

Nanobiotechnology Center

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PIs: Barbara Baird, Carl Batt, Harold Craighead

Cornell University (Lead Institution)



The Nanobiotechnology Center (NBTC) leads the effort to explore biology using nano- and microfabricated devices. The Center brings together life scientists, physical scientists and engineers to create an array of tools that effectively address and integrate biology across subcellular and molecular scales and to develop related new technologies. The NBTC thrives in the environment provided by its lead institution Cornell University, which has a strong tradition in the interdisciplinary mode of research needed to forge new discoveries in nanobiotechnology and to nourish a high level of cross-cutting interactions. The Center also draws on resources and the talents of a diverse group of scientists at partner institutions: the Wadsworth Center (New York State Health Department), Clark Atlanta, Howard, Princeton, and Oregon Health & Science Universities. The Center, through its vibrant education program and through active collaborations with K-12 educators and science museums, brings the discoveries within nanobiotechnology to a broad audience. Partnerships with industry and government laboratories disseminate the latest technological advances of the NBTC. The Center has developed a highly integrated research and education effort with participation by NBTC faculty, postdoctoral associates, and students.

Interest and activity in nanotechnology has grown remarkably in the past few years, fueled in part by the National Nanotechnology Initiative and similar thrusts in many other countries. Within this advance of ideas and exploration, *Nanobiotechnology* (a term coined at Cornell) emerges as an exciting science and technology opportunity melding nano-microfabrication and biosystems to the benefit of both. As a pioneer and leader in this new area, the NBTC vision is that nanobiotechnology is the genesis of substantial new insights into the structure and operation of biological systems, and likewise, that nanobiotechnology will lead to the design of new classes of micro- and nanofabricated devices and systems. The use of microfabrication, as a method of miniaturizing biological and biomedical devices, is just beginning to reach the bioscience industry. The ability to address effectively the molecular scale has created a new set of tools for scientific investigation and device construction that will inevitably lead to new levels of understanding and manipulation. NBTC research aggressively pushes the boundaries of technological capabilities while enhancing scientific understanding at the confluence of physical, chemical, and biological systems.

The overall mission of the NBTC unites traditional academic disciplines into the emerging field of nanobiotechnology. Through a close collaboration of interdisciplinary scientists at the participating institutions, the Center operates to meet goals in three overlapping areas: i) Research - provide new insights into the function of biological systems and create new technology based on biological components in ways that can only be addressed by development and utilization of nanofabricated tools; ii) Education – foster a lifelong interest in science and technology by teaching people of all ages about the nano world; iii) Knowledge transfer - disseminate understanding and technologies derived from nanobiotechnology research to promote its application in the public and private sectors. Partnerships with federal and state government agencies, private foundations, and companies are developed to support these activities and to extend the reach of the Center. NBTC activities impact well beyond the Center

by leveraging the individual research efforts of NBTC faculty, providing firm foundation for major university training and initiatives, and guiding the international community toward success in nanobiotechnology.

Thirty-six faculty in the six partnering institutions are currently NBTC members. Presently, seventeen postdoctoral associates and thirty-four graduate students are supported by the NBTC and work on projects associated with the research programs. Approximately fifteen undergraduate students, ten high school students and five high school teachers receive NBTC stipends to participate in REU and other Center-wide summer research programs. A large number of additional postdoctoral associates, graduate students, and undergraduates, with salary support from other sources, participate in NBTC-related research. Collaboration across interdisciplinary lines with a widening circle of faculty, continues to increase NBTC membership.

Research is organized into six distinct but synergistic programs with interdisciplinary multi-investigator projects. Each program is driven by a set of biological questions and nanotechnological approaches:

Biomolecular Devices and Analysis

What properties of biomolecules determine their function?

High speed and high sensitivity analyses of biochemicals with new approaches.

Biomolecular Dynamics

How does biomolecular motion result in active structures and cellular function?

Investigation and utilization of molecular motion and mechanical properties.

Cellular Microdynamics

What properties of cells dictate their functions?

Analysis of cell structure and function in engineered microdevices.

Cell-Surface Interactions

How do cells grow, differentiate, and function in response to their environment?

Investigation of the response and control of cells on structured surfaces.

Nanoscale Cell Biology

What are the mechanisms of cell stimulation and response?

Investigation and utilization of nanoscale cellular activities with micro- and nanofabricated tools.

Nanoscale Materials

How do materials function in biology on the nanoscale?

Study of materials engineered at the nanoscale for new properties that can be exploited in nanobiotechnology.

Research programs typically include researchers from two or more of the partner institutions, and regular meetings are facilitated with videoconferencing. The research program structure builds on the strengths of the Center and is responsive to natural evolution and to opportunities for breaking new ground.

Three cross-cutting technology platforms provide the framework to unify and support the NBTC research programs and provide additional means to communicate and share ideas and technical innovations among the faculty, students, and staff.

Molecules: Molecules of nanobiotechnology
Surfaces: Novel methods of patterning and functionalizing surfaces for specific interactions with molecules and cells
Devices: Sensors and devices for nanobiotechnology

The NBTC education program aggressively pursues its goal to promote science, math, engineering, and technology to students of all ages. The Science Club for Girls and professional development opportunities for teachers are a vital core of the education effort. The education program places emphasis on impacting underrepresented minorities through the establishment of programs for middle schools with high minority populations. Regular communication during biweekly Tech Platform Luncheons enhances professional development of Center graduate students and postdoctorates. The Center is collaborating with the Sciencenter to develop a traveling museum exhibition on nanobiotechnology which will premier in Summer 2003.

An increased number of published papers, public presentations, a sponsored symposium, invention disclosures and patent applications provide evidence of knowledge transfer from the Center. is evidenced by. The Center continues to develop its website, enhancing access to Center activities and information. Transfer of knowledge is also promoted by the Center's shared facilities, with installation of new equipment fitting the growing needs of NBTC users and attracting other academic and industrial users. In the next two years NBTC will move, together with the Cornell Nanofabrication Facility, into nearly completed Duffield Hall. This will be one of the nation's most sophisticated research and teaching facilities for nanotechnology.

Significant Research Accomplishments

- Microfabricated flow cell and x-ray scattering, NMR, and IR measurements to observe folding of individual protein and RNA molecules in real time
- Development of polymer lift-off method to create biocompatibly patterned surfaces and stimulate targeted signaling by immune cells
- Chip-based electrophoretic separation of molecules that interface directly with mass spectrometers
- Electrochemical detector array for subcellular localization of individual secretory events in nerve cell model
- Separation of single DNA molecules in nanofluidic chambers
- Positive-tone 3D microfabrication with two-photon generated compounds

References

For further information about this project link to <<http://www.nbtc.cornell.edu>>