

NOVEMBER 2024

## NOTE TO OUR READERS:

Welcome to the new issue of "The Science Spectrum," our monthly newsletter showcasing the remarkable work of our school students and alumni. Their dedication has shaped this edition to be both engaging and informative for science enthusiasts like you. We hope you enjoy it.

*PS: If you'd like your science contributions featured in our publication, please send them to the email below. We look forward to reviewing them.*

**email: [sciencespectrum.newsletter@gmail.com](mailto:sciencespectrum.newsletter@gmail.com)**

## DID YOU KNOW?

Sound waves can make bubbles in liquid give off tiny flashes of light? It's called sonoluminescence! When sound waves hit a bubble just right, they create intense pressure changes, causing the bubble to rapidly collapse and release energy in the form of light. It's like a tiny light show happening in a glass of water! The science behind it is still a mystery, though.

## PIONEER FEATURE

### MORE THAN A SCIENTIST: MADAME MARIE CURIE

To me, she brought light into our lives. And I mean that literally. Madame Marie Curie—the woman who brought a new kind of energy into the world—is the reason we even have nuclear power today. Without her hard work laying the groundwork in nuclear physics, there's a good chance we'd be living in a darker world, quite literally.

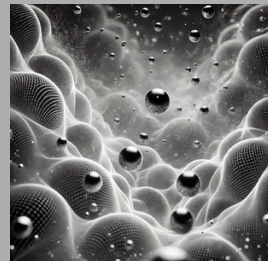


She's also a Nobel Laureate—actually, the only person with Nobel Prizes in both Physics and Chemistry. But her journey wasn't easy. Curie didn't just dive into science; she had to push against the very community that was supposed to support her. She faced constant discrimination and a serious lack of funding, yet still managed to make some of the biggest discoveries of her time. Her dedication makes her a true symbol of courage and commitment for women in science.

So, now what can we do for her? Well, there's A LOT. You can support the females around you who want to pursue science. As a parent, you can remind your child that academia is a real option, something they can reach for. And as a woman? Jump into science, make your mark, and bring the world the next groundbreaking discovery it's waiting for.

## SUPERNOVA NEUTRINOS

Neutrinos are tiny subatomic particles, often called 'ghost particles' because they barely interact with anything else. Given that throughout your life an estimated  $2.5 \times 10^{21}$  neutrinos will sweep through you, the probability of any given neutrino interacting with you is about 1 in a trillion trillion. Now, what are SuperNova Neutrinos?



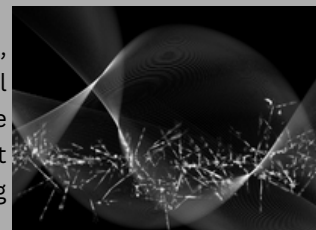
A core-collapse supernova explosion, which happens when a big star collapses near the end of its life, produces supernova neutrinos\*, which are elementary particles. Within ten seconds of the collapse, these neutrinos remove about 99 percent of the dying star's gravitational energy. Neutrinos, which have a very weak interaction with matter, escape extremely instantly from the collapsing star's dense core, frequently before the explosion's light reaches us. About  $10^{58}$  neutrinos and antineutrinos with energy between 10 and 20 MeV are released during a supernova in a variety of lepton flavours.

Nano materials, substances engineered at the scale of nano meters (one billionth of a meter), are revolutionizing science and technology. By harnessing the unique properties that materials exhibit at such small scales, researchers and engineers are creating new applications across various industries, from medicine and electronics to energy and environmental science.

**RAM PRAKASH**  
A2 Level

## A BRIEF ON BOSE-EINSTEIN CONDENSATE

So far, based on human understanding, there are two classes of fundamental particles: fermions and bosons. They are classified based on spins, but we are not to get to the depth of this interesting fundamental property, as of now.



Interestingly, these fundamental particles that make up the entire universe have wave-particle duality—they exhibit both wave and particle properties. Those minuscule particles cannot be located exactly when we try to measure other properties; if they are located, the other properties, such as momentum/energy, become uncertain. This is defined as Heisenberg's uncertainty principle. We can think of this as the "particles" energies affecting the accuracy of their measurements."

Energy is directly related to temperature. Hence, when the temperature is reduced, the bosons (wave-particles) spread in space and slow down, increasing the probability of finding them due to overlapping. At ultra-low temperatures, extremely close to 0 Kelvin, bosons condense into a state where they all occupy the same quantum state (quantum physical property), forming what is called a Bose-Einstein Condensate.

Spoiler: Exact 0 Kelvin cannot be attained with the latest knowledge in physics and the resources available. Let's see about that in a later issue of "The Science Spectrum."

**DEV DARSHAN**  
A2 Level

# The Science Spectrum

KNOW YOUR ROOTS — AND ATOMS

## SHAPE MEMORY ALLOYS

Shape memory alloys (SMAs) are unique metals with the ability to remember. Sure, it sounds like a fictional item from a video game, but these metals have the ability to return to their original shape after being deformed. This incredible property has opened the door to innovative applications, improving the quality of life and creating sustainable solutions worldwide.

One standard use of SMAs in medical devices: for example, stents made of SMAs are widely used to support blood vessels, expanding comfortably with arteries to restore healthy blood flow. This non-invasive technology has revolutionised heart and vascular treatments, reducing recovery time and enhancing patient outcomes.

Moreover, in recent years SMAs have caught the eye of aerospace engineers, who use them to make self-adjusting components that respond to temperature changes, boosting fuel efficiency & reducing carbon emissions. In earthquake-prone areas, SMAs have been used to create dampers in buildings to absorb seismic energy, making structures more resilient to natural disasters. Another unique area under development is the creation of wheels for the space rover. In 2017, NASA updated the world with news of their Mars rover's having cracks due to uneven surfaces on Mars. Researchers in the Glenn Research Centre are developing wheels that can compress and reform in an instant using SMAs.

As researchers continue exploring new possibilities, these smart metals are paving the way for smarter, cleaner and more adaptable technologies that will make the world a better place.

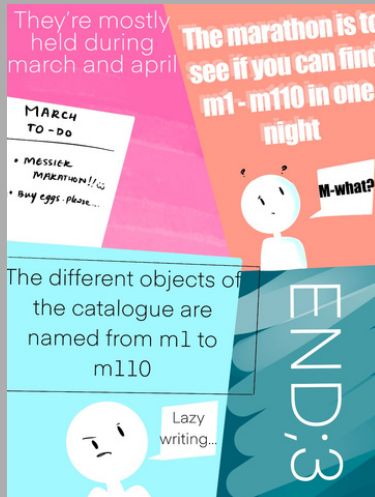


RAYAN KRISHNA  
AS LEVEL

## MONTHLY SPOTLIGHT

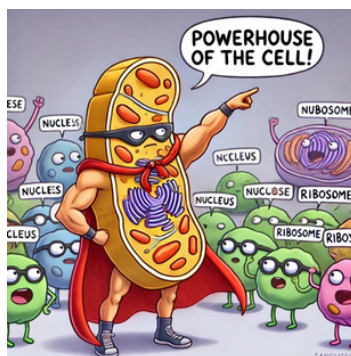
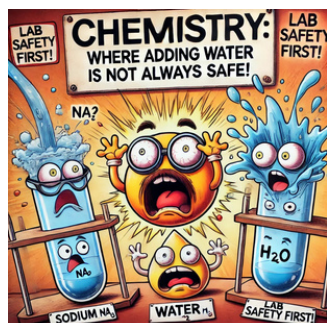
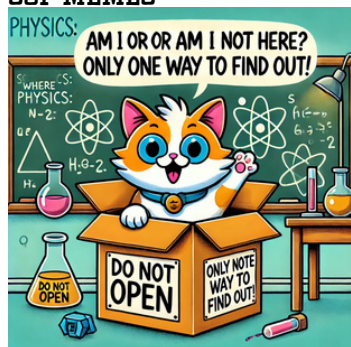
- Chandrayaan-4 Mission: India is set to launch the Chandrayaan-4 mission to the Moon in 2028, aiming to collect samples with a partnership involving Japan's uncrewed lander and rover.
- Meteor Magic: The South Taurid meteor shower is lighting up the skies now, offering a dazzling display of fireball meteors for stargazers across the U.S.
- Hunger Circuit: Scientists have discovered a brain circuit that plays a key role in regulating appetite, comprising three types of neurons. This finding could reshape our understanding of hunger.
- Asteroid Alert: Asteroid Apophis will pass close to Earth in 2029, potentially causing surface changes due to gravitational effects. Get ready for a cosmic show!
- Titan's Secrets: Saturn's moon Titan might be hiding a thick methane ice crust, which could provide clues about extraterrestrial life.

## COMIC CORNER



RISHI CHANDAR  
A2 Level

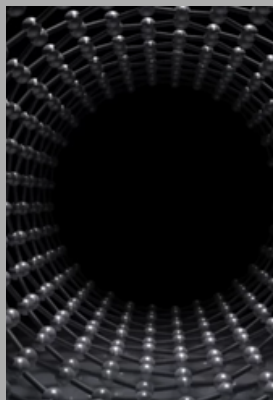
## SCI-MEMES





## WHAT ARE NANO MATERIALS?

At their core, nanomaterials are materials with structural features smaller than 100 nano meters. To put this into perspective, a human hair is approximately 80,000-100,000 nano meters in diameter, making nanomaterials incredibly small. This extreme reduction in size allows nanomaterials to exhibit distinct physical and chemical properties that differ from their bulk counterparts.



### Unique Properties of Nanomaterials

Nanomaterials exhibit unique properties due to their small size and large surface area. These characteristics often include:

1. **Enhanced Strength**
2. **Improved Electrical and Thermal Conductivity**
3. **Increased Chemical Reactivity**
4. **Unique Optical Properties:**

Many nanomaterials, such as carbon nanotubes, have significantly higher strength-to-weight ratios compared to bulk materials. Carbon nanotubes, for instance, are stronger than steel but weigh only a fraction of it, making them ideal for applications in aerospace and advanced construction.

Some nanomaterials, like graphene (a single layer of carbon atoms arranged in a two-dimensional lattice), exhibit exceptional electrical and thermal conductivity. This makes them suitable for use in advanced electronics, such as high-speed processors and efficient batteries.

The increased surface area of nanomaterials makes them more chemically reactive, which can be advantageous for catalysis in chemical reactions. Nanocatalysts are used in industrial processes to make chemical reactions faster and more efficient.

The way nanomaterials interact with light can be very different from bulk materials. For instance, gold nanoparticles can appear red or blue depending on their size, making them useful in biomedical imaging and as color-changing sensors.

ADHVIK SUNIL  
AS LEVEL

## PHONE VS BACTERIUM— AN INTRO INTO

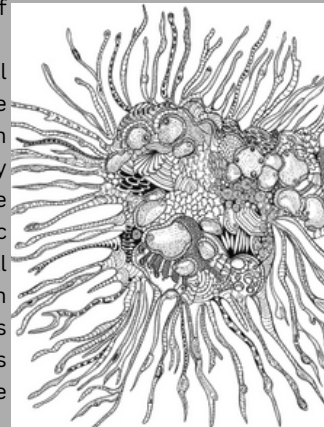
Your phone could sense a touch, and so could a bacterium. But when it comes to a collision with a random air molecule, the phone remains unaffected, while the bacterium moves around. Why?

All particles are in constant motion, no matter what, but the degree of motion differs. The more particles there are, the less noticeable the motion becomes. This is because the amplitude of vibrations diminishes as the number of particles increases. It's an example of how the effects of vibrations get averaged out in larger systems.

Now, when a massive object like a phone is already made up of countless particles colliding together, the impact of a small gas molecule won't have any significant effect. On the other hand, a bacterium is microscopic; since it consists of far fewer particles, the collision with an air molecule can have a much more noticeable impact.



The human body is made up of trillions of cells, each specialised and adapted to perform its function. As we age, each cell dies or gets damaged and most of them are replaced by younger newer cells through cell repair and division. However, the body does not possess the ability to regenerate certain types of cells, such as cardiac muscle cells or neurons in the central nervous system, which are often found in organs critical to sustaining human life. This means any damage to such cells is permanent and incurable, over time the organ loses its ability to function normally.



This is what occurs when someone is afflicted by a chronic disease such as Alzheimer's. Fortunately, after conducting decades of research and investing billions, scientists have discovered a potential cure in the form of stem cells.

Stem cells are undifferentiated and unspecialized cells that are found in 2 main forms- Adult and embryonic stem cells. Embryonic stem cells, as their name suggests, are found in the embryo. These cells are undifferentiated i.e. they have not differentiated and developed any structures to perform one specific function like a brain or heart muscle cell. These cells have the ability to differentiate into any type of cell in the body(pluripotent). Adult stem cells however are slightly more specialised/developed and have a smaller range of cells they can specialise into.

This means that, if harnessed and utilised in an appropriate manner, embryonic stem cells can be used to replace damaged cells and in theory can cure any such degenerative diseases such as Alzheimers.

Stem cells will help enhance our understanding of how diseases infect and affect specific body cells. They will help treat autoimmune, cardiovascular, and genetic diseases. They will provide a medium to test drugs on human body cells and therefore significantly improve the reliability of such tests. The number of lives and amount of money stem cell treatment can save can be highly beneficial socially speaking.

Research into stem cells has been successful, with scientists developing biocompatible synthetic organs and tissues using stem cells. With such high prospects and widespread applications, stem cells are the future of modern medicine.

SHIVAM V  
A2 LEVEL

## EPIGENETICS: HOW ENVIRONMENT INFLUENCES GENES

Imagine your DNA as a huge library with thousands of books, each containing specific instructions on how your body works. But here's where it gets fascinating: not all the books get read in the same way. Epigenetics is like a system of bookmarks and sticky notes that tells your body which instructions to follow closely, which to skim, and which to ignore. These notes aren't random, instead they're influenced by everything around you: your diet, your environment, stress, and even the air you breathe.

### What is Epigenetics?

"Epi-" means on or above in Greek, and "epigenetic" describes factors beyond the genetic code. Epigenetics is the study of changes in gene expression that happen without altering the actual DNA sequence. Think of it as a way your body adapts to your environment. These changes are made by adding chemical "tags" to your DNA, which act as signals to switch genes on or off.

The interplay of DNA methylation and histone post-translational alterations, which cause as the result of regulatory proteins and non-coding RNAs, are key epigenetic players to rearrange chromatin into areas such as euchromatin, heterochromatin, and nuclear compartmentalization. Unlike traditional genetics, which we often think of as fixed, epigenetics shows that genes can change based on external factors. These changes can have profound effects on your health and even be passed down to future generations.

### How Does the Environment Influence Our Genes?

- 1. Diet and Obesity:** What we eat has a powerful effect on our genes. For example, studies show that children of mothers who consume high-fat diets during pregnancy are at greater risk for obesity, diabetes, and heart disease. This is because the mother's diet can cause epigenetic changes that affect how her child's genes control metabolism and fat storage.
- 2. Pollution and Respiratory Health:** Pollution is another big influencer. Exposure to air pollution, especially for children, has been shown to increase the risk of respiratory problems like asthma. This happens because pollutants can add or remove epigenetic "tags" on genes that regulate inflammation, potentially silencing genes that help protect the lungs. Research even suggests that children in highly polluted areas are more likely to develop epigenetic changes that make them susceptible to respiratory illnesses.
- 3. Stress and Mental Health:** Stress, especially during early development, can leave lasting marks on our genes. Studies show that children who experience severe stress or trauma have changes in genes associated with anxiety and depression. These epigenetic changes can last a lifetime and increase susceptibility to mental health issues later in life. High-stress experiences in children can even have a ripple effect, affecting the mental health of future generations through inherited epigenetic changes.

### The Role of Epigenetics in Disease Risk

Amazingly, epigenetic factors account for 50-70% of the risk for diseases like cancer, heart disease, and diabetes. This means that while our DNA provides a foundation, our lifestyle and surroundings play a significant role in determining our health risks. For instance, smoking has been shown to lead to epigenetic changes that silence tumor-suppressing genes, increasing the risk of cancer. In the winter of 1944/45 during World War II, food supply was reduced due to blocked food transport by Germans, and food delivery by boat was impossible because water canals were frozen. Famine and lack of sufficient vitamins and proteins in diets affected the whole population, especially pregnant women. Since then studies have been carried out on the long-term effects of this incidence on newborn babies and individuals under such conditions.

The results of these studies showed that individuals born after the famine had a higher susceptibility to a subset of diseases, including schizophrenia, stress sensitivity, and obesity.

### Can We Change Our Genetic Destiny?

The exciting part is that some epigenetic changes are reversible! Studies show that making positive lifestyle changes can have a direct impact on gene expression. Here are some ways to support healthy epigenetic changes:

- **Healthy Eating:** Foods rich in antioxidants, such as fruits and vegetables, can protect DNA from harmful changes and may even reverse some negative markers.
- **Regular Exercise:** Exercise has been shown to improve gene expression related to cardiovascular health and reduce risks of obesity-related diseases.
- **Managing Stress:** Practicing mindfulness, meditation, or simply taking time to relax can counteract some of the negative effects of chronic stress on genes.

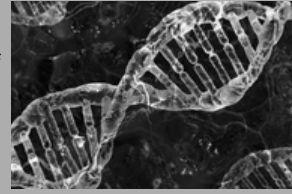
### Epigenetics Across Generations

What's truly remarkable is that some epigenetic changes can be passed down from parents to children, affecting future generations. This phenomenon, known as **transgenerational epigenetics**, means that the lifestyle choices you make today—whether they're related to diet, stress, or exposure to toxins—could impact your children's health and even your grandchildren's. For instance, if a parent experiences severe stress or malnutrition, their children may inherit epigenetic changes that affect their health.

### Conclusion

Epigenetics shows us that we are not merely bound by our genes. Our choices and environments can actively shape our genetic expression, offering us a unique opportunity to positively impact our health. With this knowledge, we can make informed lifestyle choices that may not only enhance our own lives but also create a healthier future for generations to come.

SHREEVATSAV  
A2 LEVEL



## DIY PAPER SPINNER

### Instructions:

- Cut the paper into square; then Cut the square halfway up from the bottom on both sides to make two flaps.
- Fold the Flaps: Fold one flap forward and the other flap backward to create "wings."
- Add Weight: Attach a paperclip to the bottom if you want to add weight (optional).
- Test Your Spinner: Hold the paper spinner high up, let it go, and watch it spin as it falls!

### Physics Behind It:

- The wings create air resistance, slowing the spinner's fall and causing it to spin. Gravity pulls the spinner downward, while air resistance pushes against the wings, creating a steady, rotating descent. This is a fun way to observe forces acting on a falling object.