Cancer Nanotechnology and Nanotoxicology: Response to NIH RFAs

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I. Nanotechnology and cancer research

-many biological processes including those leading to cancer occur at the nanoscale.

-Advances in nanotech have enabled the fabrication, visualization, characterization and delivery at the nanoscale.

-Combining the two (nanotech and cancer research) enables us to detect, understand mechanisms, image, target, and activate more precisely.
NCI Alliance for Nanotechnology in Cancer

- Established in 2004

**Mission:** To harness the power of nanotechnology to radically change the way we diagnose, treat and prevent cancer.

**Programs:**
- Center of Cancer Nanotechnology Excellence (U54)
- Cancer Nanotechnology Platform Partnerships (U01)
- Cancer Nanotechnology Research Training Programs (T32)
- Pathway to Independence Awards (K99/R00)
- Nanotechnology Characterization Laboratory (NCL)

[www.nano.cancer.gov](http://www.nano.cancer.gov)
NCI Nanotech Alliance: Priority Areas

- **Prevention and Control**
  - Delivery of cancer preventing agents
  - Multicomponent anticancer vaccines

- **Early Detection and Proteomics**
  - Molecular sensors for detection of cancer-associated biomarkers
  - Collection platforms for simultaneous mass spectroscopic analysis of cancer-associated markers

- **Imaging Diagnostics**
  - “Smart” injectable, targeted contrast agents that improve the resolution of cancer to the single cell level
  - Nanoscale devices for addressing the biological diversity of multiple cancer cells within an individual tumor

- **Multifunctional Therapeutics**
  - Developing nanoscale devices that integrate diagnostic and therapeutic functions
  - “Smart” therapeutic devices that control the spatial and temporal release of therapeutics while monitoring effectiveness

- **Quality of Life Enhancement in Cancer Care**
  - Nanoscale devices that optimally deliver medications for treating conditions that may arise over time with chronic anticancer therapy, including pain, nausea, loss of appetite, depression, etc.

- **Interdisciplinary Training**
  - Cross-training in molecular and systems biology to nanotechnology engineers and in nanotechnology to cancer researchers
  - New interdisciplinary coursework/degree programs to train a new generation of researchers skilled in both cancer biology and nanotechnology
Nanotech at the U: Tools for Cancer Research

- **Nanomaterials**
  - Materials for delivery of bioactive and imaging agents to cancer cells, sensing, etc.
  - Can be organic (e.g., polymers) or inorganic (e.g., iron oxide, silica or gold nanoparticles)

- **Nanobiosensors**
  - Nanometrically engineered surfaces for detection of biomarkers
  - Nanopores embedded in glass membranes for biosensing

- **Nanomedicine & Drug Delivery**
  - Drug, gene, imaging agent delivery (polymers, micelles, dendrimers, polymer/gene complexes, nanobubbles, etc.)
  - Nanotoxicology

- **Interfacial Sciences**
  - High throughput sensing for molecular recognition
  - Spectroscopy at interfaces
  - Protein adsorption, phase segregation

- **Micro and nanofabrication**
  - E.g., nucleic acid, protein and cell-based microarrays
  - Micro and nanofluidics for high throughput

- **Imaging, Diagnostics and Therapeutics**
  - “The real state of cancer therapy is location, location, location”
  - Multifunctional carriers for delivery and diagnosis (Theranostics)

- **Gastrointestinal Cancers**
  - Often nanotechnology enabled systems are broadly applicable to a wide variety of cancers, e.g., targeting angiogenesis or can be tailor made (specific overexpression of receptors or exploiting tumor physiology)

- **Cell response and regulation**
  - Can nanoparticles aid in understanding fundamental cellular mechanisms?
  - How do nanoparticles influence fundamental cellular mechanisms?

- **Nuclear Control of Cell Growth and Differentiation**
  - Nanoparticles may interact with nucleus and regulate cell function. They can also provide tools for enabling this research—e.g., high throughput sensing

- **Cancer Control and Population Sciences**
  - Nano & Personalized medicine
  - Delivery of cancer preventing agents
  - Quality of life assessment with nano-enabled

**Key Challenge: Integration**
Previous Success @ the U and Future Plans

**Cancer Nanotechnology Platform Partnerships (U01) (Awarded)**
Magnetoresistive Sensor Platform for Parallel Cancer Marker Detection (Principal Investigators: Marc Porter and Sean J. Mulvihill)

**Physical Sciences Oncology Network NCI (U01) (Awarded)**
Multi-Tensor Decompositions for Personalized Cancer Diagnostics and Prognostics (Principal/Co- Investigators: Orly Alter and Margit M. Janát-Amsbury)

**Pathway to Independence Awards (K99/R00) (Awarded)**
Inhibition of Metastasis-Initiating Cells by Chimeric Polypeptide Nanoparticles (Principal Investigator: Mingnan Chen)

**Research Training Programs (T32) (Pending Review)**
Utah Training Program in Cancer Nanotechnology (Principal Investigators: Hamid Ghandehari and Sean J. Mulvihill)

**Innovative Research in Cancer Nanotechnology (U01) (To be submitted April 2016)**

*Scope to be defined; ideas welcome*
II. Nanotoxicology

**Unwanted Exposure**
- Consumer products
- From cosmetics to fuel cells
- Pollution
- Etc.

**Intended Exposure**
- Deliberate administration into the body
- Drug delivery systems
- Biosensors
- Imaging agents
- Etc.

**Nanotoxicology:**
“The study of the interactions of nanostructures with biological systems with an emphasis on elucidating the relationship between the physical and chemical properties (e.g. size, shape, surface chemistry, composition, and aggregation) of nanostructures with induction of toxic biological responses.”

*Current Opinion in Biotechnology. 2007, 18, 565-571*
Nanotoxicology: Current Funding and Future Plan

1) Biological Fate and Biocompatibility of Dendritic and Silica-Based Nanoconstructs *(Awarded)* (PI: Ghandehari, Collaboration with Grainger, Hlady, Moos and Zharov; R01)


*Focus on routes of exposure*

*Ideas / thoughts welcome*
BIRCWH: Interdisciplinary Research in Women’s Health

Internal Submission Deadline: FRIDAY, OCTOBER 16th, 2015

Goals:

- Anything Women’s Health
- The I in BIRCWH stands for Interdisciplinary
- 5 year award
- Every 2 years another opportunity for new applicants
- A couple more announcements to follow
- Evenly split between MD, PhD, Pharm D…