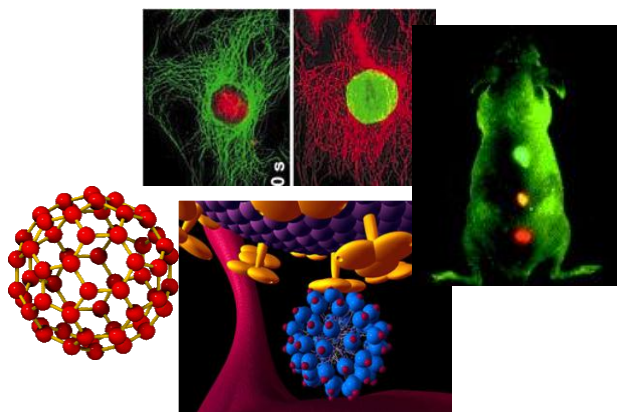
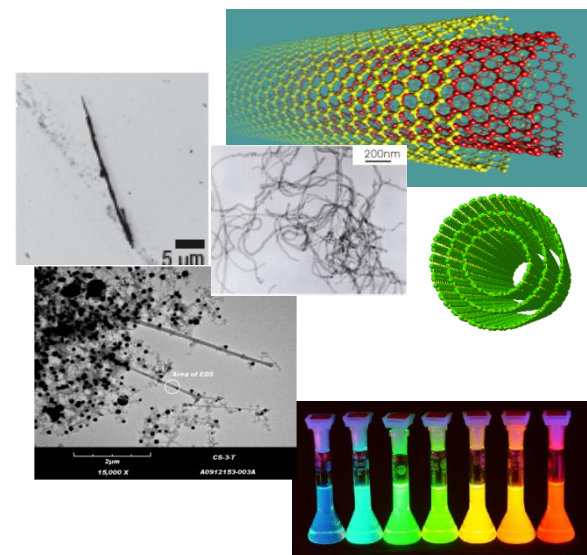
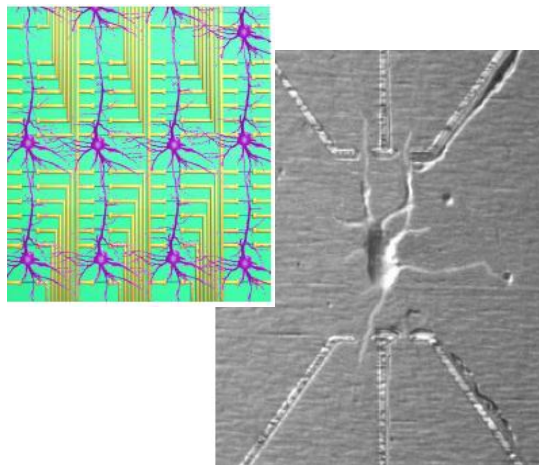
- Prioritize which nanomaterials to research
- Establish standard measurements, terminology, and nomenclature
- Maximize data quality
- Stratify knowledge for risk assessment
- Partner to achieve the NNI EHS research goals
- Engage internationally

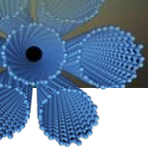




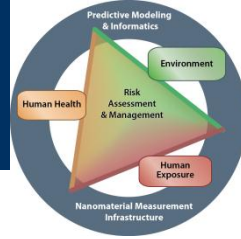
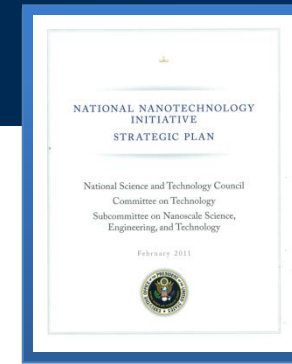
Prioritizing Nanomaterials for Research

- Potential for hazard
- Likelihood of exposure
- High reactivity
- Biological Novelty
- Identified in a health or environmental event





2011 NNI Strategic Plan



Vision

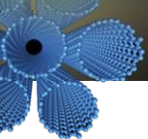
• A future in which the ability to understand and control matter on the nanoscale leads to a revolution in technology and industry that benefits society.

Goals

- Advance world-class nanotechnology research and development
- Foster the transfer of new technologies into products for commercial and public benefit
- Develop and sustain educational resources, a skilled workforce, and the supporting infrastructure and tools to advance nanotechnology
- **Support responsible development of nanotechnology**

Objectives (new)

- Three to five year outcomes and deliverables



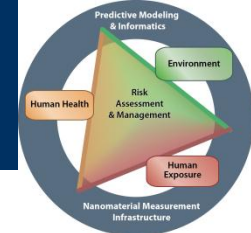
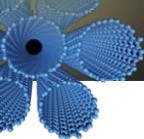
NNI Strategic Plan Goal 4: Responsible Development

4.1 Incorporate safety evaluation of nanomaterials into the product life cycle, foster responsible development, and, where appropriate, sustainability across the nanotechnology innovation pipeline

4.2 Develop tools and procedures for domestic and international outreach and engagement to assist stakeholders in developing best practices for communicating and managing risk

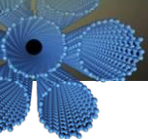
4.3 Identify and manage the ethical, legal and social implications (ELSI) of research leading to nanotechnology-enabled products and processes

4.4 Employ nanotechnology and sustainable best practices to protect and improve human health and the environment

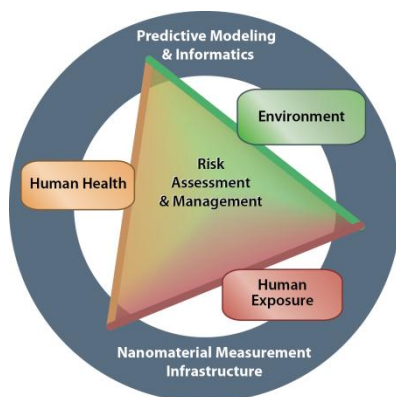


Alignment between Goals and Objectives of the NNI Strategic Plan and the NNI EHS Research Strategy

<p>NNI Strategic Plan Objective 4.1.1.1:</p>	<p>NNI EHS Research Strategy Goals:</p>	<p>Explanation of the Relationship:</p>
<p>Incorporate safety evaluation of nanomaterials into the product life cycle, foster responsible development, and, where appropriate, sustainability across the nanotechnology innovation pipeline, by developing and applying measurement tools (defined as protocols, standards, models, data, and instruments) to assess the physico-chemical properties of engineered nanoscale materials (ENMs) and their biological effects in the environment and on human health and quantify exposure across the nanotechnology product life cycle.</p>	<ul style="list-style-type: none"> ■ Develop measurement tools for determination of physico-chemical properties of engineered nanoscale materials in relevant media and in products ■ Develop measurement tools for determination of biological response, and to enable assessment of hazards and exposure for humans and the environment from engineered nanomaterials and nanotechnology-based products throughout all stages of their life cycles ■ Understand the relationship of physico-chemical properties of engineered nanoscale materials to <i>in vivo</i> physico-chemical properties and biological response. ■ Identify, characterize, and quantify exposures of workers, the general public and consumers to nanomaterials. ■ Understand the environmental fate, exposure, and ecological effects of engineered nanomaterials. 	<p><i>The NNI Strategic Plan objective 4.1.1.1 maps directly to the goals and research needs articulated in the NNI EHS research strategy. The Nanomaterial Measurement Infrastructure (NMI) goals direct development of measurement tools to determine the physico-chemical properties of ENMs in relevant media and in NEP and for the biological response across the ENM and NEP life cycles. The NMI research needs specify the types of assays and measurement tools necessary to achieve the NMI goals, and the resulting tools are applied in the human exposure assessment, human health, and environment categories to make the quantitative measurements of exposure and biological effect. Quantitative measures of exposure are also consistent with the human exposure assessment goal to identify, characterize, and quantify exposures of workers, the general public, and consumers to nanomaterials.</i></p>



2011 NNI Environment, Health, and Safety Research Strategy



**Draft document available at:
<http://strategy.nano.gov/>**

**More information on the NNI:
nano.gov**