

Nanoscience and Nanotechnology Research for Biology and Medicine



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BRP Grantee Meeting
Bethesda, 15-16 August 2005



National Institutes of Health Bioengineering Consortium

NIBIB Home

BECON Home

NIH Bioengineering Consortium (BECON)

Bioengineering Consortium

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What's New? [What's New?](#)

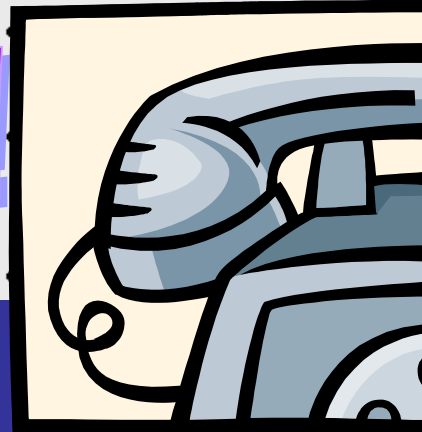
Why are you here? [Why are you here?](#)

What's new at BECON? [What's new at BECON?](#)

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What's new at NIH? [What's new at NIH?](#)

BECON - The Bioengineering Consortium (BECON) is the focus of bioengineering activities at the NIH. The Consortium consists of representatives from all of the NIH Institutes for Biomedical Sciences and Technology. The BECON is a part of the Institute of Biomedical Engineering (NIBIB).



**Contact Program Directors
in the Institutes!**

Your portal to bioengineering
grants & programs at NIH

<http://www.becon.nih.gov>



NANOTECHNOLOGY RESEARCH SUPPORT AT NIH



NIH supports nanoscience and nanotechnology research in the context of many programs.

While in some of those programs/projects, the focus may be on the nano-research *per se*, in other cases the nano-research may be a component of a larger project with broader goals.

Several examples are provided here, to demonstrate support for the breadth of potential applications of nanotechnology for understanding, diagnosing and treating disease.



NANOTECHNOLOGY RESEARCH SUPPORT AT NIH



Program announcements issued through BECON:

- Nanoscience and Nanotechnology in Biology and Medicine
- Bioengineering Nanotechnology Initiative (SBIR)
- Exploratory/Developmental Bioengineering Research Grants
- Bioengineering Research Grants
- Bioengineering Research Partnerships
- Mentored Quantitative Research Career Development (K25)
- *Awards under these programs are listed on the BECON web site: www.becon.nih.gov/nano.htm*



NANOTECHNOLOGY RESEARCH SUPPORT AT NIH



Nanoscience and Nanotechnology in Biology & Medicine

- i) create & use structures, devices & systems that have novel properties and functions because of their small size, to achieve a fundamental understanding of biological processes or for disease detection, therapy, or prevention; ii) conceive, fabricate and test devices to detect and analyze nanoscale entities of relevance to biomedicine; iii) study biological systems at the nanoscale to develop nanotechnologies and nanostructured materials for use in biomedicine.
- Encourages team approach to nanotechnology research.
- R01 (research project).
- R21 (exploratory/developmental) if little preliminary data and potential for groundbreaking impact. R21s are for up to 3 years, up to \$125,000 per year direct cost.
- **Review panel dedicated to this program announcement.**
- Application Receipt: February 18 & August 18, through 2006
- <http://grants.nih.gov/grants/guide/pa-files/PAR-03-045>



NANOTECHNOLOGY RESEARCH SUPPORT AT NIH



Nanoscience and Nanotechnology in Biology & Medicine

- 20 awards in FY 2004 – 10 R21, 10 R01
 - 8 NIBIB
 - 4 NIGMS
 - 4 NHGRI
 - 2 NCI
 - 1 NIA
 - 1 NIDCR
- \$4.8 million



NANOTECHNOLOGY RESEARCH SUPPORT AT NIH



Bioengineering Nanotechnology Initiative (SBIR)

- Nanotechnology is emerging as a field critical for enabling essential breakthroughs that may have tremendous potential for affecting biomedicine.
- Encourages team approach to nanotechnology research
- Phase I may request up to 2 years, \$200,000 per year
- Phase II may request up to 3 years, \$400,000 per year
- Applications Receipt per SBIR:
April 1, August 1 and December 1
- Competes with other SBIR applications
- <http://grants.nih.gov/grants/guide/pa-files/PA-02-125>



BIOENGINEERING RESEARCH SUPPORT AT NIH



Bioengineering Research Partnerships

- For basic and applied research by a multi-disciplinary team applying an integrative, systems approach to develop knowledge and/or methods to prevent, detect, diagnose, or treat disease or to understand health and behavior.
- Partnership must include bioengineering expertise and basic biology and/or clinical expertise.
- Identify lead investigators in Abstract
- Maximum request = \$2M per year for five years
- Need approval >6 wks before submission if request >\$500,000 direct cost
- Research Project (R01) mechanism
- Application receipt: January 21, August 20 (2004 through 2006)
- <http://grants.nih.gov/grants/guide/pa-files/PAR-04-023.html>

Reviewed in Special Emphasis Panels



BIOENGINEERING RESEARCH SUPPORT AT NIH



Bioengineering Research Grants

- For basic and applied multi-disciplinary research that addresses important biological or medical research problems.
- Hypothesis-driven, discovery-driven, developmental, or design-directed research.
- Multi-disciplinary research performed in a single laboratory or by a small number of investigators that applies an integrative, systems approach to develop knowledge and/or methods to prevent, detect, diagnose, or treat disease or to understand health and behavior.
- Research Project (R01) mechanism
- Applications Receipt: February 1, June 1, and October 1
- <http://grants.nih.gov/grants/guide/pa-files/PA-02-011.html>
(will be re-issued)



BIOENGINEERING RESEARCH SUPPORT AT NIH



Mentored Quantitative Research Career Development (K25)

- For research-oriented physical/mathematical scientists and engineers to engage in supervised study & research leading to increased competence to perform biomedical, behavioral, bioengineering or bioimaging research.
- PI's on NIH grants are not eligible
- Up to five years of support, NIH/IC limit on salary, \$40,000 supplies/personnel/travel/tuition
- Requires commitment of 75% of effort
- Application Receipt: February 1, June 1, and October 1
- <http://grants.nih.gov//grants/guide/pa-files/PA-02-127.html>



NANOTECHNOLOGY RESEARCH SUPPORT AT NIH

Tissue Engineering

Functional Tissue Engineering of Musculoskeletal Tissues



- To stimulate innovative research that will enhance our understanding of functional tissue engineering of musculoskeletal tissues (articular cartilage, ligaments, tendons, bone, meniscus, intervertebral disc and skeletal muscle).
- NIAMS, NICHD, NIDCR
- <http://grants.nih.gov/grants/guide/pa-files/PA-02-014.html>

Novel Approaches to Corneal Tissue Engineering



- To explore new approaches that could lead to enhanced engineering of corneal tissues, includes studies of early developmental processes to delineate the interactions between individual corneal tissue layers, the biomechanical properties of the stroma, cellular control of matrix deposition, control of corneal growth and maturation, and studies of synthetic replacement materials.
- NEI
- <http://grants.nih.gov/grants/guide/pa-files/PA-02-053.html>



NANOTECHNOLOGY RESEARCH SUPPORT AT NIH

Diagnostics & Therapeutics

Novel Technologies for *in vivo* Imaging



- For the development and delivery of novel image acquisition or enhancement technologies and methods for biomedical imaging and image-guided interventions and therapy, and which may incorporate limited pilot or clinical feasibility evaluations using either pre-clinical models or clinical studies. This initiative will facilitate the proof-of-feasibility, development, and delivery of novel imaging technologies and limited evaluation studies to show proof-of-concept and functionality.
- NCI
- <http://grants.nih.gov/grants/guide/pa-files/PA-04-095.html>

Speech Processor Optimization for Cochlear Implants



- To advance the design of speech processors for cochlear implants. The goal of this RFA is to support the development of innovation and enhancements for cochlear implants that will increase the level of patient performance. The research may involve conceptualization, design, fabrication, and/or testing of algorithms for evoking neural activity with cochlear implants.
- NIDCD
- <http://grants.nih.gov/grants/guide/rfa-files/RFA-DC-04-001.html>



NHGRI DNA Sequencing Technology Development

“\$100,000 and \$1000 genome”



Capillary/microchannel integrated system, near-term

Jovanovich/Mathies/Barron
(Microchip Biotechnologies, Inc.)
Gorfinkel (SUNY Stony Brook)
Kellogg (Network Biosystems)

Microfluidic device

Fair (Duke U)

SBS/polony integrated systems, near-term

Costa/Smith (Agencourt Personal Genomics)
Lohman/Margulies (454 Life Sciences)
Church (Harvard Med)

SBS/polony component

Benner (U of Florida)
Ju (Columbia U)
Metzker (Baylor/LaserGen)
Ronaghi (Stanford U)
Williams, P (Arizona State U)

SBS single-molecule

Quake (Stanford U)
Williams, J (LiCor Inc.)

Free-running polymerase

Hardin (VisiGen)
-9 Turner (Nanofluidics)

Sequencing-by-hybridization/denaturation

Huang (UCSC)
Mishra (NYU)

Biological nanopore

Ghadiri/Bayley (Scripps/Oxford)

Synthetic nanopore

-9 Collins (U of Maine)
-9 Davis (Stanford U)
-9 Ramsey (U of North Carolina)
-9 Golovchenko/Branton/Deamer
(Harvard)
-9 Timp (UIUC)

Nanopore with modified analyte

-9 Benner (U of Florida)
-9 Marziali (U of British Columbia)
-9 Meller (Rowland Inst)
Ju (Columbia)

Other near-field sensing of unmodified DNA

-9 Lindsay (Arizona State U)
-9 Lee (Oak Ridge Nat'l Lab)

-9 → \$20 m over life of grants



NIDCR Salivary Diagnostics Program

- Development of Technologies for Saliva/Oral Fluid Based Diagnostics
- to encourage outstanding multidisciplinary research aimed at the development of new technologies or the advancement of existing technologies for simultaneous multi-analyte detection in saliva and other oral fluids
- 7 U01 awards



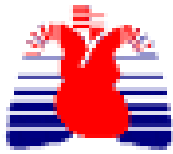
Nanotechnology at NHLBI

- NHLBI held a Working Group in 2003 to assess the potential of nanotechnology for heart, lung, blood and sleep diseases. The Working Group identified 4 areas where nanotechnology could have an immediate impact:
 - Targeted therapeutics
 - Tissue engineering to replace defective valves, damaged heart muscle, clogged blood vessels
 - Molecular imaging
 - Biosensors and diagnostics



Nanotechnology at NHLBI

- An NHLBI RFA for multidisciplinary Programs of Excellence in Nanotechnology was funded in 2005, awarding \$54 million over 5 years.
 - Washington University
 - Georgia Tech
 - Burnham Institute
 - Massachusetts General Hospital



Nanotechnology at NHLBI

- A new initiative to support innovative nanotechnology research for the diagnosis and treatment of heart, lung, blood and sleep disorders
 - has been developed and approved by the NHLB Advisory Council
 - and is currently under consideration for release.

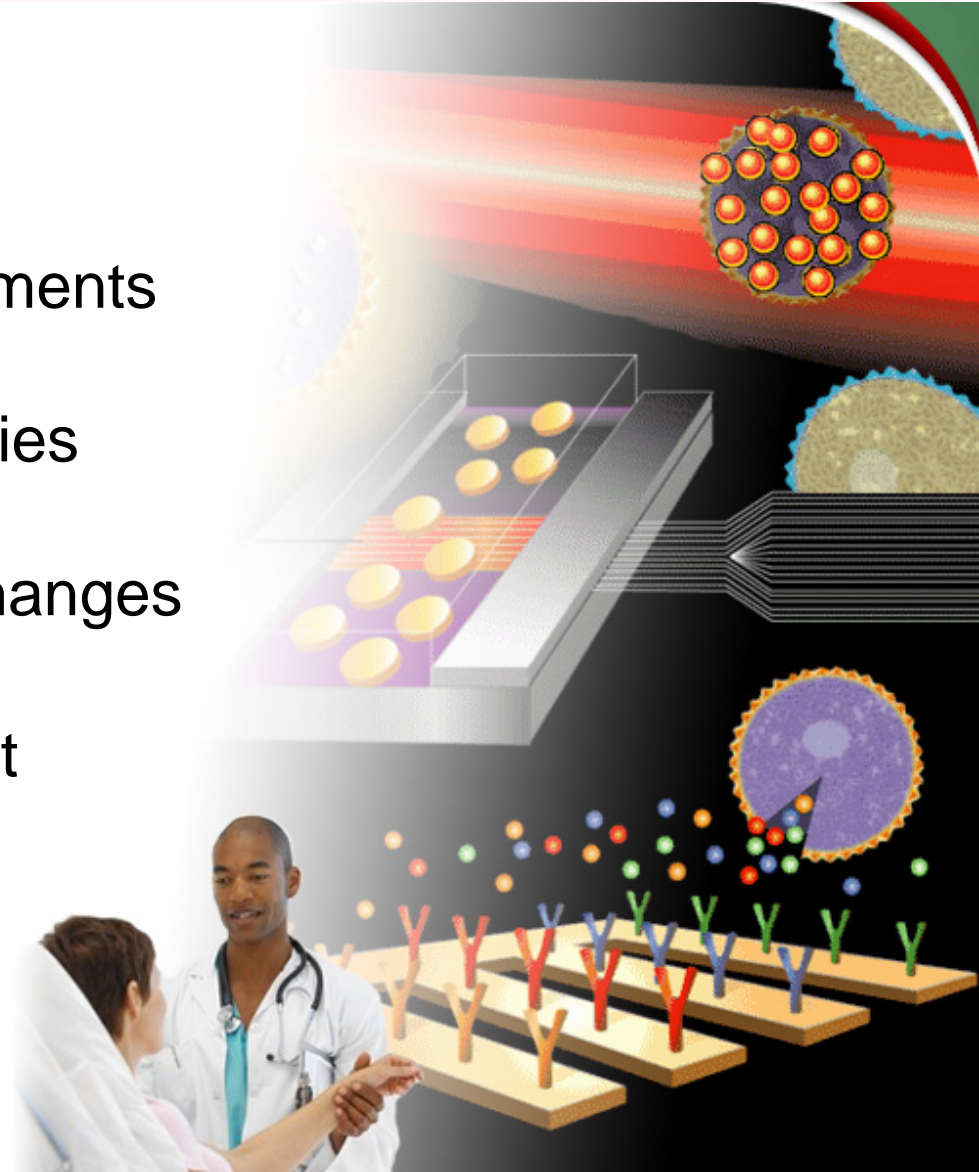
Alliance for Nanotechnology in Cancer

- \$144.3M initiative launched in September 2004
- Designed to “ignite” nano-product development and commercialization
- Encompasses public and private sectors
- Emphasizes cross-disciplinary collaborations
- Participates in the National Nanotechnology Initiative (NNI)



Alliance Goals

- Early detection
- Real-time efficacy assessments
- Delivery of multiple therapies
- Monitoring of molecular changes
- Symptomatic management
- Targeted discovery



Alliance Strategies

Major Programs of the Alliance:

- 1 Centers of Cancer Nanotechnology Excellence**
- 2 Multidisciplinary Research Teams**
 - Training
 - Interagency Collaborations
- 3 Nanotechnology Platforms for Cancer Research**
- 4 Nanotechnology Characterization Laboratory**

Nanotechnology Characterization Laboratory

Mission:

- Perform and standardize the preclinical characterization of nanomaterials developed by academic, government, and industrial researchers
- Accelerate use of nanoparticles for drug delivery, as image contrast agents, and for diagnostics
- Collaborate with other government agencies to leverage resources and expertise

How the Alliance Applies Systems-level Approaches

- Requires academic and commercial partnerships for each supported Alliance project
- Establishes training programs
- Commits major funding that leverages existing infrastructure
- Coordinates with other Federal agencies to leverage NCI funds and creates synergies
- Pre-qualifies new materials and informs standards through the Nanotechnology Characterization Laboratory
- Reduces the risk of investment in new products

Alliance Milestones

Centers of Cancer Nanotech Excellence selections

- Announcement: Fall 2005

Fellowships in Cancer Nanotech

- RFA receipt date: Nov. 16, 2005

Nanotech Characterization Lab

- Accepting nanomaterials to characterize

Nano.Cancer.Gov Website

- Available for the latest info on funding opportunities and nanotech news

National Cancer Institute
U.S. National Institutes of Health | www.cancer.gov

NCI Alliance for Nanotechnology in Cancer
Transforming the diagnosis, prevention, treatment and clinical outcomes for cancer patients

Nanotech Highlights

[Request for Applications RFA-CA-06-010](#)
Fellowships in Cancer Nanotechnology Research
Receipt Date: November 16, 2005

[Nanotechnology in Cancer Spotlighted at NSTI Nanotech 2005](#)
Speaker: Gregory Downing, D.O., Ph.D., National Cancer Institute

[NCI NCL Solicitation NOT-CA-05-011](#)
Nanotech Strategies for Cancer Research

DELIVERING
today's knowledge in
Nanotech Oncology

This Week's Nanotech News [view all]

[Nanoscale "Cell Within A Cell" Delivers Multiple Therapies that Kill Tumors](#) Aug 1

[DNA Nanoparticles Deliver Genes Intravenously](#) Aug 1

[Nanostructured Scaffold Growing New Bladder Tissue](#) Aug 1

[Nanofluidics Produces Million-Fold Concentration of Proteins](#) Aug 1

Quick Links

[Nanotechnology Characterization Lab](#)

[Nanotechnology Teaming Site](#)

[Funding Opportunities](#)

[Upcoming Events](#)

Monthly Feature

[Self Assembly for Nanoscale Devices](#)

National Cancer Institute
U.S. National Institutes of Health | www.cancer.gov

NANOTECHNOLOGY CHARACTERIZATION LABORATORY

About the NCL | Objectives | Partnerships | Working with the NCL | Resources | Contact Us

MEASURING
the future in health

News & Events

09.01.2005
Need Submission Due Date for NCL Application Materials in Sept. 2005. View submission procedures and evaluation criteria for NCL review of nanomaterials.

05.27.2005
"Nanotechnology for the Biologist," Journal of *Feinberg's Biotech*

Nanotechnology Characterization Lab

Eliminating suffering and death from cancer requires an unprecedented collaborative effort that leverages resources from government, industry, and academia. Working in concert with the National Institute of Standards and Technology (NIST) and the U.S. Food and Drug Administration (FDA), the National Cancer Institute (NCI) established the Nanotechnology Characterization Laboratory to perform preclinical efficacy and toxicity testing of nanoparticles.

The NCL will serve as a national resource and knowledge base for all cancer researchers to facilitate the regulatory review of nanotechnologies intended for cancer therapies and diagnostics. By providing the critical infrastructure and characterization services to nanomaterial providers, the NCL can accelerate the transition of basic nanoscale particles and devices into clinical applications.

NCL Spotlight

NCL Business Plan
Learn how the NCI, NIST and FDA are collaborating to fight cancer.

Quick Guide to Application Process
View submission procedures and evaluation criteria for NCL review of nanomaterials.

ncl.cancer.gov

nano.cancer.gov



NANOTECHNOLOGY RESEARCH ENVIRONMENT, HEALTH, AND SAFETY



National Toxicology Program

Toxicological Evaluation of Nanoscale Materials

- NIEHS/NIH, NIOSH/CDC, NCTR/FDA
- Nanoscale materials activities initiated 2002
- Size- and composition-dependent biological disposition of nanoscale crystalline fluorescent semiconductors.
- Short- and long-term studies of one or more carbon-based nanoscale materials (e.g., SW- or MW-nanotubes, fullerenes)
- Evaluate role of core and surface composition in possible immunotoxicity of the above (quantum dots and CNTs)
- Phototoxicology studies of representative nanoscale metal oxide particles used in industrial setting and consumer products (e.g., TiO_2)
- Skin uptake, inhalation, and oral routes of exposure



NANOTECHNOLOGY RESEARCH ENVIRONMENT, HEALTH, AND SAFETY



- FY06 Joint solicitation on health and environmental effects of manufactured nanomaterials
- EPA, NIEHS, NIOSH (CDC), and NSF

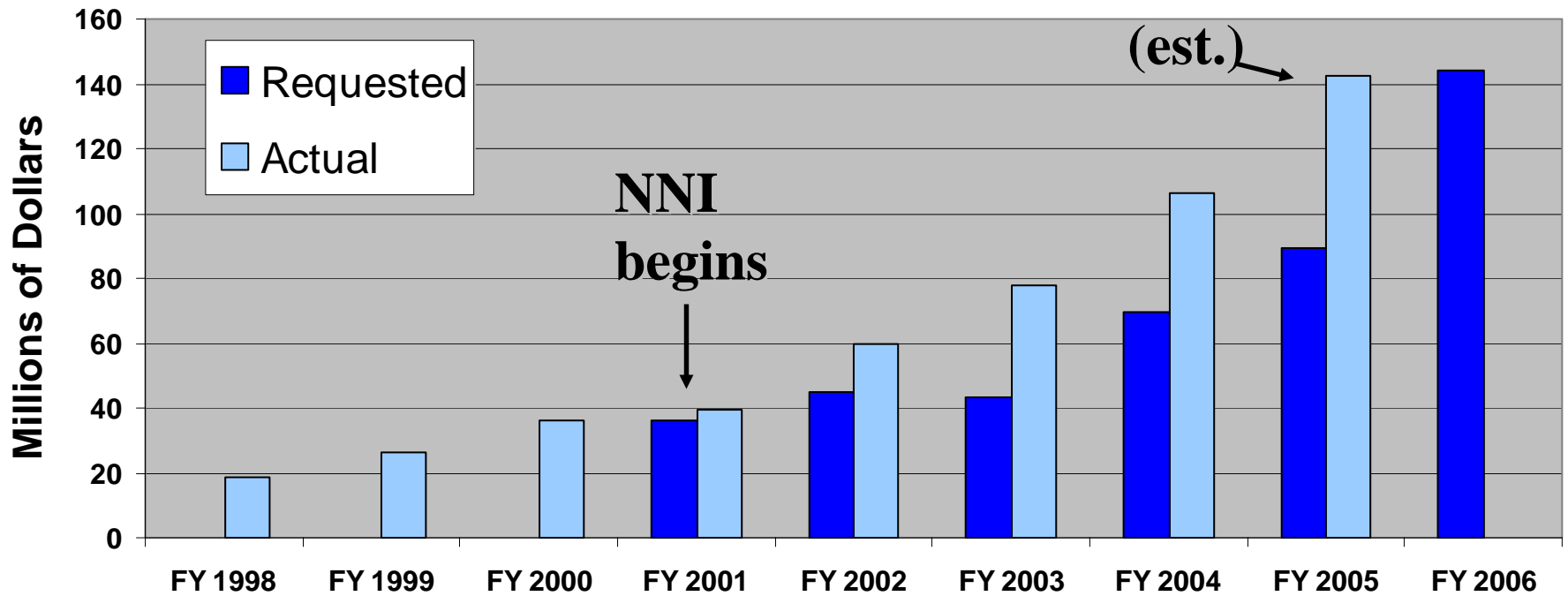


NIH NANOSCIENCE/NANOTECHNOLOGY NANOMEDICINE NCI ALLIANCE CONTACTS

National Cancer Institute NCI Alliance for Nanotechnology	Dan Gallahan Greg Downing, Travis Earles Richard Fisher, Paul Sieving Denis Buxton Jeff Schloss, Allison Peck Winifred K. Rossi Karen Peterson
National Eye Institute	Maria Giovanni
National Heart, Lung, and Blood Institute	Jim Panagis, Kuan Wang
National Human Genome Research Institute	Bill Heetderks, Peter Moy
National Institute on Aging	Louis Quatrano
National Inst of Alcohol Abuse and Alcoholism	Roger Miller
National Inst of Allergy and Infectious Diseases	Eleni Kousvelari
Nat'l Inst of Arthritis & Musculosk & Skin Diseases	Maren Laughlin
National Institute for Biomedical Imaging and Bioengineering	Tom Aigner
National Institute of Child Health and Human Development	David Balshaw, Sally Tinkle
National Inst on Deafness & Other Communication Disorders	John Bucher, Nigel Walker
National Institute of Dental and Craniofacial Research	Cathy Lewis
National Inst of Diabetes and Digestive and Kidney Disorders	Mike Huerta
National Institute on Drug Abuse	Joe Pancrazio
National Institute of Environmental Health Sciences	John Bowers
National Toxicology Program	King Li
National Institute of General Medical Sciences	
National Institute of Mental Health	
Nat'l Inst of Neurological Disorders and Stroke	
Center for Scientific Review	
Clinical Center	



NIH Nanotechnology Funding



SBIR/STTR

FY	2001	2002	2003	2004
\$M	4.4	7.9	7.2	11.9



National Nanotechnology Initiative (NNI) Advances in Biomedicine and Healthcare

- Detecting Disease *Before* Health Has Deteriorated
 - Imaging
 - Sensors
- Implants to Replace Worn or Damaged Body Parts
 - Controlling interactions of synthetic and inorganic materials with the body, for effective integration
- Delivery Of Therapeutics
 - Particle Size
 - Targeting
- Research Tool correlates of the above

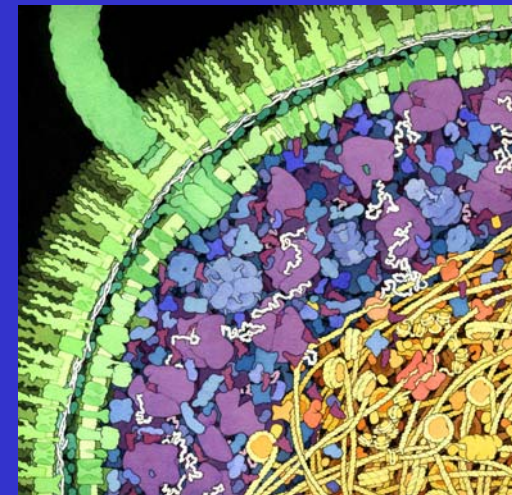


NIH Roadmap

ACCELERATING MEDICAL DISCOVERY TO IMPROVE HEALTH



NANOMEDICINE ROADMAP INITIATIVE



National Institutes
of Health



Department of Health
and Human Services

**Clinical
Enterprise**

**Re-engineering the
Clinical Research
Enterprise**

**Molecular
Libraries
and Imaging**

**Building Blocks,
Biological Pathways
and Networks**

**Public-Private
Partnerships**

**Implementation
Groups**

**Structural
Biology**

**High-risk
Research**

**Bioinformatics and
Computational Biology**

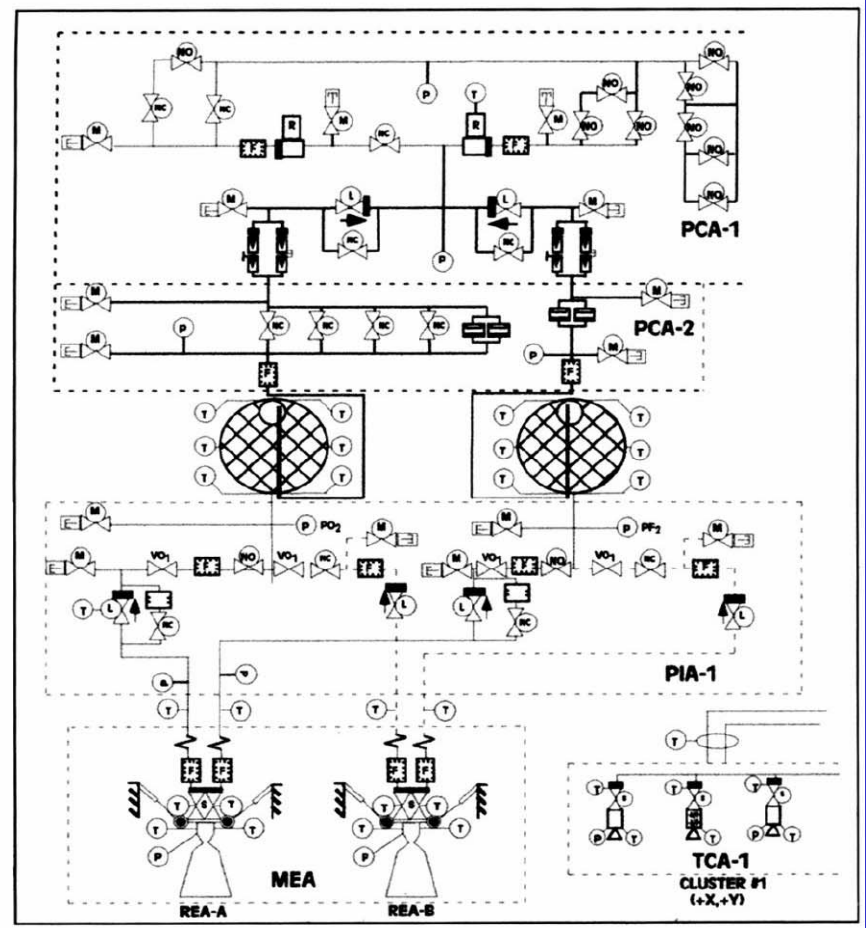
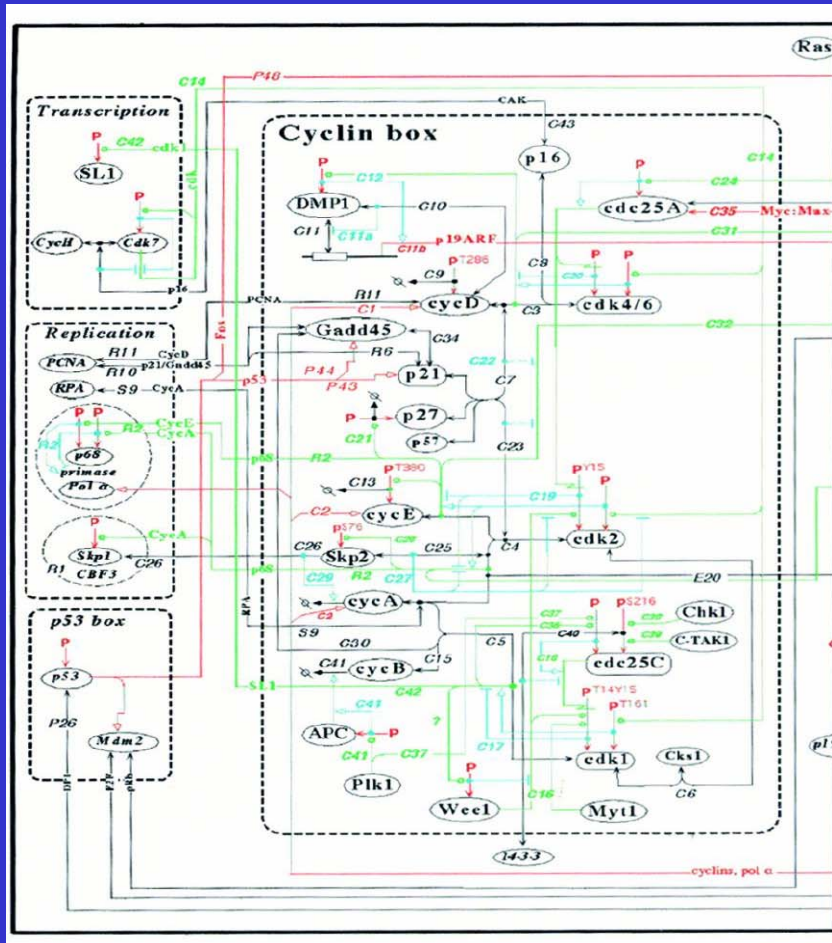
**Interdisciplinary
Research**

Nanomedicine

**New Pathways to
Discovery**

Research Teams

Need to understand biological systems



Brent Cell, 2000

NIH Roadmap Briefing
February 2004



The Biological Data Of The Future

- Destructive
- Qualitative
- Uni-dimensional
- Low temporal resolution
- Low data density
- Variable standards
- Non cumulative

- Non-destructive
- Quantitative
- Multi-dimensional and spatially resolved
- High temporal resolution
- High data density
- Stricter standards
- Cumulative

Nanomedicine Development Centers

The NIH Vision

- Characterize quantitatively the physical and chemical properties of molecules and nanomachinery in cells;
- Gain an understanding of the engineering principles used in living cells to "build" molecules, molecular complexes, organelles, cells, and tissues; and
- Use this knowledge of properties and design principles to develop new technologies, and engineer devices and hybrid structures, for repairing tissues as well as preventing and curing disease.

Beginning a ten-year process

- We need a more quantitative analysis of biomolecules and their interrelationships.
- To understand design, we need to measure physical parameters such as force, stoichiometry of subunits, kinetics, material requirements, energy utilization and transduction.
- *Collecting this comprehensive data set requires:*
 - *a coordinated effort to develop uniform standards,*
 - *a lexicon of engineering terms and definitions applicable to biological processes and structures, and*
 - *data systems to collect and analyze the data.*

Beginning a ten-year process

continued...

- As we develop this lexicon we will discover gaps in our ability to collect essential data.
- To complete the analyses, new tools and strategies will be discovered and applied.
- The endpoint of this activity will be a characterization of biomolecular systems in a format that will interface seamlessly with engineering specifications required to create blueprints for the design of new nanomachines or structures.

Scope of centers

- multidisciplinary -- biology, physics, chemistry, engineering, math, computational, clinical...
- biomedical focus of model system/theme -- e.g.,
 - pathway, motor system, transport
 - cell type, disease model
- toxicity, biocompatibility -- goal is to develop particles, materials and devices that can be used *in vivo*.
- broad (but not comprehensive) technological approach
- generality of tools (broadly applicable)
- design of tools: throughput, comprehensive measurement (à la HGP)
- operate as network of centers

NANOMEDICINE ROADMAP INITIATIVE

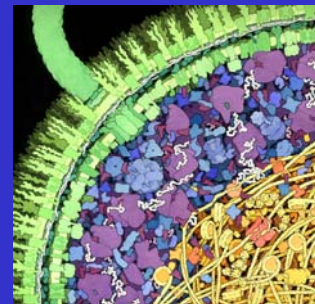


Biology
/
Medicine

**Nanotechnology
Tools**

**Design principles
of subcellular
nanosystems**

**Nanotechnology
Tools**



Status of the initiative

- 20 planning awards made in September 2004
- Meeting of awardees in Spring
- Limited competition for Centers awards
 - \$6 M annual investment in Centers in FY 2005
- Open competition for Centers awards
 - \$6 M annual additional in Centers in FY 2006

From white paper instructions...

...NIH intends that the Nanomedicine Roadmap Initiative projects should depart from established, ongoing projects and should propose truly novel approaches, breaking new scientific and technical ground. Our primary goal is to stimulate new ideas and directions that would not be likely to receive funding in routine grant solicitations.