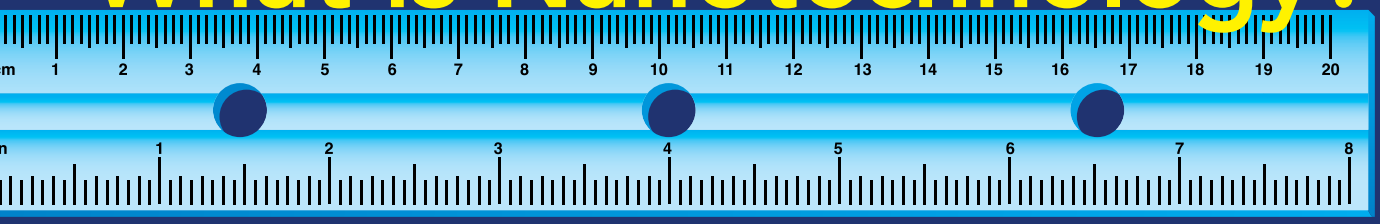
FIRST EDITION • MAY 2007 www.nanooze.org

ALL ABOUT THE THINGS TOO SMALL TO SEE

Welcome to Nanooze!

What is a nanooze (say nah-news)? Nanooze is not a thing, Nanooze is a place to hear about the latest exciting stuff in science and technology. What kind of stuff? Mostly discoveries about the world that is too small to see and making tiny things using nanotechnology. Things like computer chips, the latest in fashion and even important stuff like tennis rackets. Nanooze was created for kids, so inside you will find interesting articles about what nanotechnology is and what it might mean to your future. Nanooze can be found on the web at ***www.nanooze.org*** *or just 'google' 'nanooze'. There is lots more there including interviews with real scientists, the latest in science and even games!*

What is Nanotechnology?



To understand nanotechnology, first you should know it's a big word for some mighty small stuff. In fact, "small" as we know it doesn't even come close to being small enough.

Let's learn some things about the first part of the word. "Nano" comes from the Greek word for dwarf. Today, scientists use nano as a measure for something that requires special microscopes for them to see. Grab a ruler, and flip to the centimeter side. See how long 1 centimeter is? Now imagine if you could fit 10 million points between 0 and 1. The space between two of those points is a nanometer. Do you only have inches on your ruler? Well, imagine 25 million points crammed inside of one inch. Don't try it. Just trust us!

So, now we're talking tiny. Something smaller than a cell in your body. Way smaller than the head of a pin or thinner than a hair on your head – though people who know nano say hairs can be very different so we'll stay away from that. Either way, it's definitely too small to see.

As for technology, you may know that factories make big things like cars. When it comes to nanotechnology, scientists work in factories, too. But they are called fabrication facilities, or fabs for short. This is where the technology part comes in: scientists use machines that take things only nanometers big, move and mix them with other ingredients, and turn them into materials that help make car parts stronger and lighter. Pants and shirts that keep stains away. Or sunscreens and medicines that work better.

NANOTECHNOLOGY COULD EVEN HELP CLEAN UP POLLUTED WATER OR LAND.

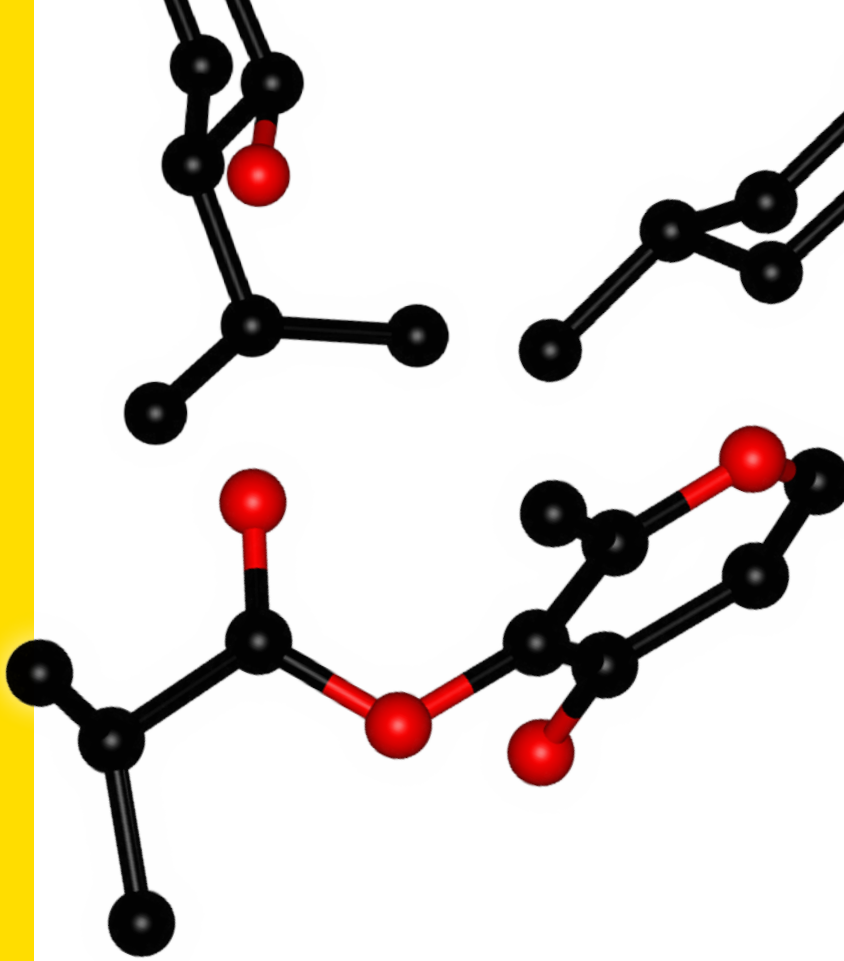
Of course, even scientists don't know everything about nanotechnology. Students and teachers in colleges all over the world use those superpowerful microscopes and other machines to learn how nanometer size things work. Like all chemicals and materials, they have to be sure they know what they are doing before they use them. And they have to be very careful that they are using them right.

YOU'LL BE HEARING A LOT MORE ABOUT NANOTECHNOLOGY IN THE YEARS AHEAD.

It might even be something you'll want to study in high school or college. For now, Nanooze is here to help you learn a little bit about this super small world and have some fun while you're at it.

How Big is a Nanometer?

A nanometer is a unit of measure, just like inches, feet and miles. By definition a nanometer is one-billionth of a meter. A meter is about 39 inches long. A billion is a thousand times bigger than a million, as a number you write it out as 1,000,000,000. That is a big number and when you divide a meter into one billion pieces, well that is very small. So small you cannot see something a nanometer in size unless you use very powerful microscopes like atomic force microscopes.

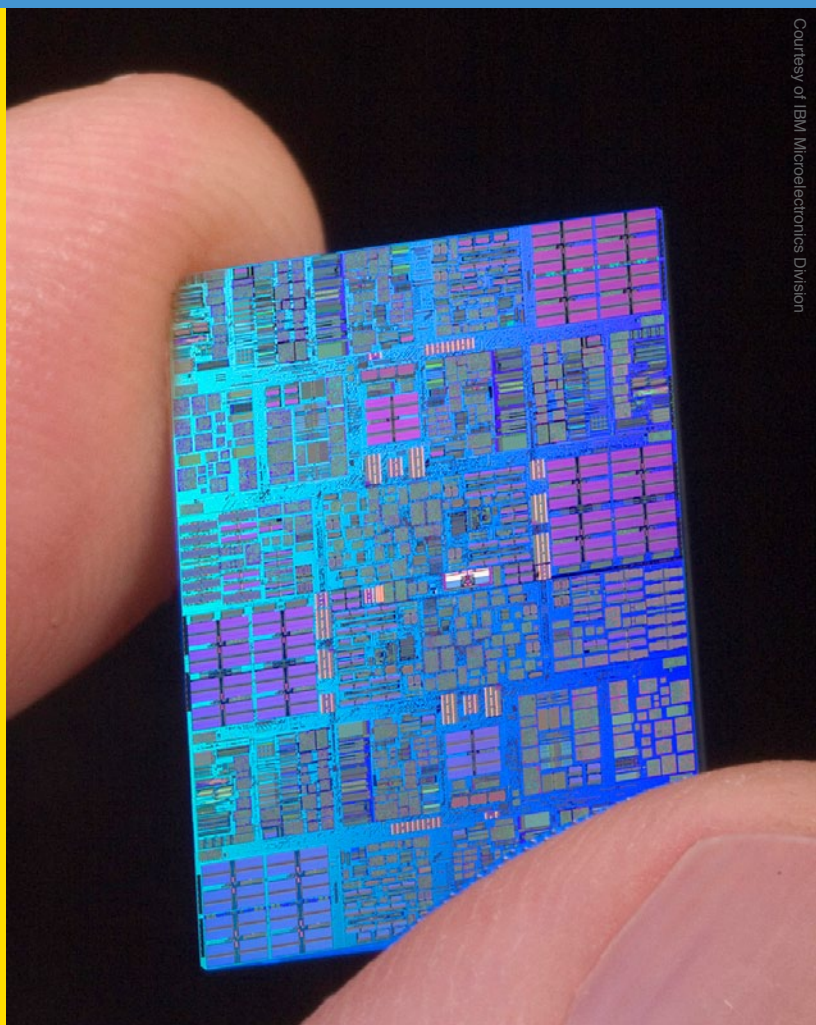


A nanometer is used to measure things that are very small.

Atoms and molecules, the smallest pieces of everything around us, are measured in nanometers. For example a water molecule is less than one nanometer. A typical germ is about 1,000 nanometers. We can measure even larger things in nanometers, so a hair is about 100,000 nanometers wide. That is a lot of nanometers!

Shaquille O'Neal, a very tall basketball player, is **2,160,000,000** nanometers tall!

Inside of your computer are tiny switches that are only 100 nanometers wide. About 1,000 of these switches can fit across the width of a single hair. Modern computers have about 100,000,000 switches packed inside, stacked one on top of another. We use nanotechnology to make these tiny switches.



Courtesy of IBM Microelectronics Division

Important things happen at the nanometer scale.

We can think of the smell of freshly baked cookies and that is something that happens on the nanometer scale. The molecules that are released from the cookie when it bakes are less than a nanometer in size and so they are carried through the air to our noses because they are so small. Gravity does not have much of an effect on them and so they float along. They reach our noses and when they are very very close, less than a nanometer away, we can smell them.

Swing Your Racket Like Vitas Gerulaitis

Nanotechnology is all about making **materials** that take advantage of their **unique properties** at the nanometer scale.

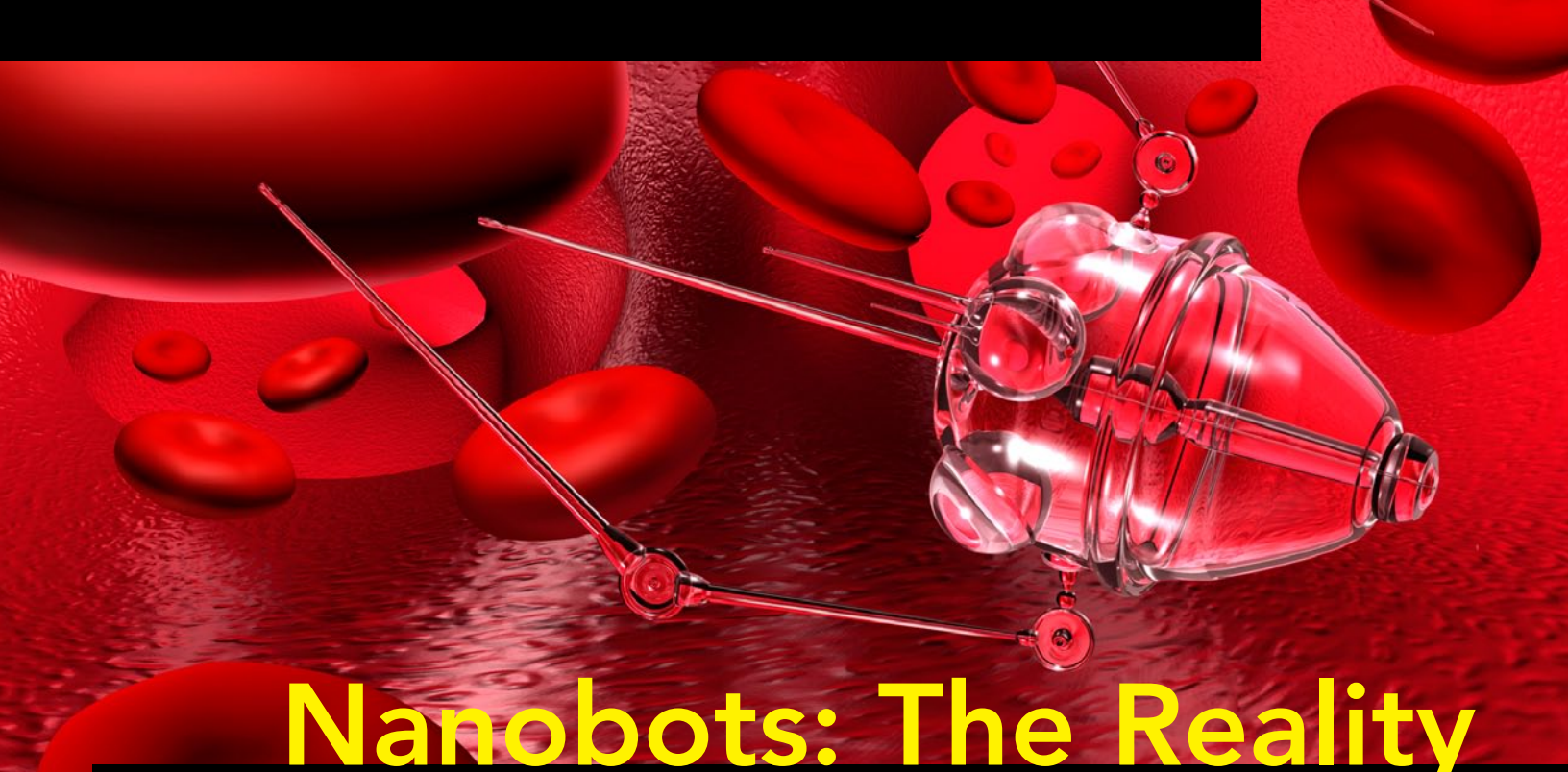
So what's up with that? Carbon nanotubes are tiny tubes of just carbon that are about two nanometers wide. But carbon nanotubes are fifty-times stronger than steel. That is because all of the carbon atoms are bound to one another without any breaks.

Most stuff breaks because of defects. If you take a wafer (silicon? Nah a vanilla one) it will break along a line of defects in the structure of the cookie. Most times you can't see them but if you use a powerful electron microscope then you can see these little tiny defects. If the defects are all lined up, then that is a problem because they can then form a break when you apply a stress. Carbon nanotubes free of defects are really strong. Right now scientists don't know how to make really long carbon nanotubes or how to best glue a lot of them together.

YOU CAN DO ALL SORTS OF USEFUL THINGS WITH CARBON NANOTUBES.

They are strong and they are also light. Some kinds of sports equipment work better when they are strong and light. Light meaning that you can swing them really hard and it takes less energy to move them. Strong so that they don't break or even bend too much. The tennis racket company Babolat is teaming up with another company, Nanoledge, that makes carbon nanofibers and other nanometer scale materials to make cool tennis rackets. A long time ago, tennis rackets were tennis rackets were made of wood and so they were heavy and slow. Now using carbon nanotubes tennis rackets, golf clubs and other sports equipment can be made better.

The real challenge is putting things like carbon nanotubes into the materials in a way that they help make the equipment stronger and lighter. Scientists are studying these composites and different ways of bonding the nanometer scale materials into them. You can't make stuff completely out of carbon nanotubes because we can't make carbon nanotubes too long (yet), and unless you want to make a nanometer sized golf club, you need other materials in the composite. But someday, scientists will figure this out and use carbon nanotubes to make something really cool, like an elevator to space.



Nanobots: The Reality

So you see on the Internet little robot things that swim around your blood and kill germs……where can I get some?

The little robot things are sometimes called nanobots and they seem like a cool idea. If you need to kill some germs you just get some of these nanobots and they swim around and kill all of the bad germs. Nice idea, but they do not really exist. They are science fiction but they do sound cool.

There are a lot of problems in making things really small and small enough to zoom through narrow places like in your blood stream. There are parts of your blood stream where the capillaries are only a thousand nanometers wide. That is really small.

Part of the problem is just controlling where the nanobots go because they are so tiny. Think about dust. It floats around and is blown by the wind. You can really control where it goes. You can catch it by using something like Endust® but then it just sticks there. That is because things like static electricity are so powerful because the dust is so small that the dust defies gravity.

The other big problem is something called thermal motion. When things get really small, lets say 1/1,000th the width of a hair they vibrate almost uncontrollably. Probably you have seen this kind of vibration when you look at tiny stuff in water under the microscope. It is called Brownian motion. All of this rattling around makes it hard to keep little machines in one piece and so these nanobots would probably shake apart.

But the biggest problem is power. You want your nanobot to move. When something is 1/1000th the width of a hair or about 100 nanometers, it is really tough to move, especially in liquids. So to move along and chase germs you need a lot of power. To swim along, a nanobot would probably need a battery that was about 1000 times bigger than itself and even that is just a guess. Tiny things likes germs can swim: nobody is really sure how they do it, but they power themselves using biological energy. That might be one way to power a nanobot but it is going to be really tough!

Can we someday figure all this out and make a nanobot? Sure. But we need to solve a lot of these problems and then you might ask why would we want to do it?