# Nanobiotechnology Resources for K-12

## Resources for Grade School Students

Nanozone

Nanozone, for kids ages 8-14, explores the basics of nanotechnology and nanoscience with games,videos and comics.

Molecularium Project

The Molecularium Project provides educational tools and games for kids to learn and have fun with the nanoparticle world.

NanoMission

Nanomission is a three dimensional learning game that promotes learning about molecular building, nanoimaging, creation of nanodevices, nanomedicine, quantum behavior, and manipulating electrons of nanomaterials.

NISE Network Catalog

The NISE Network Catalog contains many tools and guides, programs, and media dealing with nano-related art and nature, biology and medicine, energy and environment, fundamentals, information technology, applications, and society, policy, and economics.

NANOYOU

NANOYOU (Nano for Youth) provides hands-on activities and labs dealing with nanoscience.

## Resources for High School Students and More

Nanotechnology in Biology

This is the first of two exercises developed by El Paso High School teachers as part of a two week workshop on nanotechnology education, part of the National Center for Learning and Teaching of Nanoscale Science and Engineering (NCLT) Professional Development Workshop held June 19-30, 2006 at the University of Texas at El Paso. Developed for junior high school students, the presentation begins with an introduction to the nanoscale and the importance of nanotechnology. This is followed by several exercises focused on manipulating matter on the nanoscale.

The Virginia Virtual Lab

The University of Virginia Virtual Lab provides lecture notes, supporting animations, simulations,

and readings so that high schoolers can learn more about nanoscience (including nanocarbon, nanotubes, DNA, and nanoscience instruments)

Nanobiotechnology and Biosensors

This presentation is meant to provide an overview of the field of Nanobiotechnology and Bioelectronics with a focus on the development of electrical biosensors. It covers the principles, technologies, methods and applications of nanotechnology in the development of biosensors.

Nanobiotechnology-A different perspective

In this presentation, Murali Sastry focuses on an emerging branch of nanotechnology that derives its inspiration from biology.

NCN Nano-Devices for Medicine and Biology This NCN theme seeks to extend the understanding and computational tools developed in the Nanoelectronics and NEMS themes and apply them to the development of devices for medicine and biology

Illinois BioNanotechnology Seminar Series : Development of Anticancer Medicine This presentation explores new developments in chemical and engineering processes to prepare anticancer nanomedicines.

Engineering Nanomedical Systems This tutorial discusses general problems and approaches to the design of engineered nanomedical systems.

NCN Nano-Devices for Medicine and Biology: Tutorials Here are a few tutorial lectures that convey new approaches to the development of new kinds of devices for applications in medicine and biology.

**More Nanohub Resources for K-12**

## Resources for Teachers

Understanding Nano This lesson plan was created to help high school science teachers provide an introduction to nanomedicine.

## Resources for Undergraduates

The Impact of Protein Flexibility on Ligand Binding to Proteins-A Computational Perspective] This presentation shows the development of new concepts incorporating protein flexibility to identify binding modes for ligands of biomedical interest and to quantify their interaction with the target protein. Based on examples from lead optimization and the prediction of adverse drug reactions, I will discuss our progress and current limitations.

Self-association of peptides and proteins-Retrospect and prospects In this presentation, various

aspects of protein and peptide self-association are discussed, with particular reference to the work from the speakers lab and their potential application particularly their relevance to pharmaceuticals

Basic Rules of Protein Folding This presentation shows an alternative to the usual computational approach and seeks fundamental principles of folding which can be easily implemented. They show how a set of simple rules qualitatively reproduces the pathway for protein folding. The usefulness of these rules is firstly as a tutorial guide in understanding protein folding. Secondly, they may serve to guide large-scale protein-folding programs to compute more efficiently.

Illinois Center for Nanoscale Science and Technology and Nano-CEMMS-A Hard Day in the Life of a Soft Cell With every beat of the heart, inflation of the lung, or peristalsis of the gut, cell types of diverse function are subjected to substantial stretch. But what physical laws govern the abilities of the cytoskeleton to deform, contract, and remodel at the nanoscale? New data support the idea that the cytoskeleton is at once a crowded chemical space and a fragile soft material in which the effects of biochemistry, molecular crowding, and physical forces are complex and Inseparable, yet conspire nonetheless to yield remarkably simple phenomenological laws. These laws appear to be universal and thus comprise a striking intersection between the worlds of cell biology and soft matter physics.

NCN Nano-Devices for Medicine and Biology-Tutorials From among the many tutorial lectures available on the nanoHUB, this lists a few that convey new approaches to the development of new kinds of devices for applications in medicine and biology.

NCN Nano-Devices for Medicine and Biology-Research Seminars Research seminars about nano-devices for medicine and biology.

NCN Nano-Devices for Medicine and Biology-Simulation Tools for Research Many simulation tools are available on the nanoHUB. The tools have been well-tested and here include supporting materials so that they can be effectively used for research. The research tools include a first time users guide and supporting publications and theses.

NCN Nano-Devices for Medicine and Biology-Simulation Tools for Education Many simulation tools are available on the nanoHUB. The tools have been well-tested and here include supporting materials so that they can be effectively used for education or intelligently used for research.

Nanoparticles in Biology and Materials- Engineering the Interface through Synthesis Monolayer-protected nanoparticles provide versatile tools for nanotechnology. In our research, we use these nanoparticles as building blocks for the creation of functional magnetic and electronic nanocomposite materials. Simultaneously, we are using these particles as scaffolds for biomolecular recognition. These materials exploit the size (similar to that of proteins) and surface tunability of nanoparticles for applications including biomacromolecule recognition and delivery.

## Nanobiotechnology Tools

The Biology Monte Carlo Demo: With the recent availability of high-resolution structure information for several key ion channel proteins and large-scale computational resources, Molecular Dynamics has become an increasingly popular tool for ion channel simulation.

NanoGromacs: NanoGromacs is an interface for molecular dynamic simulation using Gromacs. It can perform lipid and protein simulations on user provided structures. The users can upload their own input structures, select corresponding force field files and set the run-time parameters. The simulation result structure can be visualized using PyMOL on the nanoHUB. The interface also can show the dynamic effect of the simulation process. The simulation result also can be analyzed by utilities from Gromacs. The users can also download the result pdb file then use their favorite visualization tool like VMD or RasMol to view it locally. NanoGromacs simplifies the task of assembling the input files required. It ignores tedious command line execution of Gromacs. And it also provides users with visualization result and analysis tools.

BioMOCA Suite: The BioMOCA Suite can perform ion channel flow simulations on any user supplied channel. The suite includes: a map generator subtool, which produces protein maps for BioMOCA from the supplied PQR file; a lipid wrapper subtool, which allows the user to embed their channel in a membrane; and the boundary force potential calculator, which determines the potential energy barrier presented by the channel. The user can also download the acc and charge files produced by the map generator and lipid wrapper.

Cyber-Infrastructure for Imaging and Simulation of Molecular and Cellular Mechanics: This is a simulation-driven science project to understand the inner workings of cellular structures and biological systems, and to design detection and manipulation devices for a wide range of applications in nano-medicine and nano-biotechnology. Our specific plan focuses on two important and synergistic aspects of molecular and cell mechanics: a) analysis tools for nano-bio imaging and b) design tools for mechano-sensing devices.

Stretching Simulation of an Alpha-Helical Protein Domain: This tool uses steered molecular dynamics (SMD) to apply a tensile load to the ends of a molecule (such as an alpha-helical protein domain)

Polymer Nano Brush: This tool calculates structural properties of polymer brushes using a molecular theory

Protein Contact Maps: This tool allows the user to easily generate contact maps and distance maps for protein molecules

Forced Protein Unfolding: This tool enables users to easily perform non-equilibrium molecular dynamics simulations of a protein subject to an external force and then analyze their simulation results both quantitatively and through animations of the protein dynamics.

Hydrophobocity Lab: With this tool, the user will be able to tune the interaction between water and hydrocarbon chains (modeled by a single particle with an effective potential) and observe

the changes in hydrophobicity and aggregation.

BioSensor Lab: This is a tool that evaluates and predicts the performance parameters of a label-free, electronic biosensor.

Poisson-Nernst-Planck Cyclic Peptide Ion Channel Model: This tool simulates ion flow in a system modeled after cyclic peptide ion channels using Poisson-Nernst-Planck (PNP) theory.