NANOTECHNOLOGY
PUBLIC ENGAGEMENT

NANO TECHNOLOGY

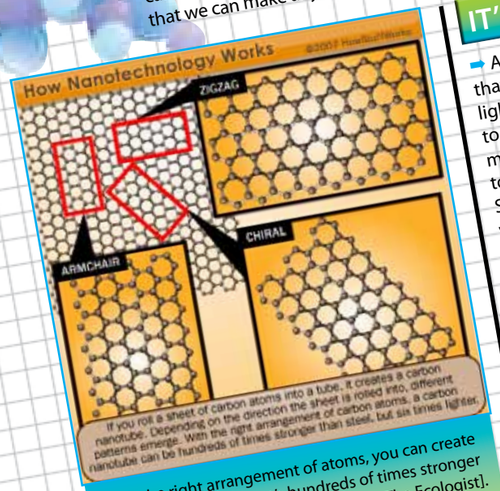
There's an unprecedented multidisciplinary convergence of scientists dedicated to the study of a world so small, we can't see it -- even with a light microscope. That world is the field of nanotechnology

INTRODUCTION TO NANOTECHNOLOGY

In order to understand the unusual world of nanotechnology, we need to get an idea of the units of measure involved. A centimeter is one-hundredth of a meter, a millimeter is one-thousandth of a meter, and a micrometer is one-millionth of a meter, but all of these are still huge compared to the nanoscale. A nanometer (nm) is one-billionth of a meter, smaller than the wavelength of visible light and a hundred-thousandth the width of a human hair [source: Berkeley Lab].

As small as a nanometer is, it's still large compared to the atomic scale. An atom has a diameter of about 0.1 nm. An atom's nucleus is much smaller -- about 0.00001 nm. Atoms are the building blocks for all matter in our universe. You and everything around you are made of atoms. Nature has perfected the science of manufacturing matter molecularly. For instance, our bodies are assembled in a specific manner from millions of living cells. Cells are nature's nanomachines. At the atomic scale, elements are at their most basic level. On the nanoscale, we can potentially put these atoms together to make almost anything.

In a lecture called "Small Wonders:The World of Nanoscience," Nobel Prize winner Dr. Horst Störmer said that the nanoscale is more interesting than the atomic scale because the nanoscale is the first point where we can assemble something -- it's not until we start putting atoms together that we can make anything useful.



With the right arrangement of atoms, you can create a carbon nanotube that's hundreds of times stronger than steel, but six times lighter [source: The Ecologist]. Engineers plan to make building material out of carbon nanotubes, particularly for things like cars and airplanes. Lighter vehicles would mean better fuel efficiency, and the added strength translates to increased passenger safety.

IT'S A SMALL WORLD AFTER ALL

➡ At the nanoscale, objects are so small that we can't see them -- even with a light microscope. Nanoscientists have to use tools like scanning tunneling microscopes or atomic force microscopes to observe anything at the nanoscale. Scanning tunneling microscopes use a weak electric current to probe the scanned material. Atomic force microscopes scan surfaces with an incredibly fine tip. Both microscopes send data to a computer, which can assemble the information and project it graphically onto a monitor [source: Encyclopædia Britannica].

➡ One of the exciting and challenging aspects of the nanoscale is the role that quantum mechanics plays in it. The rules of quantum mechanics are very different from classical physics, which means that the behaviour of substances at the nanoscale can sometimes contradict common sense by behaving erratically. You can't walk up to a wall and immediately teleport to the other side of it, but at the nanoscale an electron can -- it's called electron tunneling. Substances that are insulators, meaning they can't carry an electric charge, in bulk form might become semiconductors when reduced to the nanoscale. Melting points can change due to an increase in surface area. Much of nanoscience requires that you forget what you know and start learning all over again.

➡ **So what does this all mean?** Right now, it means that scientists are experimenting with substances at the nanoscale to learn about their properties and how we might be able to take advantage of them in various applications. Engineers are trying to use nano-size wires to create smaller, more powerful microprocessors. Doctors are searching for ways to use nanoparticles in medical applications. Still, we've got a long way to go before nanotechnology dominates the technology and medical markets.

PRODUCTS WITH NANOTECHNOLOGY

You might be surprised to find out how many products on the market are already benefiting from nanotechnology.

SUNSCREEN - Many sunscreens contain nanoparticles of zinc oxide or titanium oxide. Older sunscreen formulas use larger particles, which is what gives most sunscreens their whitish color. Smaller particles are less visible, meaning that when you rub the sunscreen into your skin, it doesn't give you a whitish tinge.

SELF-CLEANING GLASS - A company called Pilkington offers a product they call Activ Glass, which uses nanoparticles to make the glass photocatalytic and hydrophilic. The photocatalytic effect means that when UV radiation from light hits the glass, nanoparticles become energized and begin to break down and loosen organic molecules on the glass (in other words, dirt). Hydrophilic means that when water makes contact with the glass, it spreads across the glass evenly, which helps wash the glass clean.

CLOTHING - Scientists are using nanoparticles to enhance your clothing. By coating fabrics with a thin layer of zinc oxide nanoparticles, manufacturers can create clothes that give better protection from UV radiation. Some clothes have nanoparticles in the form of little hairs or whiskers that help repel water and other materials, making the clothing stain-resistant.

SCRATCH-RESISTANT COATINGS - Engineers discovered that adding aluminum silicate nanoparticles to scratch-resistant polymer coatings made the coatings more effective, increasing resistance to chipping and scratching. Scratch-resistant coatings are common on everything from cars to eyeglass lenses.

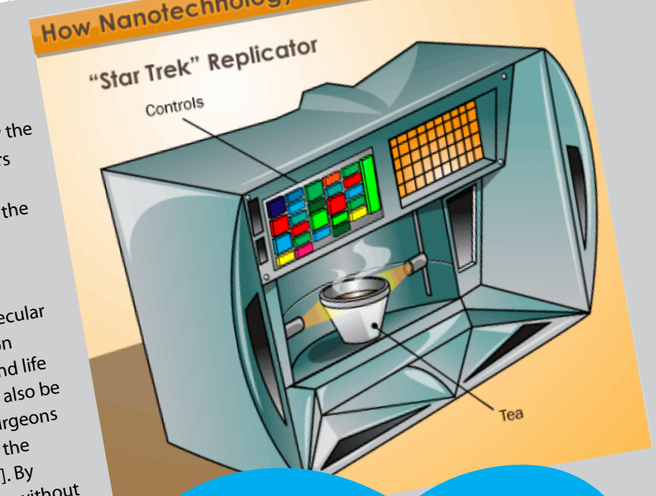
ANTIMICROBIAL BANDAGES - Scientist Robert Burrell created a process to manufacture antibacterial bandages using nanoparticles of silver. Silver ions block microbes' cellular respiration [source: Burnsurgery.org]. In other words, silver smothers harmful cells, killing them.

TENNIS, ANYONE?
Nanotechnology is making a big impact on the tennis world. In 2002, the tennis racket company Babolat introduced the VS Nanotube Power racket. They made the racket out of carbon nanotube-infused graphite, meaning the racket was very light, yet many times stronger than steel. Meanwhile, tennis ball manufacturer Wilson introduced the Double Core tennis ball. These balls have a coating of clay nanoparticles on the inner core. The clay acts as a sealant, making it very difficult for air to escape the ball.

THE FUTURE OF NANOTECHNOLOGY

➡ In the world of **"STAR TREK,"** machines called replicators can produce practically any physical object, from weapons to a steaming cup of Earl Grey tea. Long considered to be exclusively the product of science fiction, today some people believe replicators are a very real possibility. They call it molecular manufacturing, and if it ever does become a reality, it could drastically change the world.

➡ Nanotechnology may have its biggest impact on the **MEDICAL INDUSTRY**. Patients will drink fluids containing nanorobots programmed to attack and reconstruct the molecular structure of cancer cells and viruses. There's even speculation that nanorobots could slow or reverse the aging process, and life expectancy could increase significantly. Nanorobots could also be programmed to perform delicate surgeries -- such nanosurgeons could work at a level a thousand times more precise than the sharpest scalpel [source: International Journal of Surgery]. By working on such a small scale, a nanorobot could operate without leaving the scars that conventional surgery does. Additionally, nanorobots could change your physical appearance. They could be programmed to perform cosmetic surgery, rearranging your atoms to change your ears, nose, eye color or any other physical feature you wish to alter.



THE ENVIRONMENT

Nanotechnology has the potential to have a positive effect on the environment. For instance, scientists could program airborne nanorobots to rebuild the thinning ozone layer. Nanorobots could remove contaminants from water sources and clean up oil spills. Manufacturing materials using the bottom-up method of nanotechnology also creates less pollution than conventional manufacturing processes. Our dependence on non-renewable resources would diminish with nanotechnology. Cutting down trees, mining coal or drilling for oil may no longer be necessary -- nanomachines could produce those resources.