Nano exhibition Audio Description

1. *Nano* exhibition overview

Welcome to *Nano,* an exhibition where you can imagine and discover the nanoscale world. In this world, new materials and technologies are being built at the tiny scale of atoms and molecules!

This audio description guides blind visitors with companions and low-vision visitors through the exhibition. It provides a verbal description of the hands-on activities, images, and text included in the experience.

The *Nano* exhibition has a variety of different elements, including four hands-on exhibits, four large signs, and a seating area. Altogether, the exhibition is about 400 square feet.

At the *Small, Smaller, Nano* exhibit, you can use magnets to explore how a material called magnetite behaves differently at different sizes. Which material is more surprising—magnetite sand, powder, or liquid?

The *Static vs. Gravity* exhibit provides another chance to compare how size matters—this time, by spinning circular cases filled with plastic beads of different sizes. Find out which force is stronger, static or gravity!

You can learn more about the relationship between size and properties at the sign entitled, "What happens when things get smaller?" You can also discover tiny technologies that are helping us to solve big problems.

The *Build a Giant Carbon Nanotube* exhibit lets you use foam construction pieces to make a large model of a tiny structure called a carbon nanotube. You'll work atom by atom—just like scientists who are creating tiny new nanotechnologies.

A related sign asks, "What's new about nano?" Here, you'll learn how nature inspires different nanotechnologies, from stain-resistant pants to climbing robots.

More examples of nano in nature, technology, and your own home are found at the sign entitled, "Where can you find nano?" Squeeze, listen, look, and touch to discover nano all around you.

At the *Balance our Nano Future* exhibit, you balance blocks on a tippy table, trying to create a stable "nano world." Can you put the people, buildings, and other things where you think they belong, without tipping the balance?

Learn more about different perspectives on the benefits and risks of nanotechnology at the sign entitled, “What does nano mean for us?”

Finally, take a rest and explore other resources! The *Nano* exhibition includes a seating area with comfortable furniture and additional reading materials. You can also find more things to learn and do on our website, whatisnano.org.

You can go through the *Nano* exhibition in any order. This audio description is divided into chapters, so you can access relevant information as you move through the exhibition.

To find the audio description chapter related to each part of the exhibition, you’ll need to locate the tactile labels with the AD icon. These labels have a blue square with the capital letters “AD” printed in white. To the left of this AD icon is a large blue numeral, which indicates a specific chapter number. Both the icon and the number are raised, so you can feel them. The AD labels are found on the top surface of the tables and cases in the exhibition.

Enjoy your visit to *Nano*!

2. *Small, smaller, nano*

At the *Small, Smaller, Nano* exhibit, you can explore how size makes a difference in the way materials behave.

(Note that this exhibit uses strong magnets. If you have a medical device, please use caution.)

This exhibit has three tables, which are set at right angles, like a propeller. The tables are at slightly different heights. Each table has a different activity station, called “Small,” “Smaller,” and “Nano.” The tallest table is the Small station. The medium-height table is the Smaller station, and the lowest table is the Nano station.

Each station has a transparent, vertical tube filled with a clear liquid plus a small amount of an iron oxide called magnetite. Magnetite is attracted to magnets.

The magnetite is a different size at each station. There are small grains of black sand, even smaller bits of magnetite powder, and tiny, nano-sized ferrofluid particles.

On either side of the tubes there is a black magnet mounted on a pipe. You can slide the magnets up and down the pipes, and use them to move the magnetite inside the tubes. Each material behaves differently, depending on its size.

At the Small station, the tube contains coarse grains of chunky black sand, about a millimeter and a half across. The sand is a little tricky to drag up the tube with the magnet. When you pull the magnet away, small clumps of sand fall back to the bottom of the tube.

At the Smaller station, the gray magnetite powder is very fine—only three micrometers across. It’s easy to carry it up the tube. When you pull the magnet away, the powder drifts back down.

At the Nano station, the ferrofluid is a big surprise! It's a shiny, black glob of liquid that's attracted to the magnet. When you move the magnet away, the ferrofluid oozes back to the bottom of the tube. The ferrofluid is fun to play with. You can make it spiky by holding a magnet close to it, and you can stretch and pull it between the two magnets.

Ferrofluid is made of nano-sized particles of magnetite suspended in liquid. The tiny size of the magnetite particles—only 10 nanometers across—gives ferrofluid its unusual properties.

(A nanometer is one billionth of a meter. For comparison, DNA is only about two nanometers across!)

Ferrofluid is used in car brakes, computer hard drives, and loudspeakers.

3. *Static vs. Gravity*

At *Static vs. Gravity*, you can explore how size makes a difference in the way materials behave. Two circular cases stand upright on the top of the table.

Each case holds white plastic beads. The case on the left has small beads, one and a half millimeters wide. The case on the right has large beads, nine and a half millimeters wide.

Spin the cases, and observe what happens to the beads! The big beads fall to the bottom of the case as it spins, rolling over each other and rattling. In contrast, most of the small beads hover or cling to the sides of the case.

When you spin the cases, gravity and static electricity work against each other. Gravity pulls the beads down, while static electricity pushes them away from each other. The small beads are light and have a lot of surface area, so static electricity makes them float.

The staticky beads in this exhibit are pretty small, but nano-sized things are much, much smaller. Because nano-sized things are so tiny, different physical forces (like static electricity) can dominate at the nanoscale.

4. What happens when things get smaller?

What happens when things get smaller? This large, vertical sign explains that materials can behave differently when they're nano-sized—including familiar metals like gold and iron. The table attached to the sign explores how tiny technologies can help us solve big problems related to medicine, energy, water, and food.

On the vertical sign, at the 9 o'clock position, there is a photo of three squares of stained glass: orange, pink, and red.

What gives the glass its vibrant color? In each case, it's nano-sized particles of gold! Nanoparticles of gold can look red, orange, or even purple—not shiny and golden.

Next to each square of glass is an image of the nanoparticles that color the glass. Red glass, for example, gets its color from particles of gold that are only 10 nanometers across! (A nanometer is one billionth of a meter, even smaller than an atom!)

Iron is another material that can behave differently when it's very, very small.

At 5 o'clock on the sign, there's a photo of a shiny, black liquid called ferrofluid. Ferrofluid is a remarkable material that's made from nano-sized particles of an iron oxide called magnetite. Magnetite nanoparticles can be suspended in liquid, creating a surprising material that's attracted to magnets! Next to the photograph of ferrofluid is an image of nanoparticles of magnetite.

There are other surprises at the nanoscale, too. Different physical forces dominate. For example, when things are nano-sized, gravity is barely noticeable and static electricity has a much greater effect. Scientists are learning how to take advantage of these special nanoscale properties to create new materials and technologies.

The table attached to the sign provides more information about new nanotechnologies. It has a series of four flip boards introducing different technologies that address important issues.

The top side of each flip board shows a photograph of a technology. If you flip up the board, underneath you'll find a photo showing how the technology is used and text explaining what it does.

From left to right, the technologies featured on the flip boards are gold nanoshells, a thin-film solar cell, a teabag water filter, and wax-like nanocoatings for food.

Starting on the left-hand side, the top of the first flip board shows a test tube filled with blue liquid. The caption says that the tube contains gold nanoshells. If you flip open the board, there are medical brain scan images. The text explains that future cancer treatments might use tiny gold nanoshells and infrared light to fight tumors. Nanotechnology is expected to have a big impact on medical care, from diagnosis to treatment.

The second flip board shows a man holding a transparent, flexible circuit. The caption identifies it as a thin-film solar cell. The underside of the flip board shows an array of large solar panels. The text explains that new solar cells have very thin layers of material that capture energy from the sun. They provide clean, renewable energy and are less expensive than existing solar panels.

The third flip board shows a pair of hands wearing blue gloves. The hand on your left shows a regular tea bag, while the hand on your right holds a water filter that is packaged like a tea bag. Underneath, there's a photo taken in Africa. A young girl holds out a glass of dirty water and a glass of purified water. The text explains that nano-sized charcoal removes germs and toxins from water. These small teabag water filters are easy to use and cost only pennies—so they can be used all over the world.

The last flip board shows a hand holding a shiny red apple. The caption suggests that it could have a wax-like nanocoating on it. If you flip open the board, there's a photo of farm equipment working in a green field. The text explains that food production, processing, and packaging can all use nanotechnology. For example, nano-sized ingredients can improve food texture, nutrient absorption, and shelf life.

5. *Build a Giant Carbon Nanotube*

The exhibit *Build a Giant Carbon Nanotube* lets you construct a large model of a tiny structure called a carbon nanotube. Carbon nanotubes are only a few nanometers wide, but they're super strong. Sometimes they conduct electricity, so they can be used in electronics.

At this exhibit, you use foam construction parts to build a cylinder that's six feet tall and a foot-and-a-half in diameter. That's a million times bigger than a real carbon nanotube!

The exhibit is built into a low box set on the floor. Inside the box are foam construction parts for building the giant model of a carbon nanotube. There are two kinds of parts: black disks that represent carbon atoms and gray connecting rods. The connecting rods fit into holes in the rims of the disks. By inserting the rods into the disks, you can connect the carbon atoms.

In the middle of the box, there is a base where you build the model. The base has a starter row made of wooden disks and rods. The wooden starter row shows you the pattern to build. You add the foam parts directly onto the wooden pieces in the starter row.

As you build the tube upwards, notice the shapes the carbon atoms make. They form a repeating hexagonal, or six-sided, pattern.

6. What's new about nano?

What's new about nano? This large, vertical sign explains that in the field of nanotechnology, scientists are learning to build small, useful things the way nature does—out of individual atoms. The table attached to the sign presents several technologies that are inspired by nanoscale phenomena found in nature.

The vertical sign has photographs of a stack of yellow pencils, a diamond engagement ring, and a pair of bright orange track shoes. Each photo represents a different form of carbon. The pencils contain graphite, the ring contains diamond, and the shoes contain carbon nanotubes.

These three forms of carbon behave differently because their atoms are arranged differently. (Atoms are the tiny building blocks that make up everything in the world.)

Next to each photo is an illustration that shows what the object looks like on the atomic scale—if you could zoom in so closely that you could see the atoms it’s made from.

The pencils are found at the 3 o’clock position on the sign. They contain graphite, commonly called pencil lead. Graphite is soft and slippery because its carbon atoms are loosely stacked in sheets.

The diamond ring is found at 4 o’clock. A diamond is hard and shiny because its carbon atoms are arranged in a sturdy, three-dimensional grid.

The orange track shoes are found at 7 o’clock. They contain carbon nanotubes, a nanoscale form of carbon. Tiny carbon nanotubes are very strong and light, so they’re used to strengthen materials.

Diamond, graphite, and carbon nanotubes all occur naturally. In the field of nanotechnology, scientists are learning to build things the way nature does—atom by atom.

The table attached to the sign has a series of four flip boards introducing different nanotechnologies that are inspired by nature.

The top side of each flip board shows a photograph of a technology and a natural object. Underneath the board are photos showing both objects closer up, and text that explains how they’re related.

From left to right, the flip boards feature: stain-resistant pants, inspired by lotus leaves; a climbing robot, inspired by gecko feet; a computer chip, inspired by snowflake growth; and an electronic tablet, inspired by butterfly wings.

Starting on the left-hand side of the table, the top of the first flip board shows lotus plants growing in water, and a pair of khaki pants. The underside of the flip board shows water droplets beaded up on a lotus leaf and on fabric. The text explains that some stain-resistant fabrics are made with special nanostructures that mimic lotus plants. Lotus leaves have little bumps covered in tiny, waxy nano-sized whiskers. These structures keep water and dirt from sticking to the leaf.

The top of the second flip board shows a gecko and a robot. The gecko is tan with brown speckles, and it’s climbing down a green wall. The robot has four feet and a tail, and it’s climbing up a black wall. The underside of the flip board shows the bottom of the gecko foot and the robot foot. The text explains that some robots can climb up walls, because they have feet that imitate geckos. Gecko feet have millions of nano-sized hairs that are attracted to the atoms of the surface they’re on.

The top of the third flip board shows an intricate snowflake against a blue background, and a computer chip resting on a fingertip. The underside of the flip board shows tendrils of frost growing on a glass window, and a side view of a computer chip. The text explains that some computer chips use nano-sized crystals that spontaneously grow, or self-assemble, like snowflakes do.

The top of the final flip board shows a pair of hands holding a brilliant blue butterfly. Next to it is a photo of three teenage girls looking at an electronic tablet. The underside of the flip board shows the small overlapping scales of the butterfly’s wings, and the small, glass-like layers of material that make up special electronic displays. The text explains that Blue Morpho butterflies have colorless nanostructures, which are precisely spaced to reflect blue light. Some electronic displays mimic these nanostructures to create color images while using less energy.

7. Where can you find nano?

Where can you find nano? This large, vertical sign explains that nano is all around us—in nature and in technology. The table attached to the sign has four activity stations exploring where we can find nano in our own lives.

The sign has a large photo of a comfortable, cluttered living room. The objects in the living room suggest the home of a family with children.

The text explains that nature provides many examples of nanoscale phenomena. For example, the iridescent color of some butterflies and the “sticky” feet of geckos are both caused by tiny nanostructures. And nanotechnology is in products you use all the time, including computer chips with nano-sized parts.

The table attached to the sign has four activity stations exploring where you can find nano in your life.

Each station has an interactive activity and flip boards. The flip boards guide you through the activity. They also let you play an “I Spy” game, finding examples of nano in the large living room photo.

From left to right, the four activity stations are squeeze, listen, look, and touch.

The flip board at the first, left-hand activity station says, “Squeeze. What do you smell?”

On the table above the flip board there’s a plastic squeeze bottle. If you squeeze the bottle and sniff, you can smell a fruity orange scent.

If you open up the flip board, the text explains that your sense of smell works by identifying the shape of scent molecules in the air. Every scented molecule has its own shape. Your nose is your very own nano detector!

In the large living room photo, you can find an orange and a ball-and-stick model of a scent molecule. Flip up the second board to find out where they are. There, you'll find a smaller version of the living room photo with the objects circled in yellow.

The flip board at the second activity station says, "Listen. What makes gadgets go?"

On the table above the flip board, on the right-hand side, there is a push button. Press the button and listen to the sound of a cell phone ringing. Next to the button is a raised panel with images that show the inside of a smartphone.

When you flip over the board, the text explains that computer chips have tiny, nano-sized parts. So when you use a smartphone, computer, or gaming console, you're using nanotechnology! Nano-sized parts make computer chips smaller and faster.

There are many electronic gadgets in the living room photo. Flip up the second board to find out where they're hidden.

Moving to the right, the third activity station says, "Look. Is the butterfly blue?"

On the table above the flip board, there's a plastic case holding a large blue butterfly. To the right of the case is a push button. If you press the button, a light comes on underneath the butterfly. Where the light shines through the wing, the butterfly looks brown, not blue!

If you flip up the board, the text explains that tiny nanostructures in the butterfly's wings change color when the light changes. Blue Morpho butterfly wings look blue—but they're actually made of colorless scales with nano-sized ridges. Light waves bounce off the ridges, reflecting blue light to your eyes. When the bright light passes through the butterfly from underneath, the effect is lost and you see the brown pigment from the back side of the wings.

Nanostructures also make parts of peacock feathers iridescent. There are five blue butterflies and five peacock feathers hidden in the living room photo. Flip up the second board to find out where they're located.

Finally, the flip board at the last activity station says, "Touch. Can a toy use nanotechnology?"

On the table, above the flip board, there is a photo of a cuddly brown toy bear. A groove is cut around the bear, so you can feel its shape. There is also a piece of fuzzy fabric set into the bear's tummy that you can touch.

When you flip over the board, the text explains that lots of things are made with nanotechnology, but it's not always easy to tell. Food, clothing, appliances, and even toys can include nanotechnology, although their labels don't have to say so. The toy bear contains nanosilver, a natural antimicrobial that kills germs. Socks can also contain nanosilver, to keep your feet from smelling! Most likely, these products are safe, but some people worry we don't know enough to be sure.

There are nanosilver socks and a toy bear in the living room photo. Flip the second board to find out where they are.

8. *Balance Our Nano Future*

At "Balance Our Nano Future," you can balance blocks on a tippy table to create a stable nano world.

This exhibit is built into a square table with a trick. The tabletop isn't solid—it has a tippy, circular surface set into it. Try tipping the table!

The tippy table is covered in a colorful graphic that looks like an overhead map of a town. There are four areas in the town, neighborhood, government, science and industry, and nature.

The text explains that in the neighborhood, people use nanotechnologies. The neighborhood has gray cul-de-sac roads surrounded by green grass.

In government, people promote and oversee nanotechnologies. The government area shows a grid of streets surrounded by a gray concrete color.

In science and industry, people create nanotechnologies. This area has a crossroad surrounded by a tan color.

In nature, people protect the environment. The nature area is a green space with a blue river winding through it.

Under the table there is a shelf holding a variety of colorful wooden blocks, including people, trees, animals, cars, houses, apartment buildings, a hospital, a capitol building, a bank, a grocery store, a toy store, an electronics store, a university building, a nano business, and a nano laboratory.

Try to balance the blocks on the table, putting each one where you think it belongs.

(Be sure to pick up the blocks by reaching under the table. Please don't put your hand in between the circular tippy surface and the square table edge.)

Balancing blocks on a tippy table is kind of like the challenge we face as we build a stable nano future. People, companies, and governments all need to work together to balance a variety of costs, risks, and benefits.

9. *What does nano mean for us?*

What does nano mean for us? This sign and table explore the ways that nanotechnology might influence our lives, and provide different perspectives on nanotechnology.

The vertical sign has a large photo of a city. In the foreground of the photograph, there is a row of brick houses surrounded by leafy trees. In the background of the photo, there are tall skyscrapers.

The text suggests that nanotechnology will affect our economy, environment, and personal lives. Some scientists think that new nanotechnologies could transform our lives just as much as the automobile or personal computer!

As individuals and communities, we'll need to balance the costs, risks, and benefits of nanotechnologies. By deciding whether to use products made with nanotechnology, each one of us helps shape nano research and development. Companies and governments also shape our nano future, by deciding which technologies to invest in and how to regulate them.

The table attached to the sign has a series of flip boards, which introduce different perspectives about nanotechnology.

The top side of each flip board shows a photograph of a person. If you flip the boards up, you can learn about those people's thoughts on nanotechnology.

From left to right, the people are: Gayle, from an environmental organization; Jessica, from a medical research center; Rafael, from a humanitarian agency; and David, from a venture capital firm.

Starting on the left-hand side, the first flip board shows Gayle, from an environmental organization. Gayle says:

> I got interested in nanotechnology for the environmental benefits it could bring, and then the risk question jumped out at me. Nanotechnology could lead to new ways of creating energy and cleaning up pollution. But there's a lot we don't know. Will it also create new risks for people and the environment?
>
> My organization is working to advance nanotechnology responsibly, by involving stakeholders to help shape it. That includes the government, industry, and citizens. Nanotechnology is still developing, so we can get it right the first time!

The second flip board shows Jessica, who works in a medical research center. Jessica says:

> My team is developing a cancer treatment that targets tumors without affecting healthy parts of the body. Nanotechnology gives us a whole new way to approach medicine, because we're working at the same scale the human body is built on.

> People ask me if nanomedical treatments will be risky. They might be, but existing treatments are risky, too. Chemotherapy is very hard on your body. If we can target just the tumor, that means fewer side effects.

The third flip board shows Rafael, who works in a humanitarian agency. Rafael says:

> I work to improve living conditions in developing countries. In many parts of the world, people don't have access to safe drinking water. New nano filters are cheap and easy to use, and they remove bacteria, viruses, and heavy metals from water. So they could help prevent disease in many parts of the world.
>
> I'm optimistic about nanotechnology, but it can't do everything. It's not a silver bullet. We still need to work to change governments and other institutions.

The last flip board shows David, who works in a venture capital firm. David says:

> I invest funds in high-tech industries, so I pay attention to nanotech companies. As a professional, I'm excited about the potential of nanotechnology.
>
> But as a parent, I have some concerns. I want to know my kids are safe. Not many people realize that nanotechnology is already in food. Ingredients that are generally regarded as safe can act differently on the nanoscale, so size is important. I think industry and the government need to work together to protect consumers.

These are just some of the different ways we can think about nanotechnology, and how it will be a part of our lives.

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