PASSPORT TO

ViNSE

Vanderbilt Institute of Nanoscale Science and Engineering

Friends and Family Day 2025

Welcome to Friends and Family Day!

Get ready for an exciting adventure into the world of nanoscience. Grab your passport to explore some cool stations and make scientific discoveries along the way!

BOARDING PASS

PASSENGER:

DESTINATION:
VU - VINSE

FLIGHT:
10^{-9}

GATE:
02

DATE:
04/05/2025

FIRST CLASS

NASHVILLE

VINSE

Be sure to get your passport photo taken in front of the cleanroom windows.

PASSPORT TO NANOSCIENCE

TYPE	CODE	PASSPORT ID
VINSE	**FFD**	**02122022**

NAME:

DATE: April 5, 2025

TIME: 1:00 - 4:00

VINSE

ACTIVITIES

Visit each station to discover the wonders of nanoscience!
Remember to get your book stamped at each stop.

On the first floor:

→ Concierge station - where you'll go for all questions

→ Passport photo / cleanroom gowning

FOR YOU!

Swing by the concierge desk to collect a prize for each stamp you earn.

In the basement:

What is *nano*?

There are 1 billion nanometers (nm) in 1 meter.
What does this look like?

Imagine you are only 1 nanometer tall. A single sheet of paper would look super thick – about 110 miles thick. 110 miles is the distance from Nashville to Chattanooga, a 2 hour drive!

Now, imagine if everyone on Earth was only 1 nanometer tall. The entire human population could fit inside a Hot Wheels car!

How small is *nano*?

1

How tall are you in nanometers?

_____

nanometers

2

How fast can you run the 5 billion nanometer dash?

_____

seconds

How can we use nanomaterials?

Nanomaterials are structures composed of objects on the nanoscale. Scientists study nanomaterials because they are useful in many applications, including electronics, medicine, and energy storage!

LED DISPLAYS

Samsung's QLED TV uses quantum dots in their display. These dots are tiny nanoparticles that fluoresce (glow) different colors based on their size and material.

FUN FACT

The scientists that discovered and first made quantum dots received the 2023 Nobel Prize in Chemistry!

CLEAN ENERGY

Nanomaterials can be used to create better ways to generate electricity. Did you know that you can make a simple solar cell with blackberry juice, titanium dioxide nanoparticles, and a few other basic supplies?

HEALTH

Nanomaterials can improve our health in the form of vaccines, medicine, disease detection, and even have the potential to be used to make artificial organs!

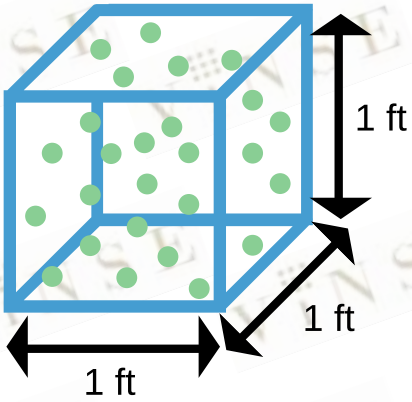
Today, you will become a nanoscientist and explore different ways we can use nanomaterials to our advantage!

The Cleanroom

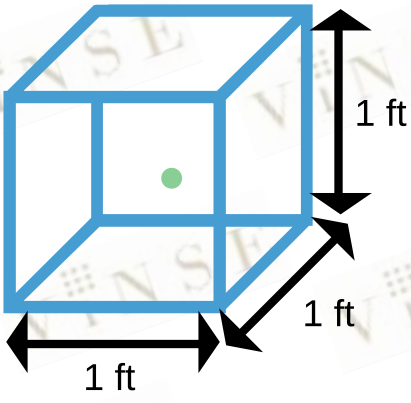
A cleanroom is a super clean science lab where the air is kept free of dust and pollutants. It is used daily by VINSE staff to make new materials.

Parts of our cleanroom are class 100, meaning there are less than **100 particles of dust** per **1 cubic foot** of air. Compare that to regular air which has about 1,000,000 particles of dust in 1 cubic foot!

Normal air:



Cleanroom air:



Gowning up!

Personal protective equipment (PPE) must be worn in the cleanroom. PPE is usually worn to protect scientists from chemicals, but in a cleanroom, PPE must be worn to protect the cleanroom from **YOU**! Humans shed skin, hair, and dust that can contaminate the cleanroom and the nanodevices made inside it.

If you are younger than 12:

Tour the cleanroom through the big windows, and learn about what gets done in each bay. Why are two of the bays orange? Why do the cleanroom workers wear cleanroom "bunny" suits?

If you are 12 and older:

Enter the pre-gown room to start your tour.

Stamp Here

Analytical Lab

Imagine you're a scientist in a lab where you get to discover amazing things about really tiny stuff – stuff so small you can't even see it with your eyes! The VINSE Analytical Lab is like a magical toolbox with awesome gadgets that let you do exactly that.

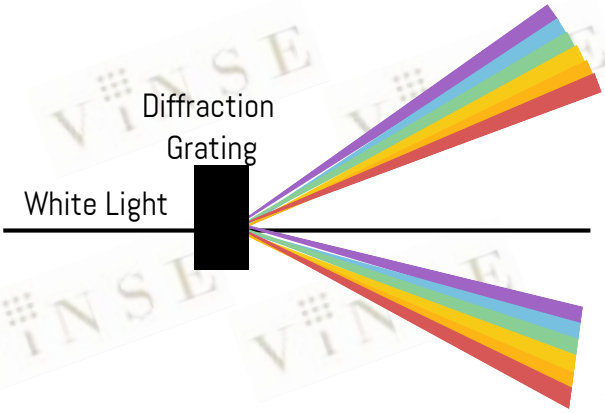
DID YOU KNOW?

The techniques you see in the VINSE Analytical Lab are often used in **Forensic Science**, or the science of solving crimes. One tool, the Raman Microscope, shines laser light at an unknown material to figure out its "fingerprint' and help scientists identify the material. As an example, we can use a Raman microscope to tell the difference between a real diamond and a fake one.

Now let's see how some of these tools work!

Zetasizer measures how tiny particles move in liquids and can figure out their size based on how fast they move.

Spectrophotometer measures how much of each color of light will pass through a material or reflect off a material.

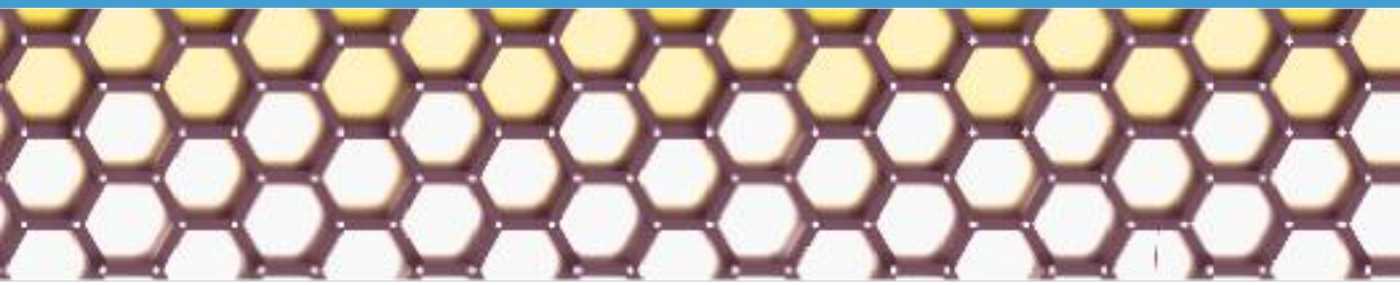


UV/Ozone Cleaner uses light to clean materials, like giving them a bath before experiments.

Diffraction grating glasses are similar to one of the parts inside the spectrophotometer. They separate white light into all the colors of the rainbow. You can take your glasses home and show your friends!

Stamp Here

The World of Carbon Nanotubes!



A carbon nanotube is a super tiny, super strong hollow tube made out of carbon. Carbon is the same stuff that makes up pencil lead and diamonds. Instead of being a big, solid thing, a carbon nanotube is made of a tiny sheet of carbon atoms that are curled up into a tube, kind of like rolling up a piece of paper.

DID YOU KNOW?

Carbon nanotubes are 100 times stronger than steel but are only 1/6 the weight! Carbon nanotubes are so strong that they could be used to make bulletproof armor.

We're going to build a giant model of a carbon nanotube using long balloons! Each balloon will represent a row of carbon atoms just like a real carbon nanotube!

DID YOU KNOW?

You might have used carbon nanotubes without even knowing it! They're super strong but light, so they're in things like tennis rackets, golf clubs, and bike frames. They also help electricity flow easily, which makes them awesome for batteries and gadgets!

Follow the steps to add a new section to our giant carbon nanotube using long balloons! As you add each balloon, imagine each end of the balloon as a carbon atom. When we link them together, they'll form a super strong, bendy structure, just like how a real carbon nanotube works in the world!

1 How many balloons did you add to our giant carbon nanotube?

Stamp Here

Can clear things be colorful?

Despite looking so colorful, peacock feathers are actually brown. The "colors" you see are due to layers of nano-rods on the feather's surface. The spacing between nano-rods in each part of the feather determines which color of light we see. The color you see changes depending on your viewing angle, too!

Only when layers of a material are **nano** do we see the beautiful colors in this way. Scientists can take notes from nature on how to access cool properties like these.

Today, you will observe the **magic of nano** by depositing a thin film of clear nail polish on black paper, allowing it to reflect light**. Just like the peacock feather, the color of the reflection is based on the thickness of nail polish in that area**.

Stick your iridescent thin film here!

DID YOU KNOW?

Scientists can deposit, or coat, nanoscale films on eyeglasses to make it easier to see and to prevent fog or dust. These nano films are also used in devices like phones, tablets, and computers to protect the screens from scratches or water damage.

By exploring how different layers of nail polish reflect light, you'll see how tiny changes can have a big impact - just like how scientists use nanotechnology to improve everyday items like glasses and phones!

Stamp Here

Have you seen a liquid that acts like a magnet?

Ferrofluids are liquids made up of tiny iron nanoparticles. When a magnet is nearby, these nanoparticles feel it and stick together like a solid. But when the magnet is gone, the nanoparticles move around like a liquid again. Nanoparticles are special because they have different properties compared to regular-sized (bulk) particles.

Bulk Iron Oxide

Nano Iron Oxide "Ferrofluid"

DID YOU KNOW?

The ink used to print US currency has ferrofluid in it to help with security features.

Scientists are studying ferrofluids to help deliver medicine exactly where it's needed in our bodies! Since the magnetic particles in the fluid can be controlled by magnets, doctors can use magnets to guide the medicine to specific areas of the body.

DID YOU KNOW?

Our bodies have enough iron to form two small nails!
Iron is essential for blood production.

Since our bodies need iron to make blood, we must be getting iron somewhere... ***our food!***

Red meat, broccoli, and cashews all naturally have iron in them. Cereal companies fortify their food with iron, which means they add iron to their cereal products.

While eating big chunks of iron isn't a good idea, tiny pieces of iron are safe for us to consume – and today, you'll get to see it for yourself!

Next time you are eating cereal, look at the food label and see how much iron you are eating!

Stamp Here

Can liquids defy the laws of physics?

Traditional (**Newtonian**) states of matter, like solids, liquids, and gases, behave the same no matter what forces are acting on them. For example, water behaves the same if it is sitting in a glass or being mixed.

Some materials are **non-Newtonian**. They do not behave the same with different forces, like being stirred. This means that some liquids can behave as solids!

"Oobleck" acts like a liquid at rest and a solid when put under pressure, so it is **non-Newtonian**!

DID YOU KNOW?

Armor can be liquid! Soaking strong body armor material in a non-Newtonian fluid can make it more resistant to impact from weapons. Since it acts like a liquid at rest and a solid under strong forces, the non-Newtonian fluid can protect the body from sudden forces like a bullet, providing extra protection.

At this station, you will make your very own 'stress ball' using oobleck! Measure about 1 cup of oobleck and pour it into a balloon, seal it, and now you have a squishy, non-Newtonian material you can carry around. When you squeeze it, it acts like a solid - how cool is that?

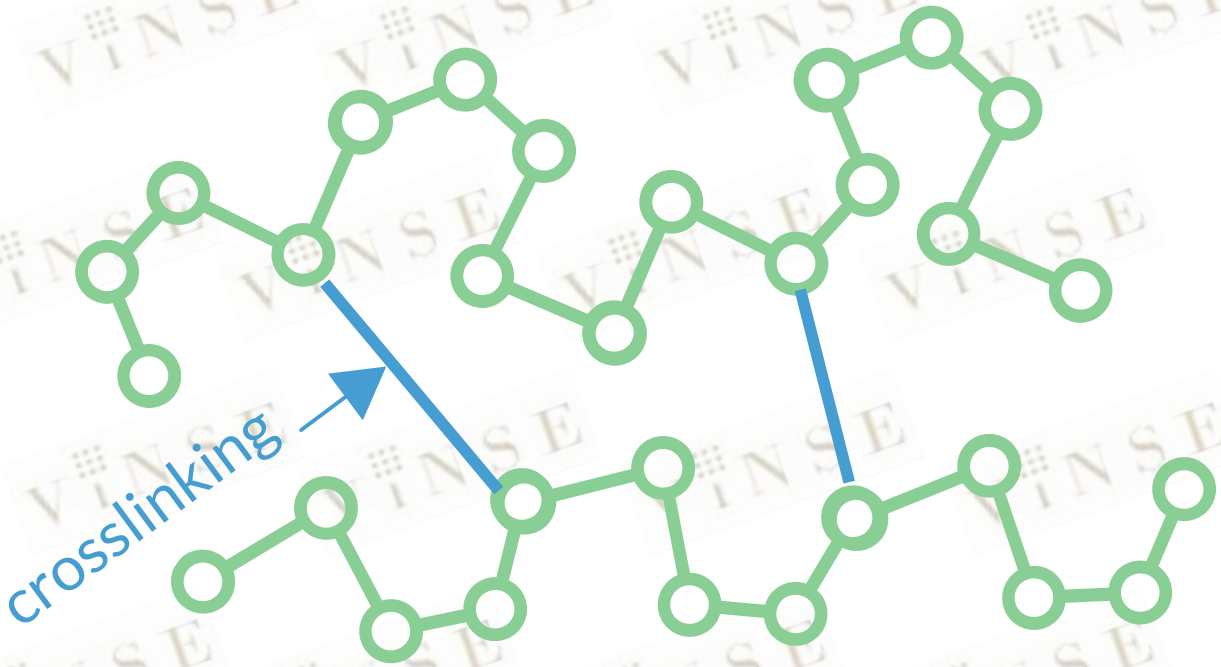
You can make your own oobleck at home by mixing 1 cup of water and 1.5 cups of cornstarch.

Stamp Here

How do seaweed and road salt make a polymer?

Polymers are all around us. Tires on our cars and bicycles, contact lenses that help us see, and your plastic toothbrushes are all made of **polymers**.

Polymers are made of long molecules composed of repeating chemical units. They can be **cross-linked** to become even stronger.

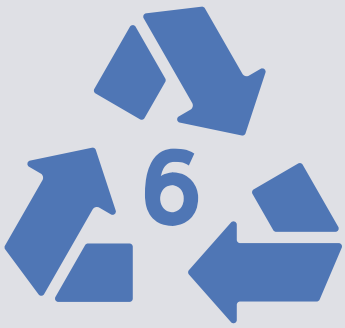


Today, you will combine a **polymer** (sodium alginate from seaweed) with an **activator** (calcium) to cross-link the polymer and make different shapes!

Polymer science is super important for making Earth-friendly materials. Scientists are working on creating polymers from plants that can break down over time. Can you imagine using plastic that doesn't last forever and doesn't hurt the environment?

DID YOU KNOW?

The recycle signs you see on water bottles and to-go boxes tell you what kind of polymer it is. For example, if there is a 6, you have **polystyrene**, which is used to make egg cartons, disposable cups/plates, and more!



Take your cross-linked polymer home with you!

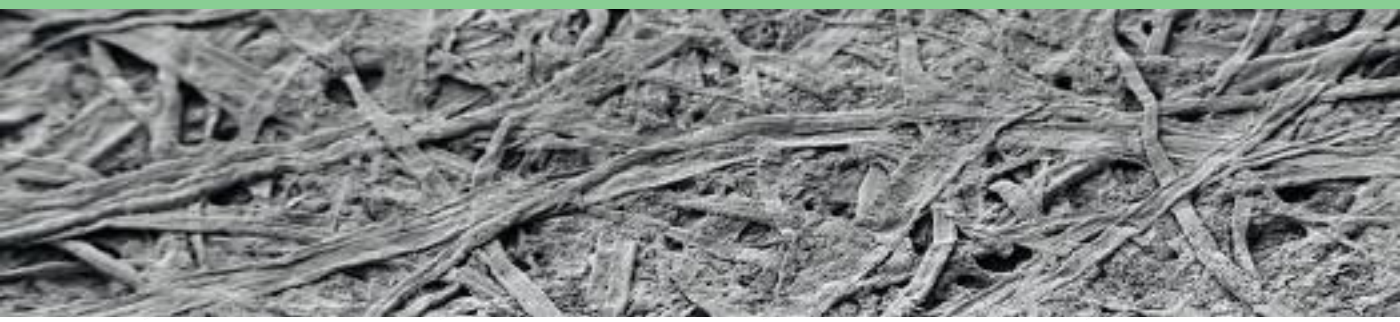
Stamp Here

Is black ink black, or are their hidden colors?

Chromatography is the process of separating parts of a mixture. Chemists use chromatography to purify their molecules from other unwanted molecules.

This is important when designing and manufacturing medication. Scientists must be able to purify life-saving drugs from a mixture of other molecules.

Paper under a microscope:



Chromatography paper is commonly used to separate liquid mixtures. Tiny holes in the paper that are too small to see by eye help the liquid travel across the paper, allowing the parts of the mixture to be separated.

In this lab, we will use chromatography paper to separate the different colors hidden inside a black marker. Some ink molecules are larger, while others are smaller, causing them to travel at different speeds and separate from each other.

Stick your separated colors here!

Congratulations on being a color detective! You've uncovered the hidden rainbow inside the black ink – just like how scientists use chromatography to uncover the secrets of different molecules.

Stamp Here

How does sunscreen protect your skin?

The sun casts harmful ultraviolet (UV) rays that damage our skin cells. Sunscreen contains special ingredients that either **reflect** or **absorb** these rays, stopping them from damaging your skin.

Some sunscreens contain zinc oxide or titanium dioxide nanoparticles that protect you by reflecting away UV light.

DID YOU KNOW?

SPF stands for "sun protection factor," telling us how effectively sunscreen protects against sunburn. You can use the UV index in weather reports to see how intense the sun's UV rays are at any time to see what precautions you should take to avoid skin damage!

In this experiment, you will be coating special beads with different sunscreens to test their ability to block UV rays and repel water. The beads are special because they change color when exposed to UV light.

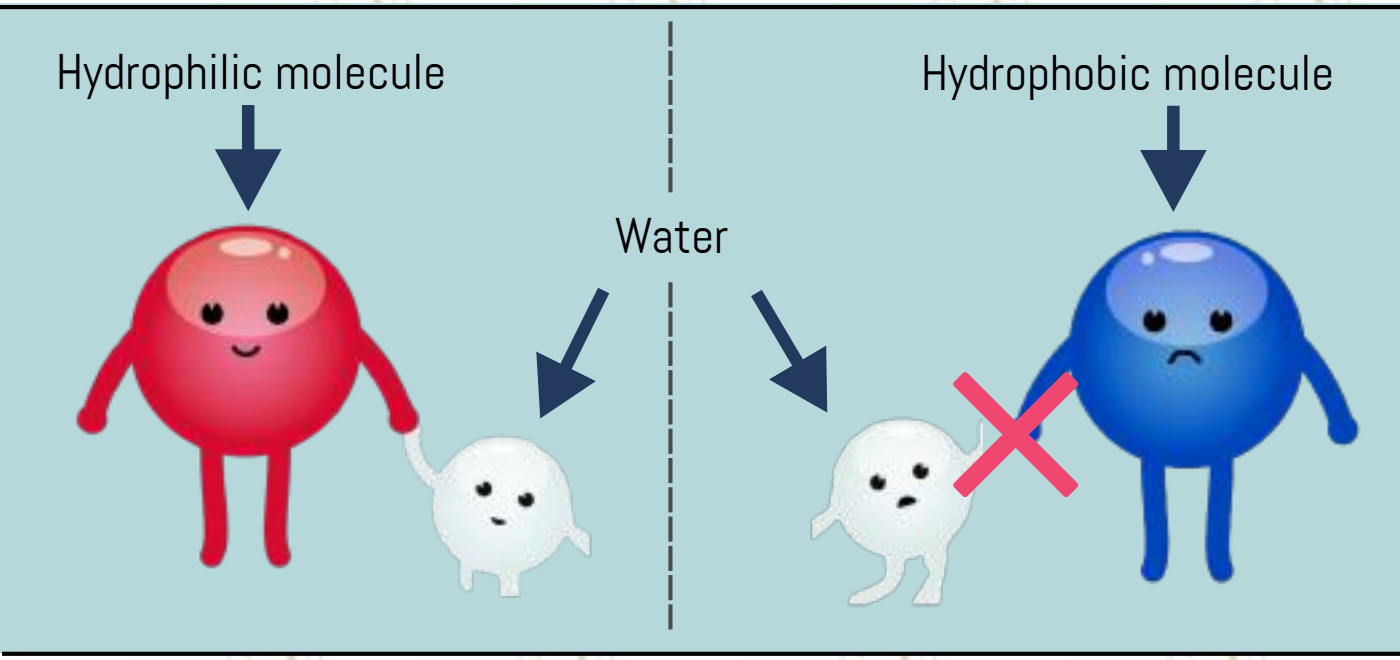
The higher the SPF in sunscreen, the more UV light gets blocked, so the beads take a longer time before they change color. If the sunscreen is water resistant, you will not be able to easily wash it off the bead.

Take your beaded bracelet home and be sure to put on sunscreen when they glow!

Stamp Here

Can you keep sand dry in a bucket of water?

The sand at the beach is **hydrophilic**, meaning it loves to soak up water. But there is also **hydrophobic** sand, which is coated with special **polymers** that make it repel water. The coating is only **1 nanometer** thick, so it still feels like regular sand, but at the nanoscale, it behaves much differently.



Hydrophobic sand was invented to clean up oil spills. Oil is also hydrophobic, so the hydrophobic sand is attracted to the oil instead of the water. The oily sand sinks and can be removed to leave behind clean water!

DID YOU KNOW?

Your rain jacket and umbrella are coated with hydrophobic polymers that prevent water from soaking through to your skin! Next time it rains, notice how the water beads up and falls when it hits your umbrella.

In this experiment, you will see the difference between **hydrophilic** and **hydrophobic** sand as they react to water in unique ways. By testing both types of sand, you can see how their properties are used in real-world applications.

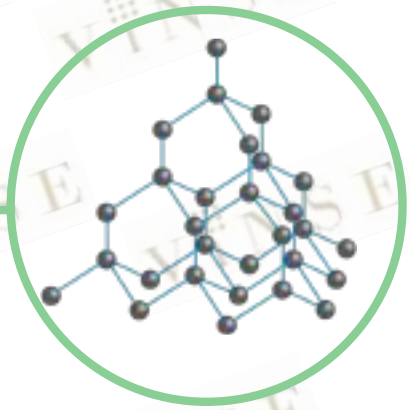
Make your own kinetic sand at home. Mix 2.5 cups of fine sand with 1.5 cups of cornstarch. Once combined, add 0.5 cups of oil. Mix well, and you'll have your own moldable sand that repels water, just like the kind used for oil spills.

Stamp Here

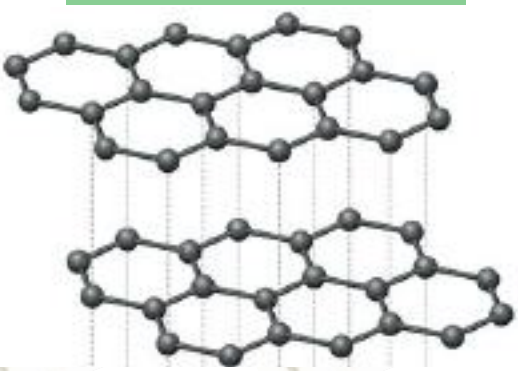
Can you win a Nobel Prize with a pencil and tape?

Carbon is commonly found in two forms in nature: graphite (found in pencil lead) and diamond. The difference between the two is how the carbon atoms are arranged!

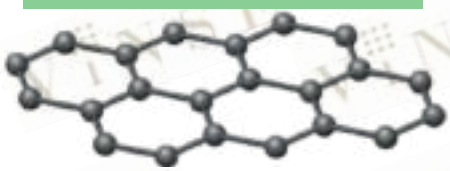
Diamond is the hardest structure on earth. Carbon atoms are tightly bonded to other carbon atoms in all three dimensions, resulting in exceptional strength.



GRAPHITE



GRAPHENE



Graphite, is super soft and consists of single layers of graphene, which are each only one atom thick. If you stacked one million layers of graphene, it would still be less than one millimeter thick.

The 2010 Nobel Prize in physics was awarded to scientists that studied graphene!

In this activity, you will peel layers of graphite using tape to make tiny pieces of graphene, the thinnest material in the world! You will also learn how graphene can conduct electricity and even create cool circuits with it!

DID YOU KNOW?

Graphene is more conductive than copper because its hexagonal structure lets electrons move easily. Stacking two layers at the right angle creates a "superconductor," which carries electricity without any resistance when cooled - no energy is lost!

Pencil here!

Stick your tape here!

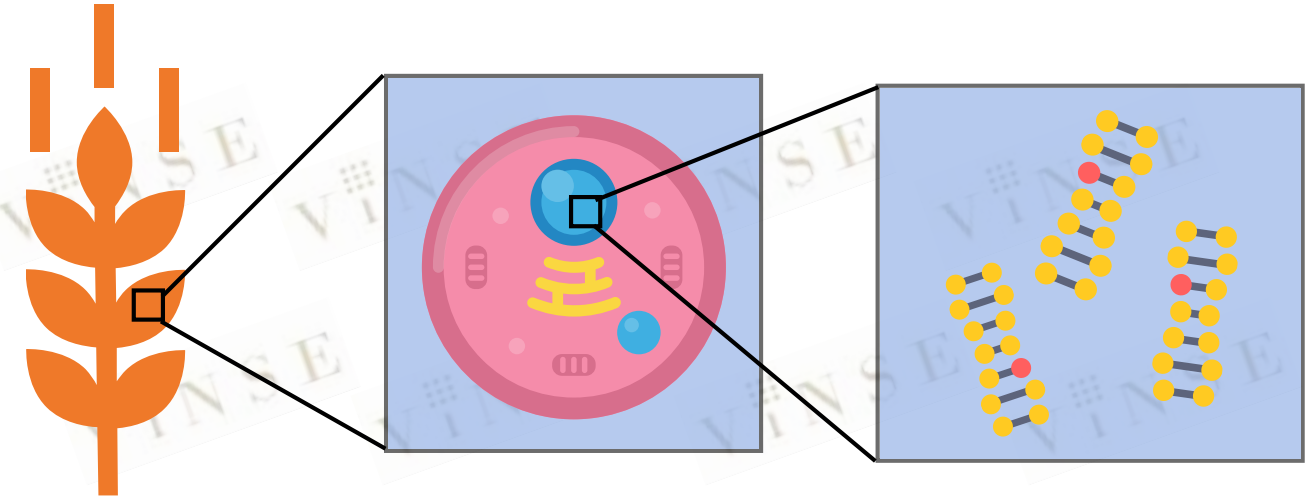
Stamp Here

Want to see DNA and the building blocks of life?

DNA is considered the instruction manual for every living thing, telling our bodies how to grow, function, and stay healthy. It carries all the information our cells need to work and is arranged to give us our unique traits, such as eye color or hair type.

Even though the width of a DNA strand is measured on the nanoscale, we can actually see DNA with our eyes when it's taken out of cells in a special way.

Today, you will extract DNA from wheat germ, a tiny plant seed! By adding shampoo and meat tenderizer, we can break down the seed's cell wall and release the DNA. Then, we can add rubbing alcohol to make the nano-sized DNA clump into visible globs that we can see!



Wheat Germ:
1,000,000 nm

Plant Cell:
10,000 nm

DNA strands:
10 nm

DID YOU KNOW?

The human body has more than 10 trillion cells, and each cell has DNA strands inside. If you line up all the DNA strands in your body end-to-end, it would stretch from here all the way out to the planet Jupiter and back more than 10 times! That's billions of miles!

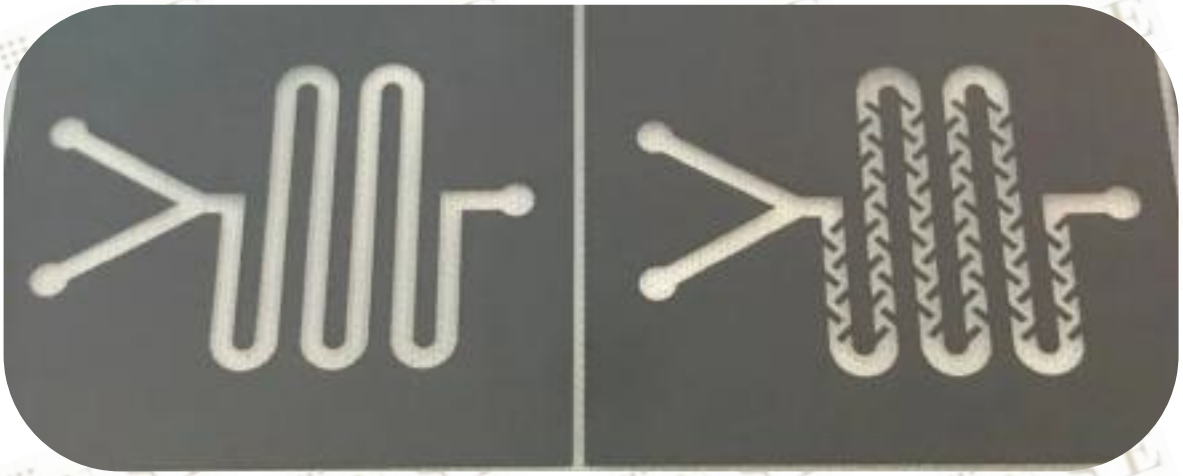
Stamp Here

Tie a piece of yarn around your tiny test tube to make a DNA necklace!

What is a Microfluidic Device?

Microfluidics is the study of how small amounts of liquids move through tiny channels. Scientists use microfluidics to shrink their experiments from taking up a full table to fitting in the palm of your hand.

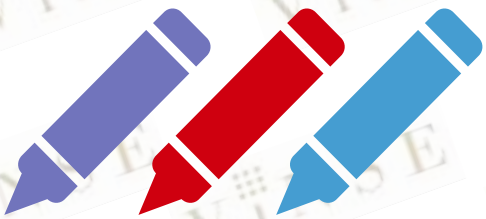
Scientists use special tools, chemicals, and UV light to carve out the tiny wells in microfluidic devices. Today, you'll make your very own device using crayons and paper – let's see what cool designs you can create!



Microfluidic devices are like tiny highways for liquids!

First, draw any closed design you like with a crayon—zigzags or shapes like stars or hearts! By gently melting the wax in the crayon, your design will become the "walls" of the fluid channels. Once you've created your channels, drop a few drops of colored water at the start of the channel, and watch it flow through your own microfluidic device.

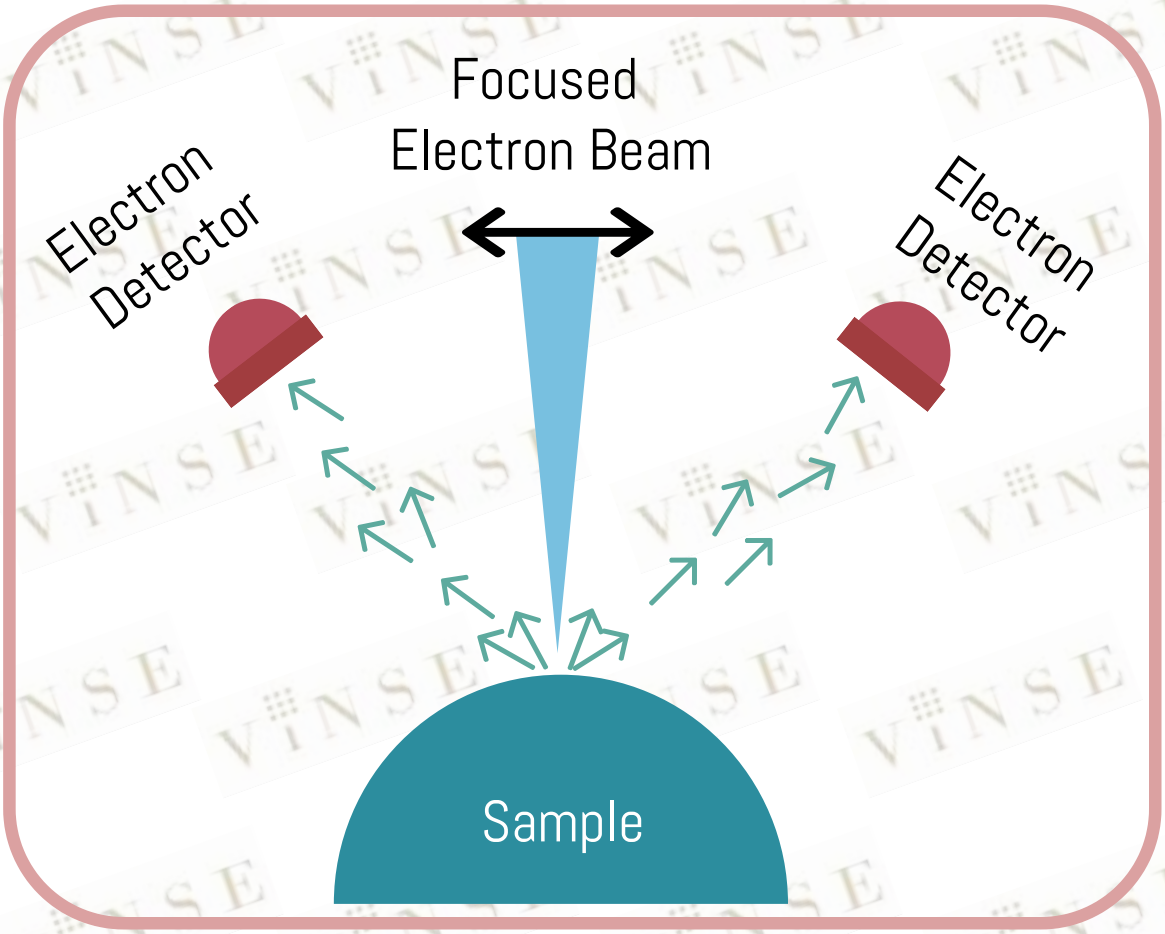
Stick your microfluidic device here!



These microfluidic devices are used to diagnose diseases, help develop drugs, and more!

Stamp Here

The Scanning Electron Microscope (SEM)



If you want to see really small things really well, then you need to use electrons! The scanning electron microscope does just that. A highly focused beam of electrons is scanned across an object, creating images with nanoscale resolution.

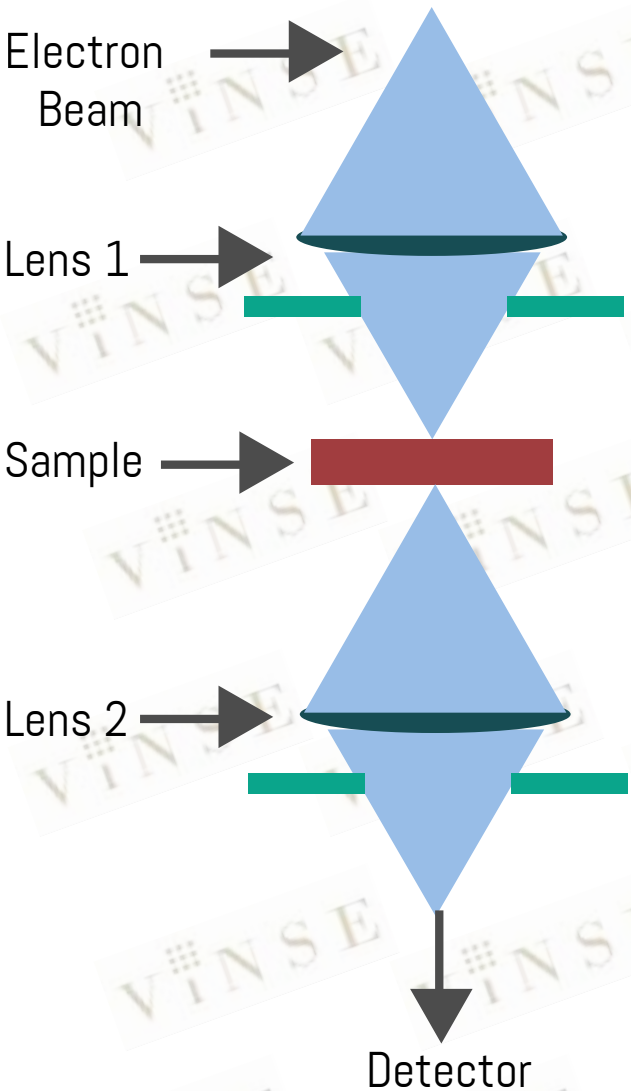
During your visit to the SEM, you can see Fred the Bee, a honeybee coated in gold. Using the SEM, you can observe all the different structures of Fred's hair, including those coming right out of his compound eyes!

Fred The Bee

You can also see the hairy mouthparts and tongue, which is why a bee feels prickly when it lands on you!

Stamp Here

The Transmission Electron Microscope (TEM)



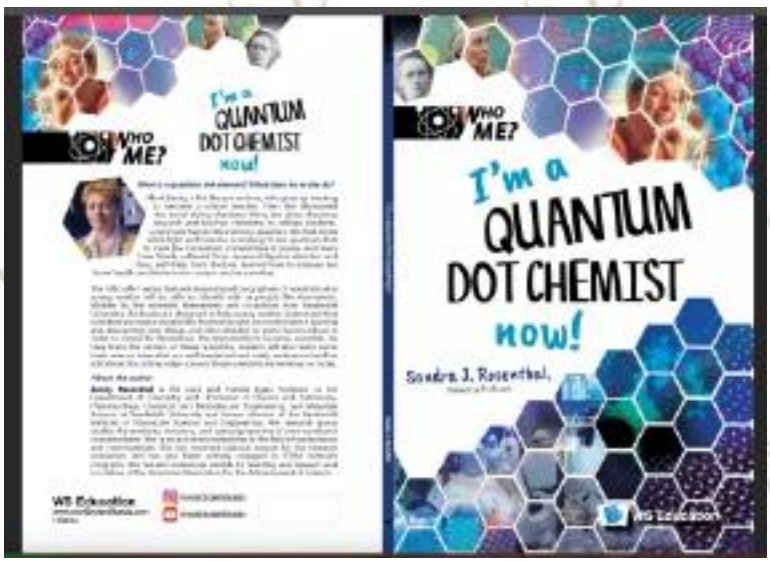
Imagine a super-powerful magnifying glass that lets you see how matter is put together. The **Transmission Electron Microscope** does just that! It sends **electrons**, not light, through really thin materials like **quantum dots**. The electrons ping-pong their way through the atoms in the material and then form an image of these atoms, similar to how shadow puppets are created using light, just on a much smaller size scale!

Quantum dots are nanosized particles, so tiny that they follow their own rules (physics rules, that is)! For example, you can change a quantum dot's color by simply changing its size, which isn't possible with most materials. The TEM is perfect for imaging quantum dots, showing us their size and shape!

DID YOU KNOW?

In 2023, three scientists won the Nobel Prize for discovering quantum dots!

Get your signed copy of "I'm a Quantum Dot Chemist" at the concierge desk!
While supplies last!



Stamp Here

Printing the Future: Explore the 3D print lab

3D printed objects are made by stacking tiny layers on each other, like building with blocks! These layers are usually made of **polymers**. Scientists use 3D printing to create **prototypes** – models they can test and improve before making the real thing!

DID YOU KNOW?

3D printers can make food! Some 3D printers can create chocolate, sugar, and even pizza – you can print your own treat!

This technology is awesome because it allows for custom creations like special toys or even prosthetic limbs. It helps make models quickly so new ideas can be tested fast. 3D printers can use many materials, including plastics and metals. Astronauts on the International Space Station use 3D printers to make tools in space, and in medicine, scientists are working on 3D printed organs that could one day work inside a person's body.

One of the best parts about 3D printing is that it uses only the materials needed, so there's less waste. It's even being used to print parts of houses! Some 3D printers can even create entire buildings, and car parts and prototypes are made this way too.

1965 Shelby Cobra replica 3D printed by the Oak Ridge National Laboratory is fully functional and only took 40 hours to print!

On this tour, you'll see a 3D printer in action! Watch how it works, making something right before your eyes.

Stamp Here

How is nano changing the way you watch movies?

Imagine watching a 3D movie on TV, but instead of wearing special glasses, everything pops out at you on its own! That's what a "glasses-free" 3D TV does.

DID YOU KNOW?

3D TVs help scientists see things in a whole new way! Doctors can use them to view images of the inside of the body in 3D, making it easier to understand.

Glasses-free 3D TVs use special tiny lenses to control how you view an image. The lenses direct some parts of the images on the TV to your left eye and other parts to your right eye, tricking your brain into thinking the image is in 3D. It's like magic, but with cool science and nanotechnology, making everything look awesome in 3D!

For our younger guests: Find these objects at the hands-on stations!

POST
YOUR
photos

#VINSEVANDY

Special thanks to Katelyn Schumacher, Elizabeth Hays, Laurel Bellocchio and Sarah Ross for their amazing work in creating the VINSE Friends and Family Day passport.