

# Main Street Science

The K-12 Education Program of the Nanobiotechnology Center



## IT'S A NANO WORLD TUTORIAL

*Creating hands-on science activities to engage the mind*

[www.NBTC.cornell.edu/mainstreetscience](http://www.NBTC.cornell.edu/mainstreetscience)

## WHAT IS NANOTECHNOLOGY?

---

*Nanobiotechnology: Building innovative tools to study biology at the nanometer scale.*

Nanobiotechnology is a big word made up of three parts:

- NANO is really, really tiny
- BIO is living things, and
- TECHNOLOGY is about tools.

All together it means making and using very tiny tools to learn about living things.

## OVERVIEW OF EXHIBITS

---

Walk through the **Gateway** of the Nano World and begin to explore biology at a scale smaller than anything you can see with the naked eye. See how nanotechnology is being applied to understand the fundamentals of life. Peer through **Giant Magnifying Glasses** that enlarge everyday objects. Explore at the **Magnification Station** and look into the Nano World of things around us. Learn in **Adventures of Tiny Things** how germs and dust affect our everyday lives—they make us sick, they make us sneeze. Enter the **Cells in Action** and step into bacteria enlarged millions of times in size. See how technology has advanced to allow us to create devices that are as small as these germs. Then be surrounded by millions of blood cells as you jump into the **Giant Blood Drop**. Get a hands-on experience as you use technology to sort cells in the **Cell Sorter**. You will experience how technology is being used to study biology at the microscopic and submicroscopic scale. Venture into the Nano World to discover how we can build innovative tools to study biology at the nanometer scale.

## THE EXHIBITS

---

### *Entrance*

***Fun fact.** If you stack three silicon atoms one on top of another their height is approximately 1 nanometer. Computer chips are made of silicon.*

The entrance to **It's a Nano World** is a portal to the nano world. Around the outer rim of the entry way are images of animals and plants, while on the inner rim are images of cells. On one side of the entrance is 'How many nanometers am I?' where children can measure their height in nanometers. There are one billion (1,000,000,000) nanometers in a meter, which is 39 inches.

### *Giant magnifying glass*

The giant magnifying glass magnifies approximately 3-4 times. It is made from a Fresnel lens. The Fresnel lens is named for its inventor, French physicist Augustin Jean Fresnel. Fresnel studied light and optics in the 19th century. It was originally developed to help project the light from lighthouses.

### *Look Closer*

Look Closer features highly magnified photographs of familiar objects such as a penny, a q-tip, a flower, a bee. Each photograph has decreasing levels of magnification until an easily recognizable photo of the item is revealed.

# Main Street Science

The K-12 Education Program of the Nanobiotechnology Center

## 10,000X Scale Gallery

This interactive collage features microscopic objects including a red blood cell, white blood cell, nerve cell, skin cell, germs (bacteria and viruses), DNA, and computer chips 10,000 times bigger than life size. Visitors can flip each picture to read a description of the object.

## Pinball machines

Each of the pinball machines represents a different story about a micro-scale object: germs, dust and pollen.

## Germ Launcher

**Fun fact.** *The largest known bacteria is *Thiomargarita namibiensis*, a single cell is so big it can be seen with the naked eye.*

The germ launcher portrays the transfer of germs and the effects that they have on people. Germs include viruses and bacteria.

## Dust Tippy Table

The dust tippy table follows the travels of dust from its sources to different places. Dust can make us sneeze. In addition dust can destroy a computer by 'short circuiting' the tiny wires inside of a computer chip. Dust ranges in size from less than a micrometer to over 30 micrometers. The average wire in a computer chip is 1/10 of a micrometer or about 1/1000 the width of a hair.

**Fun fact.** *Dust is so small it can be carried almost half-way around the world by the wind. Dust from Mongolia has been detected as far away as Arizona.*

## Pollen Pinball

The pollen pinball portrays the role of pollen in fertilizing flowers and also why we sometimes sneeze when we inhale pollen. Pollen is approximately 10-100 micrometers in size; smaller pollen is produced by plants that rely on wind to carry it to other plants.

## Video Theatre

This theater environment places visitors in the midst of a world of living moving cells and shows how scientists make tools to study them. Two videos, *Cells in Motion* and *Tiny Tools* play one after the other.

**Fun fact.** *About one billion (1,000,000,000) bacteria would fit on the head of a pin.*

*Cells in Motion* is a series of images that show cells including those found in the human body and bacteria. One segment shows the flow of blood cells through a vein.

*Tiny Tools* is a video that portrays the process scientists use to create tools to study small living things. The action takes place in a clean room, a laboratory with heavily filtered air to reduce dust and other particles. Scientists dress in 'bunny suits' (formally known as 'togs') to protect the tools that they are building from these particles. At the end of the video are images of nerve cells that are growing on microfabricated structures. Scientists build these tiny structures to study the growth and behavior of cells in order to understand how they function.

*Creating hands-on science activities to engage the mind*

[www.NBTC.cornell.edu/mainstreetscience](http://www.NBTC.cornell.edu/mainstreetscience)

# Main Street Science

The K-12 Education Program of the Nanobiotechnology Center

**Fun fact.** Inside of the average computer are tiny wires that are about 1/1000 the width of a hair. Scientists are now working on wires that are maybe 100 atoms wide.

## Cell sorters

Two ball sorters demonstrate the basic principle of how scientists use machines to separate cells. In the exhibit's cell sorters, the cells are represented by 1 3/4" dia wooden balls that look alike. Some cells glow under a UV lamp (fluorescent paint). Some cells stick to magnets (nails inside them). Visitors can vacuum up cells at the central hopper to send them to chambers where either the fluorescence or magnetic properties are determined. Visitors can then vacuum the cells up and into individual collectors.

Real cell sorters do not sort cells one at a time and there is no manual intervention. The cells are flowed in a very narrow stream, and their fluorescence is measured with a laser.

Scientists sort cells to study the different types of cells that might be in a sample of blood. For example blood can be separated into red and white blood cells. Red blood cells carry oxygen, and white blood cells fight germs.

## Blood drop

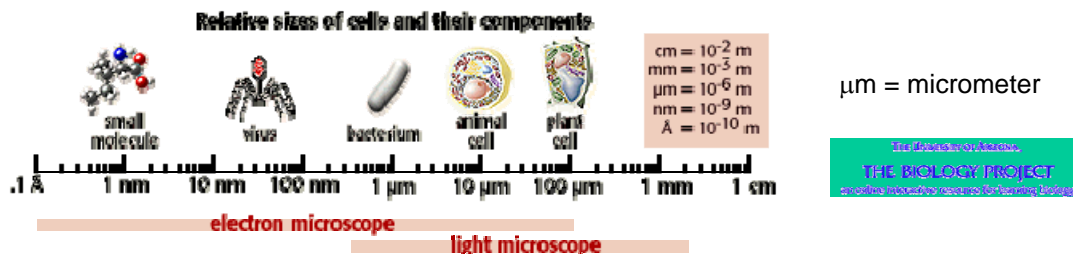
The blood drop demonstrates size and scale in a biological context. In the exhibit, the blood cells are represented by 3" red plastic balls, and there are approximately 7,500 in the tent. There are a few white blood cells, showing that blood has less than 0.1% white cells. The entire pit itself is scaled 10,000 times so that it is size of a drop relative to the blood cells.

Real blood cells are approximately 10 micrometers. If you were to take 10 blood cells and lay them end to end they would be approximately 100 micrometers, or the width of a hair.

## Powers of 10

The video loop 'Powers of Ten' was created by Ray and Charles Eames. It takes the visitor from view of the Earth that is 100 million meters ( $10^8$  meters=500 million miles) down to a region of DNA that is on the angstrom scale. (An angstrom is ten times smaller than a nanometer!)

The video starts off with a view of the Earth, then zooms into the hand of a person laying on a blanket in a park in the city of Chicago. The video continues to zoom in on a cell at the 10 micrometer size scale. Next is an image of the double helix of DNA which appears at the 100 nanometer (1000 angstrom) scale. From there the video zooms into the atomic structure of DNA and ends at the 1 nanometer (10 angstrom) size scale.



Creating hands-on science activities to engage the mind

[www.NBTC.cornell.edu/mainstreetscience](http://www.NBTC.cornell.edu/mainstreetscience)

The banner image shows a street scene with various signs. On the left, a sign reads 'GENERAL PUBLIC'. In the center, a sign says 'TEACHER TOOLS'. To the right, a sign says 'NEW BLAYING FOR KIT ONLY'. The background shows buildings and a street with a car.

# Main Street Science

The K-12 Education Program of the Nanobiotechnology Center

## ***Magnification station***

The table at the *Magnification Station* has a collection of lenses that magnify objects from 2-5 times. Lenses magnify objects by bending the light and making the objects appear bigger. Lenses have different focal lengths, which determines how far the lens must be from the object to be in focus.

On the front panel of the *Theatre* are two 'Scope on a Rope' magnification tools. The scope on a rope is connected to two video displays. One scope on a rope magnifies an object 30 times, while the other magnifies an object 200 times. These tools have a very small 'focal length' so they need to be held tight against the object that you are trying to magnify. For 200X lens, you may need to tilt it back slightly away from the sample to bring the object into focus.

## ***What's My Job? and How Big Am I?***

The basic vocabulary and content of the exhibition are reinforced at these two exhibits with a simple sorting/matching activity. Each exhibit has 7 different wooden disks with graphics representing different things. At *What's My Job?* visitors place the disks according to the questions on the exhibit top. At *How Big Am I?* they arrange the disk from largest to smallest. Pull the handle to dump out the disks and start again.