Discovery Lesson

TEACHER ENRICHMENT RESOURCE PACKET

Nano Mini Exhibition

Nanoscale science, engineering and technology (or "nano" for short) is a new, interdisciplinary field of research and development. Just within the past couple decades, scientists have developed methods and tools that allow them to explore some of the most fundamental aspects of our natural world, and to develop new materials and technologies. Some experts think that nanotechnologies may transform our lives--similar to the way the automobile and personal computer changed how we live and work. Learning objectives:

- Materials can act differently when they are nano-sized,
- Nanotechnology lets us build things as nature does, atom by atom,
- Nano is all around us, in nature and in technology,
- Nanotechnology will affect our economy, environment, and personal lives.

Think it.
Try it.
Explorit.

contents

Background Information "Nano Mini Exhibition"

Thank you for choosing Explorit Science Center's *Discovery Lesson* program to supplement your ongoing science curriculum. Whether you use the program to kick off a new unit, wrap up a nearly completed unit, or purely to excite and interest your students in the wonderful world of science, advance preparation and follow up with your students are critical to achieving the greatest educational benefit from this unique science experience.

Explorit provides two resources to help prepare you and your students for the *Discovery Lesson*. First, simple logistics of the program are detailed in the confirmation letter. Second, this Teacher Enrichment Resource Packet outlines appropriate science content and processes to help you:

- successfully prepare your students prior to visiting Explorit;
- participate fully in the *Discovery Lesson* yourself; and
- follow-up with your students back in the classroom.

The great potential of nanotechnology comes from its tiny size. Nano research and development happens at the scale of atoms and molecules. Some things have different properties on the nanoscale, which allows scientists and engineers to create new materials and devices.

Nano isn't just in the lab--we can already find it in our homes, stores, and hospitals. In the next 10 years or so nanotechnologies and materials will become even more present in our lives. We'll find nano in everyday products such as computers, food, cosmetics, and clothing. Nano might also be part of solutions to big problems, helping address needs such as clean energy, pure water, and cancer treatments.

It's important for everyone to be informed about nanotechnologies, because they'll be an important part of our future. Like any technology, nanotechnologies have costs, risks, and benefits. Since nanotechnologies are still developing, we can influence what they are and how they're used. We all have a role in shaping how nanotechnologies will play out in our future.

Nano is a big and exciting field of study, and there's a lot to know. But the most important concepts of nanotechnology are also some of the most important concepts for understanding our natural world, the process of science and engineering, and the ways that society and technologies are interconnected.

The iridescent colors of the **Blue Morpho Butterfly**'s wings are produced by nanostructures that reflect different wavelengths of light!

The Nano exhibition explores nanoscale science, engineering, and technology through hands-on exhibits, graphic and text panels, and other educational experiences. The primary visitor learning objectives of *Nano* are:

1. **Materials can act differently when they are nano-sized.**
2. **Nanotechnology lets us build things the way nature does, atom by atom.**
3. **Nano is all around us, in nature and in technology.**
4. **Nanotechnology will affect our economy, environment, and personal lives.**

Nano is conceptually organized around four exhibit areas, each of which explores one of these learning objectives. Each exhibit area includes a large graphic posing a question, plus one or more interactive exhibits that allow visitors to explore the question.

At the *Small, Smaller, Nano* exhibit, visitors use magnets to explore how a material called magnetite behaves differently at different sizes. While magnetite sand, powder, and liquid are all fun to manipulate with magnets, the ferrofluid (with nano-sized particles) is especially fascinating.

Build a Giant Carbon Nanotube lets visitors use foam construction pieces to make a large model of a nanostructure called a "carbon nanotube." They work atom by atom--just like scientists who are creating tiny new nanotechnologies.

More examples of nano in nature and technology are found at the sign entitled "Where can you find nano?" Visitors can use a series of hands-on interactives and play the "I Spy" game to discover nano in familiar places.

At *Balance our Nano Future* visitors balance blocks on a tippy table, trying to create a stable "nano world." They can learn more about different perspectives on nanotechnology at the sign entitled "What does nano mean for us?"

Classroom Activity #1

ACTIVITY #1 PIGMENT VS. IRIDESCENCE

Background: Pigment is a fixed color that most familiar items have. A shirt is red. A cup is blue. But some items display color through iridescence. Iridescence is a phenomenon caused by nanostructures that bend light causing a colorless item like an oil slick on water or a butterfly's wing to appear a certain color or show a rainbow.

Materials: construction paper in various colors, shallow dishes of water, pipettes or straws, peacock feathers, clear nail polish, black construction paper or cardstock, scissors

1. Use pipettes or straws to add a few drops of water to different colors of construction paper. What happens? Does the paper change color?

2. Now drop water on peacock feathers. How do they differ from the paper? Can you explain what's happening?

3. Cut a strip of black construction paper or cardstock small enough to fit in the tray of water and submerge it. Add a drop or two of clear nail polish to the surface of the water. What colors do you see?

4. Carefully lift the paper strip out of the water so that the nail polish sticks to the paper. What colors do you see now? What's happening?

The construction paper has pigment, so when it gets wet it might get darker, but it won't change color. The feather has no pigment. Adding water interferes with the feather's nanostructures that reflect light, letting you see a whole different rainbow. The nail polish on the surface of the water does the same thing, and the black paper lets you see that iridescent rainbow!

Classroom Activity #2

ACTIVITY #2 CUTTING IT DOWN TO NANO

Background: A nanometer is one billionth of a meter. That's 10^{-9}!

Materials: scissors, 150mm x 5mm strips of paper, rulers

1. Cut the strip in half and measure it now. It should be 75mm long.

2. Keep cutting it in half until it is 10 nanometers long. How many cuts would you have to make? Can you do it with regular scissors?

Nano is very, very small, and requires special tools!

Vocabulary

This list includes words that may be used during the *Discovery Lesson*. Specific vocabulary used depends on students' grade level and prior knowledge.

Biomimicry -- the imitation of the models, systems, and elements of nature for the purpose of solving complex human problems

Ferrofluid -- a fluid containing a magnetic suspension

Hydrophobic -- fearing water, refers to a material or substance that repels water

Magnetite -- a mineral, one of three common naturally occuring iron oxides

Nano -- scientific term meaning "one billionth," from the Greek word for "dwarf"

Nanoengineering -- the practical application of nanoscale science and technology

Nanometer -- one billionth of a meter, one inch = 25.4 million nanometers, a sheet of paper is about 100,000 nanometers thick, a human hair measures roughly 50,000-100,000 nanometers across, your fingernails grow one nanometer every second

Nanoscale -- measurements of 1-100 nanometers, a virus is about 70 nanometers long, a cell membrane is about 9 nanometers thick, ten hydrogen atoms are about 1 nanometer

Nanoscience -- the study of materials and their differing properties on the nanoscale

Nanotechnology -- the manipulation of material at the nanoscale to take advantage of the fact that common materials exhibit different properties at the nanoscale such as remarkably lower resistance to electricity or faster chemical reactions; often involves working with individual molecules

Nanotube -- a nanoscale, tube-shaped material with carbon molecules arranged in a hexagonal pattern

There are approximately 610 products currently on the market that contain nanomaterials!

Supplemental Resources

BOOKS

Brezina, Corona. **Cutting-Edge Careers: Careers in Nanotechnology**. Rosen Publishing, 2007.
A practical and inspirational look at potential career paths for budding nanoscientists.

Horton, Leigha and Stephanie Long. **Alice in Nanoland**. Science Museum of Minnesota for the NISE Network, 2010.
Delightful and whimsical exploration of current nano research.

Johnson, Rebecca L. **Real Science: Nanotechnology**. Lerner Publications Co., 2006.
Accessible and kid-friendly introduction to the basics of nanoscience, from understanding the nanoscale to the potential impacts of nano on our future.

Dr. Seuss. **Bartholomew and the Oobleck**. Random House, 1949.
As the titular Bartholomew works to save his kingdom from a downpour of oobleck (cornstarch paste), he also introduces young readers to colloids, non-Newtonian substances, and their nano properties.

Dr. Seuss. **Horton Hears a Who**. Random House, 1954.
Whos are too small to be seen, but Horton can sense them in other ways--just like materials on the nanoscale. And small size does not mean small importance!

Wells, Robert E. **What's Smaller than a Pygmy Shrew?**. Albert Whitman and Co., 1995.
An exploration of relative size. Excellent illustrations and down-to-earth explanations of abstract concepts.

WEB SITES

http://www.nisenet.org
The ultimate resource for all things nano. Includes classroom lesson plans, activity ideas, images, and much, much more.

http://whatisnano.org
Educational website with videos, audio, and diy activity ideas.

Science Standards

NGSS STANDARDS
Physical Science (1-PS4-1, 1-PS4-3, 2-PS1-1, 2-PS1-2, 3-PS2-1, 3-PS2-3, 4-PS4-2, 5-PS1-1, 5-PS1-3, 5-PS2-1)
Life Science (1-LS1-1, 4-LS1-1)
Earth Science (K-ESS2-2, K-ESS3-3, 2-ESS1-1, 3-ESS3-1, 4-ESS3-1, 5-ESS3-1)
Engineering and Technology Applications in Science (K-2-ETS1-1, K-2-ETS1-2, K-2-ETS1-3, 3-5-ETS1-1, 3-5-ETS1-2)

Explorit Programs for Schools and Groups

At Explorit's Site

Discovery Lessons	Visit our current museum exhibition
Inquiry Labs	Try a series of team challenges
Nature Safaris	Spring visits to Explorit's outdoor spaces at Mace Ranch Park

Explorit in Your Classroom

Classroom Adventures	Explorit educators visit your classroom for hour-long presentations
Young Scientist Series	A 4-week forensic science experience

For the Whole School

Health in Your World	Learn about keeping your body and the world healthy and safe
Science in Your World	The ultimate family science night

Reservations required.
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