SCIENCE FACTORS.

INSIGHT, DISCOVERY, LEARNING, INNOVATION, AND IMPACT

By
Rosalind Franklin
Council of Scientific Research (RFCSR)

March 20, 2026

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SCIENCE FOR SOCIETY !

DISCOVERY DRIVING REAL-WORLD IMPACT

Scientific Research Empowers Social Progress !

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Science APPLY PROGRAM

Scientific programs are structured initiatives designed to promote research, education, and innovation across various fields of science. They provide opportunities for hands-on learning, collaboration, and the development of critical thinking skills. These programs play a vital role in advancing scientific knowledge and solving real-world problems.

Prof. Eliora Z. Ron

Emeritus Professor
The Shmunis School of Biomedicine and Cancer Research | Tel Aviv University

"In a world flooded with information, *Science Factors* stands out for its clarity, creativity, and commitment to truth. It brings the latest discoveries from top global journals into classrooms, cafés, and conversations—without losing the wonder that makes science so human. I believe this magazine will inspire not just students, but scientists too, to see their work through fresh, curious eyes."

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LETTER *from the* EDITOR

Dr. Animesha Rath
The Editor-in-Chief

Dear Readers,

Welcome to the March issue of Science Factors, where we explore a theme that lies at the very heart of modern science: Science for Society.

Science today is no longer confined to laboratories or journals. It is increasingly defined by its ability to move beyond discovery and create meaningful impact in the real world. From healthcare innovations that prevent infections to diagnostic tools that enable early disease detection, science is shaping how we live, heal, and sustain our future.

At the microscopic level, innovation begins with understanding how molecules interact, how cells respond, and how biological systems adapt. Yet, the true power of science emerges when these insights are translated into solutions. Antibacterial coatings designed to prevent biofilm formation on medical devices demonstrate how material science can directly reduce infection risks and save lives.

Beyond healthcare, science is addressing some of the most pressing global challenges. Advances in clean energy technologies, such as indigenous electric vehicle systems and hydrogen-generating materials, highlight how engineering and physics are driving sustainable transitions.

In agriculture, the discovery of key regulatory genes and adaptive mechanisms reflects how plant science is responding to climate change and food security demands. Meanwhile, environmental innovations, including microbial solutions for water purification, remind us that nature itself often holds the blueprint for sustainable technologies.

Equally important are the human stories behind science. Education, awareness, and access remain powerful determinants of health and well-being. As illustrated through real-life narratives, knowledge can shape decisions, improve lifestyles, and ultimately extend life itself.

Across this issue, a unifying message emerges: science achieves its greatest value when it reaches people. It is not only about understanding the world, but about improving it.

As you turn these pages, we invite you to reflect on the journey of science from curiosity-driven discovery to real-world application. In this journey, innovation is not the end point; impact is.

Because in the end, science is most powerful not when it is known, but when it is used.

Happy reading,

R Animesha

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SCIENTIFIC RESEARCH EMPOWERS SOCIAL PROGRESS !

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Behind every discovery lies a story of curiosity, perseverance, and wonder. Science unfolds through relentless research and bold explorations into the unknown. These are the journeys that shape our understanding of the world—and beyond.

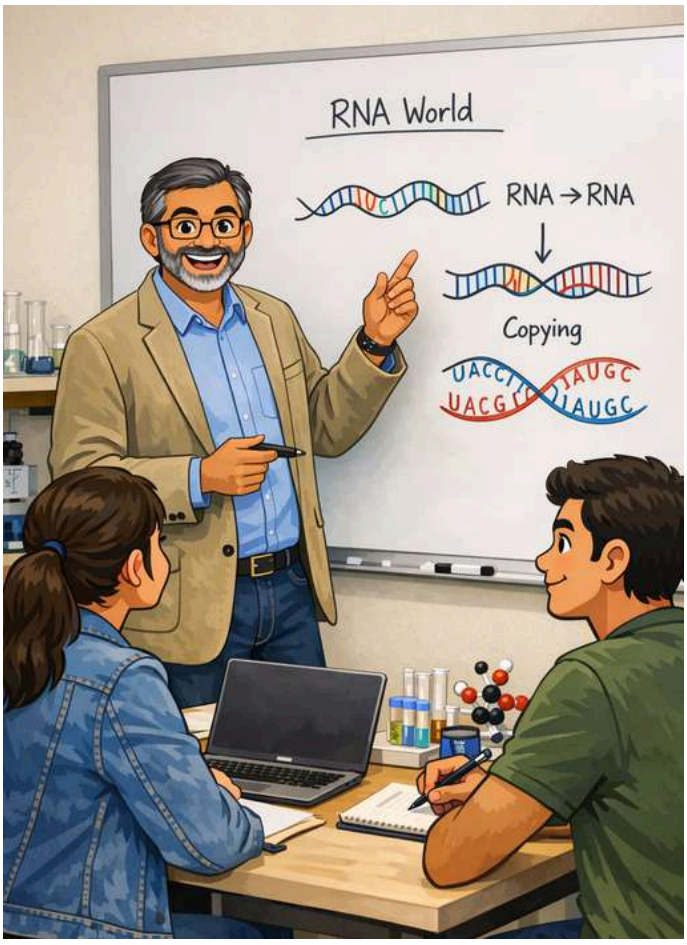
| By Dr. Preeti Sharma

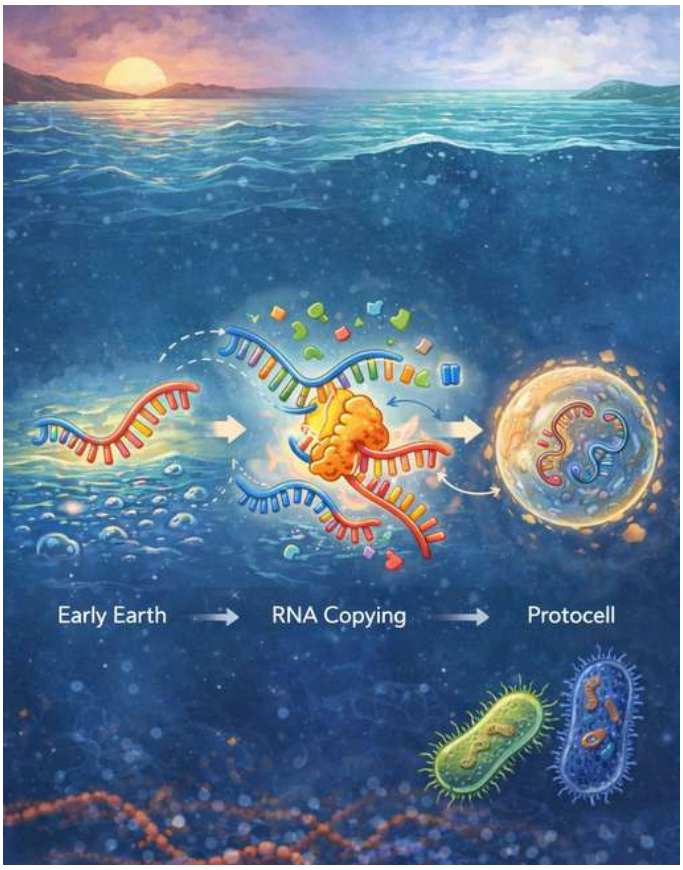
THE QUESTION THAT STARTED LIFE

FEATURED

One afternoon at a university biology lab, Professor Rao was standing in front of a whiteboard while a small group of students gathered around him. Among them was Ananya, a curious graduate student who always asked thoughtful questions. On the board, the professor had written a simple but powerful question: "How did life begin?"

Ananya looked at the board and raised her hand. "Professor, we know that life today depends on DNA and proteins. But when life first started on Earth billions of years ago, those systems probably didn't exist yet. So what came first?"Professor Rao smiled. "That is exactly the mystery scientists have been trying to solve for many years," he said. "One of the most interesting ideas is called the RNA world hypothesis."





He drew a simple diagram of a molecule on the board. "This molecule is called RNA. Today, RNA mainly helps DNA make proteins inside cells. But scientists believe that long ago, RNA might have played a much bigger role." Another student, Ravi, leaned forward. "What makes RNA so special?"

"Good question," Professor Rao replied. "RNA is unique because it can do two important jobs. First, like DNA, it can store genetic information. Second, it can also perform chemical reactions, which is something proteins usually do. Because of these two abilities, scientists think RNA might have been the first molecule that helped life start." Ananya nodded thoughtfully. "But for life to begin, molecules must be able to copy themselves, right?" "Exactly," said the professor. "Self-replication is the key. If a molecule cannot copy itself, it cannot pass information to the next generation and cannot evolve."

He then wrote another word on the board: Ribozyme. "Some RNA molecules can act like enzymes," he explained. "These special RNA molecules are called ribozymes. Enzymes normally help chemical reactions happen faster. In the case of ribozymes, the RNA itself performs the reaction."

| By Dr. Preeti Sharma

Ravi looked surprised. “So RNA can actually help build more RNA?” “Yes,” Professor Rao said. “Some ribozymes can work as RNA polymerases. That means they can take an RNA template and add small building blocks called nucleotides to create a new RNA strand that matches the template. You can think of them as tiny molecular machines that help copy RNA.” The students were impressed, but Ananya looked puzzled. “If scientists already discovered these ribozymes, then the problem of life’s origin should be solved, right?”

Professor Rao shook his head gently. “Not quite. The ribozymes scientists discovered earlier were very large and complex. Many of them contained more than 150 building blocks. This creates a problem.”

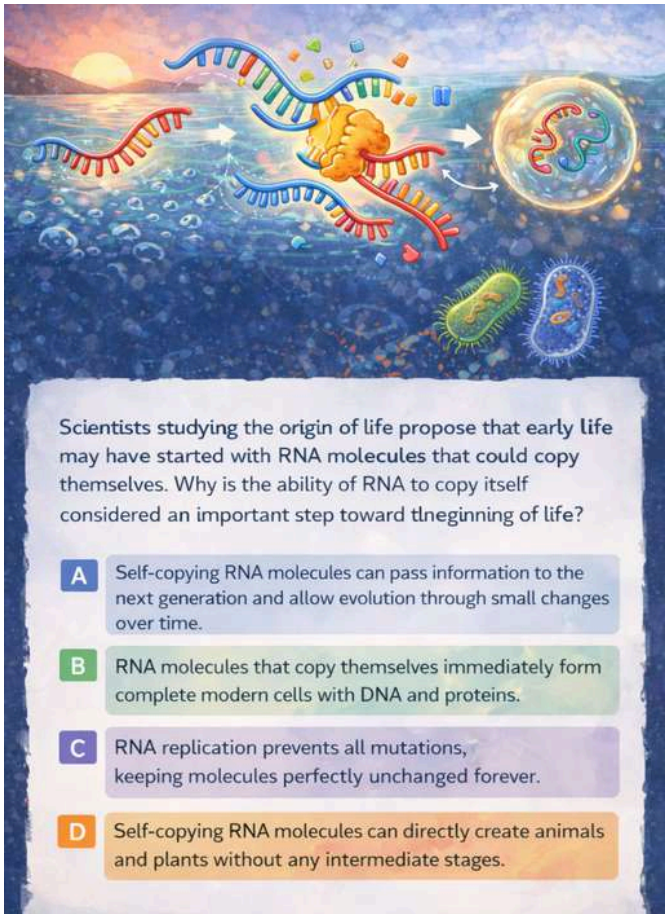
“Why is that a problem?” Ravi asked.

“Because large molecules are difficult to form naturally,” the professor explained. “In the early Earth environment, simple chemical reactions were more likely to produce small molecules, not very complicated ones. If life required large molecules from the beginning, it becomes difficult to explain how they formed.” Ananya thought for a moment. “So scientists started looking for smaller ribozymes that could still copy RNA?”

“Exactly,” Professor Rao said with a smile. “And that is what this new research focused on.” He explained that the scientists used a method called laboratory evolution. In this approach, researchers create many different RNA molecules in the lab. These molecules are then tested to see which ones perform the task of copying RNA better. The best ones are selected and improved in repeated rounds, similar to how natural selection works in nature. “After many rounds of this process,” Professor Rao continued, “the scientists discovered something exciting. They found a much smaller RNA ribozyme that can copy RNA strands.” The room became quiet as the students listened. “But the most exciting part,” he added, “is that this ribozyme can copy its own sequence and also copy the complementary strand.”

Ananya smiled. “So the molecule can help recreate itself?” “Yes,” the professor replied. “It can produce the two strands needed to rebuild the original RNA. This is an important step toward self-replication.” Ravi leaned back in his chair. “So this discovery makes the RNA world idea more realistic.” “That’s right,” Professor Rao said. “Because the ribozyme is smaller and simpler, it is easier to imagine such molecules forming naturally on early Earth.”

He paused for a moment before continuing. “Once molecules can copy themselves, something very powerful happens: evolution. Sometimes small mistakes occur when molecules copy themselves. These changes create variation. Some versions may work better than others. Over time, the better molecules survive and spread.” Ananya looked at the board again. “So simple RNA molecules could slowly evolve into more complex systems.” “Exactly,” said Professor Rao. “Eventually those systems might have led to the first primitive cells, and from there life continued evolving into the amazing diversity we see today.”



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| By Dr. Ipsita Mohanty

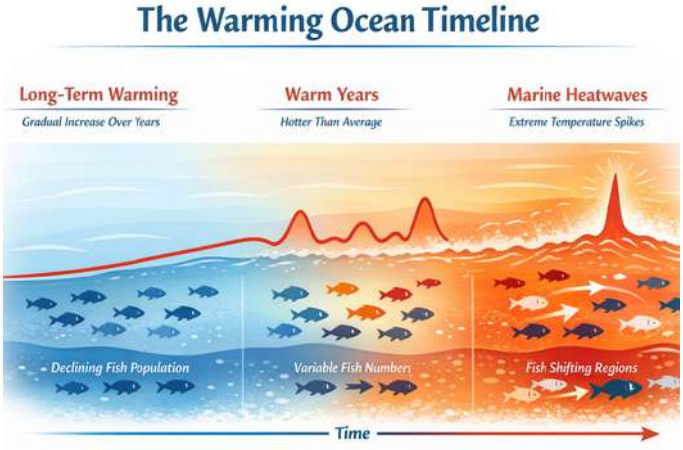
THE WARMING OCEAN AND THE JOURNEY OF THE FISH

FEATURED

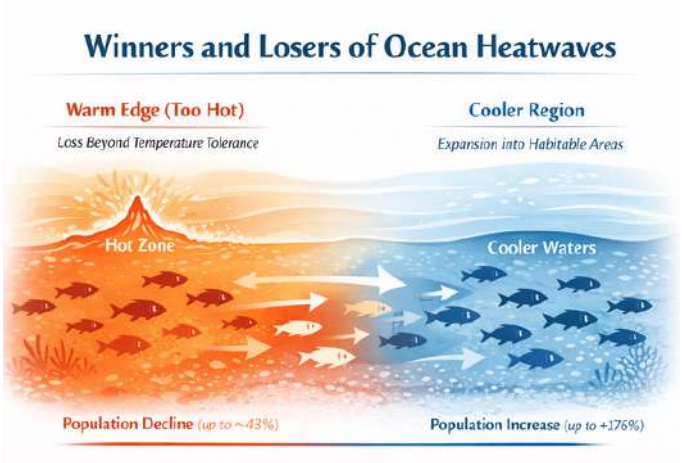
In the vast blue ocean lived many kinds of fish. Some were small and fast, some were large and slow. Among them was a curious young fish named Lumi who loved exploring the ocean and asking questions. One day, Lumi noticed something strange. The water around her home felt warmer than before. Her friend Coral also felt the change. “The ocean used to feel cooler,” Coral said. “But lately it feels warmer.” Far above the ocean, scientists were thinking about the same problem. They knew that climate change is warming the Earth, and the oceans are also becoming warmer. But they wanted to understand how different types of temperature changes affect fish populations.

Scientists explained that ocean temperatures change in three main ways. The first is long-term warming, where the ocean slowly becomes warmer over many years. The second is warm years, when some years are hotter than usual. The third is marine heatwaves, short periods when the ocean suddenly becomes very hot for days or weeks.

To understand the impact of these changes, scientists studied a huge amount of data from the oceans. They analyzed 702,037 measurements of fish biomass, covering 33,990 fish populations from 1,566 fish species. The data came from many parts of the Northern Hemisphere oceans between 1993 and 2021. Fish biomass means the total weight of fish in a population. It helps scientists understand whether fish populations are increasing or decreasing.



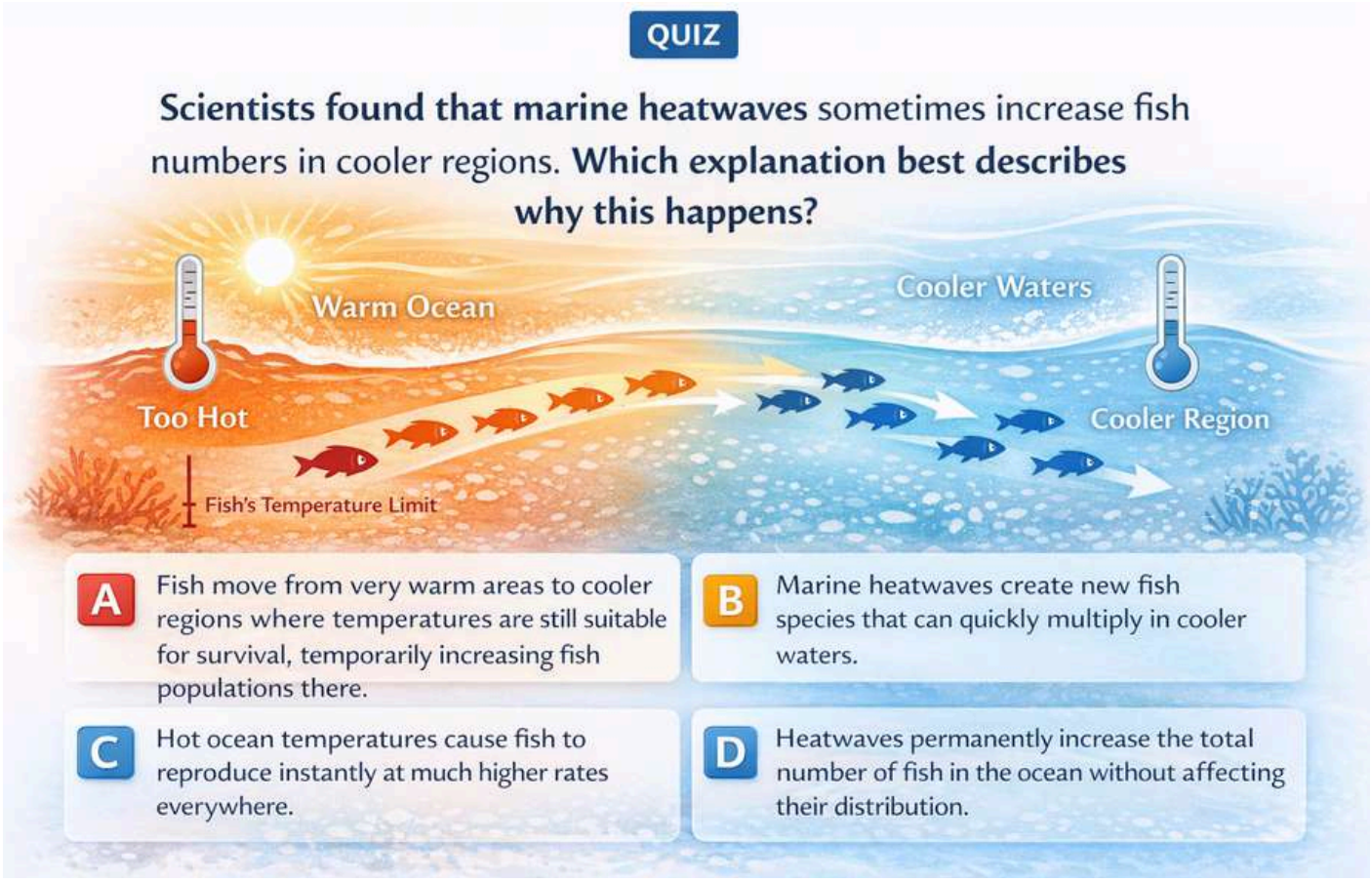
After studying the data, the scientists discovered something important. Long-term ocean warming generally reduces fish biomass. In some regions, fish populations declined by almost 20% per year. There are several reasons for this. Warmer water holds less oxygen, which fish need to survive. Warmer temperatures also increase fish metabolism, meaning they need more food. In addition, some fish species cannot tolerate high temperatures, which affects their survival and reproduction. Because of these reasons, long-term warming is expected to reduce the overall amount of fish in many oceans.



However, Lumi soon noticed something interesting. When the water suddenly became very hot for a short time, some fish disappeared from her area, but new fish from warmer regions arrived. Scientists saw the same pattern. Marine heatwaves do not always reduce fish everywhere. Instead, they shift fish populations from one place to another. In areas where fish already live near their maximum temperature limit, called the warm edge of their range, heatwaves caused large declines. Some fish populations dropped by up to 43%. But in cooler areas, warming sometimes allowed fish to move into these regions. In some places, fish biomass increased by up to 176%. This means heatwaves create “winners and losers.” Some places lose fish, while others gain them.

However, scientists warn that these increases are often temporary shifts, not real population growth. Fish are simply moving to cooler waters to escape heat. This is important for fishing industries. If fishermen see more fish in cooler regions, they might think populations are increasing. But in reality, fish may just be relocating because their original habitats are becoming too warm. If people fish too much during these temporary increases,

| By Dr. Ipsita Mohanty



they could overfish populations that are actually declining overall.

In the end, Lumi realized that the warming ocean was changing her world. Some fish were leaving, others were arriving, and the ocean was becoming less predictable. The ocean currents, food chains, and habitats were slowly changing as temperatures increased. Scientists reached the same conclusion. Climate change is reshaping where fish live and how many survive. Understanding these changes will help humans protect ocean ecosystems and manage fisheries more wisely in the future, ensuring that oceans remain healthy for both marine life and people.

One evening, as the sun's golden light filtered through the water, Lumi swam with Coral to a cooler part of the reef. There, they met new fish who had traveled from distant places, searching for better conditions. "The ocean is changing," one of them said softly. Lumi thought deeply. She realized that while change can bring new opportunities, it can also create challenges. She wondered how fish like her would adapt in the future. Above the waves, scientists were also working hard studying, monitoring, and finding ways to protect the oceans. They hoped that by understanding these changes, humans could reduce harm and help marine life survive. Lumi felt a small sense of hope. Even though the ocean was warming, she believed that with care and knowledge, her beautiful blue home could still thrive for generations to come.

As the night grew calm, Lumi looked up at the shimmering surface and promised herself to keep exploring and learning. She knew that every small step by fish below and humans above could make a difference. And somewhere, in the quiet rhythm of the ocean, hope continued to swim forward.

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Museo Nacional de Ciencias Naturales, Consejo Superior de Investigaciones Científicas, Madrid, Spain.

By Dr. Sivan Friedman

MAYA AND THE SECRET LANGUAGE OF DNA

FEATURED

Maya was a curious young student who loved learning about science. One day in her biology class, her teacher said something that caught Maya's attention: "Inside every cell of your body, there is a long instruction book called DNA."

Maya imagined this instruction book like a giant library filled with information about how the body grows, functions, and stays healthy.

After class, Maya visited a research laboratory where scientists were studying DNA. There she met Dr. Arun, a genetic scientist. He showed Maya a colorful picture of the human genome. "Our DNA has about three billion letters," he explained. "These letters form the genetic instructions that control how our body works." Maya was amazed. "So all of this tells our body what to do?" she asked. Dr. Arun smiled. "Yes, but here is something interesting. Only a small part of DNA directly makes proteins. A much larger part of DNA works like switches and control buttons that decide when genes turn on or off. These are called regulatory regions."

Maya thought for a moment. "So DNA is not just instructions it also controls when those instructions are used?" "Exactly," said Dr. Arun. "That is called gene regulation." But there was a challenge. Sometimes tiny changes happen in DNA. These changes are called genetic variants. Some variants are harmless, but others can affect how genes work. When gene regulation changes, it can sometimes lead to diseases such as cancer or heart disease. Maya wondered how scientists could study something so complicated. Dr. Arun explained that scientists often perform experiments in laboratories to see how DNA changes affect genes. But this process is very slow and expensive. "Imagine testing millions of possible DNA changes one by one," he said. "It could take many years."

To solve this problem, scientists started using artificial intelligence, or AI. AI systems can study large amounts of genetic data and find patterns that humans might miss. These systems learn by analyzing thousands of experiments and recognizing hidden connections in DNA sequences. "It's like teaching a computer to read the language of life," Dr. Arun explained. Maya imagined a computer flipping through pages of the DNA "library," quickly learning which parts were important and which acted like switches.

However, earlier AI models had a problem. They had to choose between two options. Some models could look at long sections of DNA, but their predictions were not very detailed. Other models made very detailed predictions, but they could only examine short pieces of DNA. This limitation made it difficult for scientists to fully understand gene regulation, because important regulatory signals can occur far away from the genes they control.

To overcome this challenge, researchers created a powerful new AI tool called AlphaGenome. Dr. Arun showed Maya

| By Dr. Sivan Friedman

how AlphaGenome worked. “This system uses advanced deep learning to analyze DNA sequences,” he said. “It can study very long stretches of DNA while still making detailed predictions.” Maya imagined AlphaGenome like a super-smart detective reading the DNA instruction book and understanding hidden signals inside it.

The AI was trained using huge amounts of biological data collected from real experiments. These datasets included information about transcription factor binding, chromatin accessibility, and other signals that help control gene activity. By learning from these patterns, AlphaGenome can predict how different DNA sequences affect gene regulation.

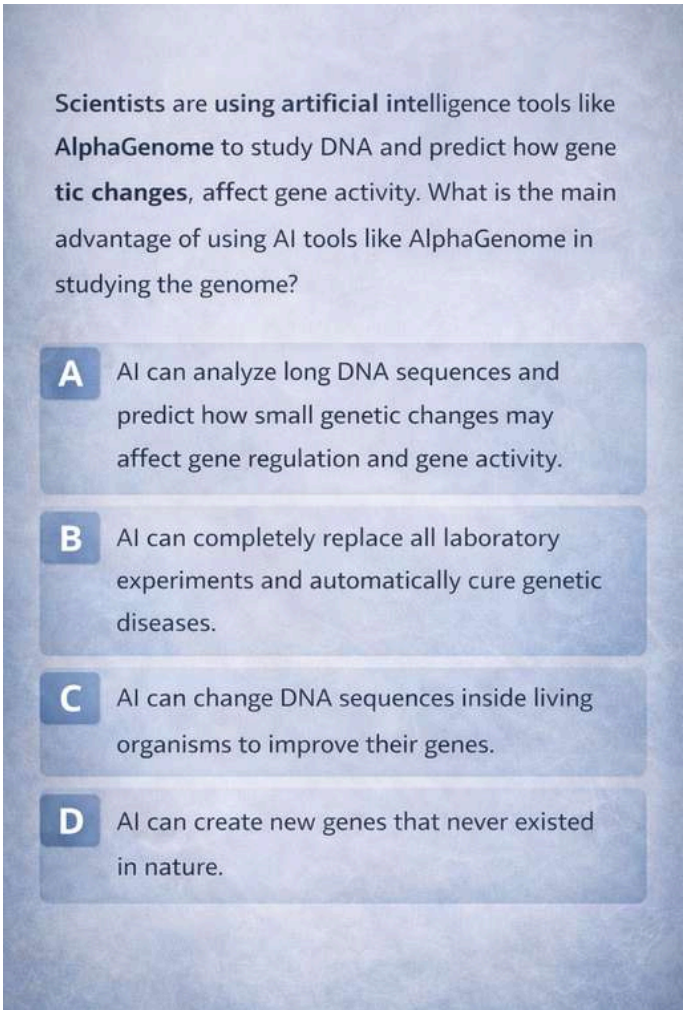
One of the most exciting abilities of AlphaGenome is predicting the effect of regulatory variants. If a single DNA letter changes, the AI can estimate whether that change will increase or decrease gene activity. “Think of it like predicting what happens if a switch in the instruction book is moved,” Dr. Arun explained.

Because AlphaGenome can study long DNA regions, it can also detect interactions between distant parts of the genome. This is important because many regulatory elements work together even when they are far apart. Scientists tested AlphaGenome by comparing its predictions with real experimental data. The results were impressive. The model was more accurate than many previous AI systems, especially when predicting how genetic variants affect gene regulation.

Maya realized why this research was so important. Many diseases are caused not by changes in genes themselves, but by changes in how genes are controlled. With tools like AlphaGenome, scientists can better understand which DNA variants might lead to disease. This could help doctors identify genetic risks earlier and design better treatments.

As Maya left the laboratory, she looked at the picture of the genome again. It no longer seemed like a mysterious code. Instead, it looked like a complex language waiting to be understood. And thanks to new technologies like AlphaGenome, scientists were finally beginning to decode the secret language of DNA.

As she walked home, Maya felt inspired. She dreamed that one day she might become a scientist too, helping uncover the secrets hidden inside DNA. She realized that science is not just about answers, but about curiosity, questions, and discovery and that even the smallest change in DNA can tell a powerful story about life.



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Google DeepMind, London, UK.

| EXPERT OPINION |

INNOVATIVE NANOTECHNOLOGY FOR ARSENIC DETECTION IN WATER

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Areas of Expertise: Nanotechnology | Colorimetric Sensing| Water Contaminant Detection | Functionalized Nanomaterials

The history of Arsenic's in medicine or science has been overshadowed by its notoriety as a poison in homicides and nowadays it is being synonymous with toxicity. Arsenic species can be present in all types of environment and can originate from natural as well as anthropogenic sources. Natural sources of arsenic are: rocks with incorporated arsenic compounds, activity of volcanoes and some biological processes. Anthropogenic sources are numerous, from mining to different types of production (pesticides, wood preservatives, and pigments). Depending on oxidation state and presence in the environment, arsenic species exhibit different toxicity. Generally, arsenic (As) exists as both arsenite (AsIII) and arsenate (AsV) in natural waters or groundwater and the As(V) to As(III) ratio has been found to be in the range of 10–100 depending on the chemical nature such as pH value of water. Dangerous arsenic concentrations in ground or natural waters are considered as a 20th–21st century calamity worldwide. High arsenic concentrations in ground water are adversely affecting over 150 million people globally in the different countries like Bangladesh, India, Pakistan, China, Vietnam, Nepal, Cambodia, Myanmar, Laos, Indonesia, USA, Argentina, Chile, Mexico, Canada, Hungary, South Africa, Poland, etc. Many water sources in the world containing high concentration of arsenic cause health problems or diseases such as cancer. Chronic long-term arsenic exposure can lead to skin effects (pigmentation, keratoses, lesions, and cancer); peripheral vascular disease; hypertension and cardiovascular diseases; cancers of the bladder, kidney, and lung; diabetes mellitus; and possible neurological effects. The World Health Organization (WHO) restrict the Maximum Contaminant Level (MCL) of arsenic in drinking water at 10 parts per billion (ppb), yet the arsenic concentration levels in many locations worldwide exceed 50 ppb.

> *"By harnessing functionalized gold nanoparticles, this innovation enables simple, rapid, and sensitive detection of toxic arsenic in water, offering a low-cost solution for real-time monitoring and public health protection"*

Arsenic contaminated water is colorless, odorless, and tasteless, and the adverse health effects of arsenic poisoning may not become apparent until long after initial consumption. As a result, an estimated 150 million people especially villagers globally are at risk of long-term arsenic poisoning from the water they drink. The available arsenic detection technologies are inadequate due to have disadvantages like expensive, time consuming, instrument based method, laboratory set-up used, required tarried technicians, requiring off-site analysis of samples, etc. On-site real time monitoring demands the effective sensing method capable to shown response with low concentrations of arsenic in aqueous media. The researchers are intended to develop the simple procedures like colorimetric technique with advantages like availability of colorimetric kits in simple form, low-cost, easy handling, using by anyone, and especially necked eye visual detection. Noble metal nanostructures are

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attracting interest due to their special characteristics, including major optical field increases that generate high light scattering and absorption. Of these, gold nanoparticles have attracted much attention as a unique and advantageous optical platform due to having intense Plasmon resonance absorption (SPR) band in visible region including large surface area, stability. Moreover, the strong surface SPR of gold nanoparticles in the visible region is exquisitely sensitive to their aggregation states influenced by the ions to be detected. However, choosing the right functional groups and successful functionalization on the gold nanoparticles are important in order to impart the selective detection of arsenic in water.

Recently, a simple, novel, rapid, selective, sensitive functionalized gold nanoparticles (AuNPs) based colorimetric method has been demonstrated for the successful sensing of arsenic ions in water. The aqueous colloid of AuNPs was synthesized separately using p-aminophenol and p-hydroquinone as reducing agents as well as stabilizers in aqueous basic medium. Au+3 ion (in Tetrachloroauric acid) was reduced to Au(0) due to oxidation of p-aminophenol to p-quinonimine (p-QI) and or p-hydroquinone to p-quinone (p-Q), respectively (see Figure). The synthesized Au(0) nanoparticles were instantly stabilized due to functionalization on the surface through electrostatic dipolar interactions with =NH functionalities of p-QI and =O functionalities of p-Q. Both the synthesized colloids of AuNPs shows a visible red-purple appearance due to SPR absorption maxima in UV-VIS spectrum at ~540 nm. The individual colloid of p-QI and p-Q functionalized AuNPs was not found to have any repose even in UV-VIS spectrum measurement towards the arsenic ion. Interestingly, the colorimetric sensing of arsenic ion was recorded in UV-VIS spectrum of equal volume (1:1) colloidal mixture of p-QI and p-Q functionalized AuNPs. Though the UV-VIS sensing response of equal volume colloidal mixture towards As(III) ions was obtained within the pH range 2-12 but the best result was observed at pH 7-8. A very similar sensing response was also recorded at pH 7-8 towards As(V) chemically reduced to As(III) using KI/SnCl2 in HCl medium. A linearity range up to 0.035 mM with sensitivity of ~16.5 mM-1 and a limit of detection of ~2.5 µM was observed towards the detection of As(III) ions. The visual detection of sensing performances towards the arsenic ions and inference effect common anions, cations, and biomolecules was tested using AuNPs colloidal mixture diluted to 1:10 (v/v). A purple-red was visualized towards the addition of common ions such as F-, Cl-, Br-, I-, HCO3-, SO42-, PO43-, CO32-, NO3-, NO2-, Ca2+, Mg2+, K+, Fe2+, Fe3+, and biomolecules such as Fructose, Sucrose, Lactose, Uric Acid, Ascorbic Acid, Dopamine (3-22 in Figure below). Whereas, an immediate decolorization of mixture of functionalized AuNPs colloid was observed from purple-red by simple addition of As(III) ions in the colloid mixture in presence of the other ions (see Figure). The dipolar interaction between the p-QI and p-Q functional groups and the AuNPs was supposed to break-up upon the addition of As(III) ions, which triggered the AuNPs to aggregate (see Figure). The visual limit of detection for the As(III) ions was evaluated as ~44 µM. It should be noted that the limit of detection was determined higher than that of the WHO recommended limit (0.133 × 10-3 mM). However, a high volume of water sample after concentrating by evaporation should be used to extend the limit of detection below the WHO recommended limit.

> *"By harnessing functionalized gold nanoparticles, this innovation enables simple, rapid, and sensitive detection of toxic arsenic in water, offering a low-cost solution for real-time monitoring and public health protection"*

Therefore, on-site sensor for ions operating in 100% aqueous medium are still rarer and they suffer from poor efficiency, response, selectivity and add restrictions to their

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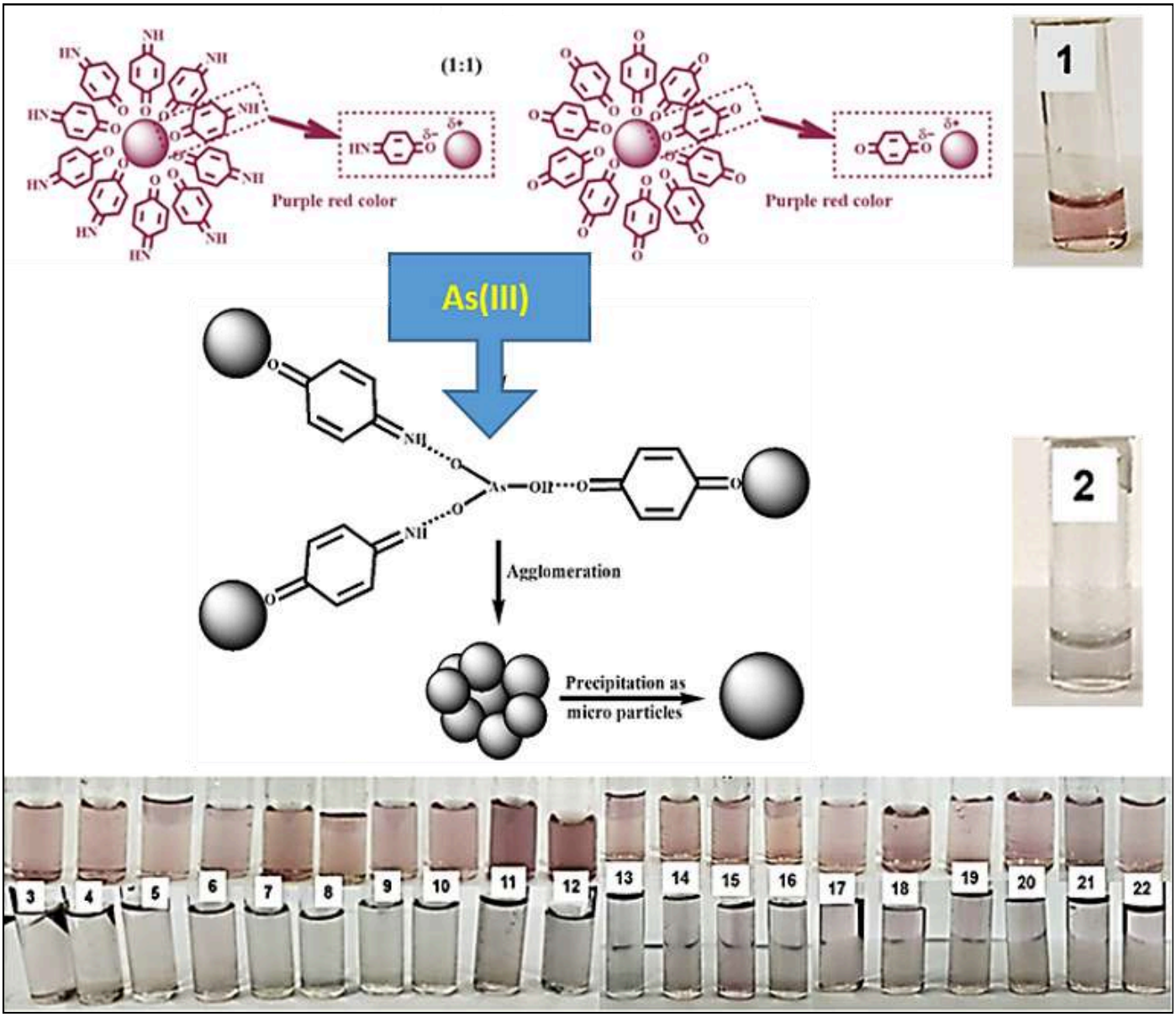

practical applications. In addition, the special emphasis should be given for the color changes, as signaling an event detected by the naked eye owing to the low cost or to avoid use of detection equipment. In order to address the above limitations, the researchers are designing metal nanoparticle based rapid as well as portable on-site optical sensor for ions in aqueous medium. To impart the ion selectivity and ultra-sensitivity, influence the strong adsorption, improve the stability, different functionalization should be introduced on the nanoparticles from nearly molecular-level. The de-stability of the nanomaterials should also be equally considered for successful sensing of any analyte through suitable strong interaction with the functional groups on the nanomaterials. Therefore, the attention should be given towards the finding of suitable functional groups on the nanomaterials surface or suitable combination of them for sensing applications.

Dr. Kar's contributions to this field are reflected in his publication in RSC Advances, "Colorimetric sensing of arsenic ion in water using a mixture of p-quinonimine and p-quinone functionalized gold nanoparticles," DOI: 10.1039/D5RA08863A which explores a simple, novel, rapid, selective, sensitive colorimetric method for the successful sensing of arsenic ions in water using stable aqueous colloid mixture of p-quinonimine and p-quinone functionalized gold nanoparticles.

| EXPERT OPINION |

NANOMATERIALS AT THE FRONTLINE: TOWARD MINUTE-SCALE CANCER DETECTION

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| Scientific Profile | | Organization Link | | Research Lab Page |

Areas of Expertise: Biosensor | Nanotechnology| Biomedical applications

Research in our laboratory focuses on the design and application of advanced nanomaterials for rapid biosensing, disease diagnostics, and catalytic technologies. We develop various advanced nanostructures to create sensitive sensing platforms capable of detecting biologically relevant molecules. One of our recent studies demonstrated that iron-doped Cu_3N nanocubes can act as highly efficient electrochemical sensors for hydrogen peroxide, an important metabolic marker released by cancer cells. By integrating these nanomaterials with simple electrode systems, we aim to create rapid diagnostic tools that can distinguish cancerous tissues from non-cancerous samples within minutes. Beyond cancer diagnostics, our laboratory also explores nanotechnology for biosensing of pathogens, targeted drug delivery, and catalytic applications, with the broader goal of developing affordable and point-of-care technologies that can make advanced healthcare and diagnostics more accessible.

Cancer remains one of the most challenging diseases of our time, not only because of its biological complexity but also because of the difficulty of detecting it early and accurately. While modern molecular diagnostics have significantly improved our ability to identify cancer, many of these techniques such as polymerase chain reaction (PCR), advanced imaging, or sequencing require expensive instrumentation, trained personnel, and centralized laboratory facilities. As a result,

> *"What if we could reveal within minutes whether a piece of tissue is cancerous, simply by detecting subtle chemical signals released by cells? Our research in nanotechnology suggests that this idea is quickly becoming a reality."*

there is a growing global demand for diagnostic technologies that are rapid, affordable, and capable of functioning at the point of care. In my view, nanomaterial-based biosensors represent one of the most promising paths toward achieving this goal. Our recent work focuses on developing a rapid electrochemical platform that can detect metabolic biomarkers associated with cancer cells within minutes. One of the key metabolic signatures of cancer progression is the abnormal production of reactive oxygen species (ROS), particularly hydrogen peroxide (H_2O_2). Cancer cells often exhibit elevated oxidative stress and altered metabolic pathways, leading to higher levels of extracellular hydrogen peroxide compared to normal cells. This biochemical difference provides a unique opportunity: if we can measure H_2O_2 quickly and selectively, it may serve as a simple indicator of cancer-related metabolic activity. To address this challenge, our research team developed a nanomaterial-based sensing platform using iron-doped copper nitride (Cu_3N-Fe) nanocubes. The nanocomposite is drop-cast onto a disposable carbon electrode, creating an electrochemically active surface capable of rapidly oxidizing hydrogen peroxide.

To explore its potential real-world relevance, we evaluated the platform using clinical tissue samples. The results showed that the sensor could successfully

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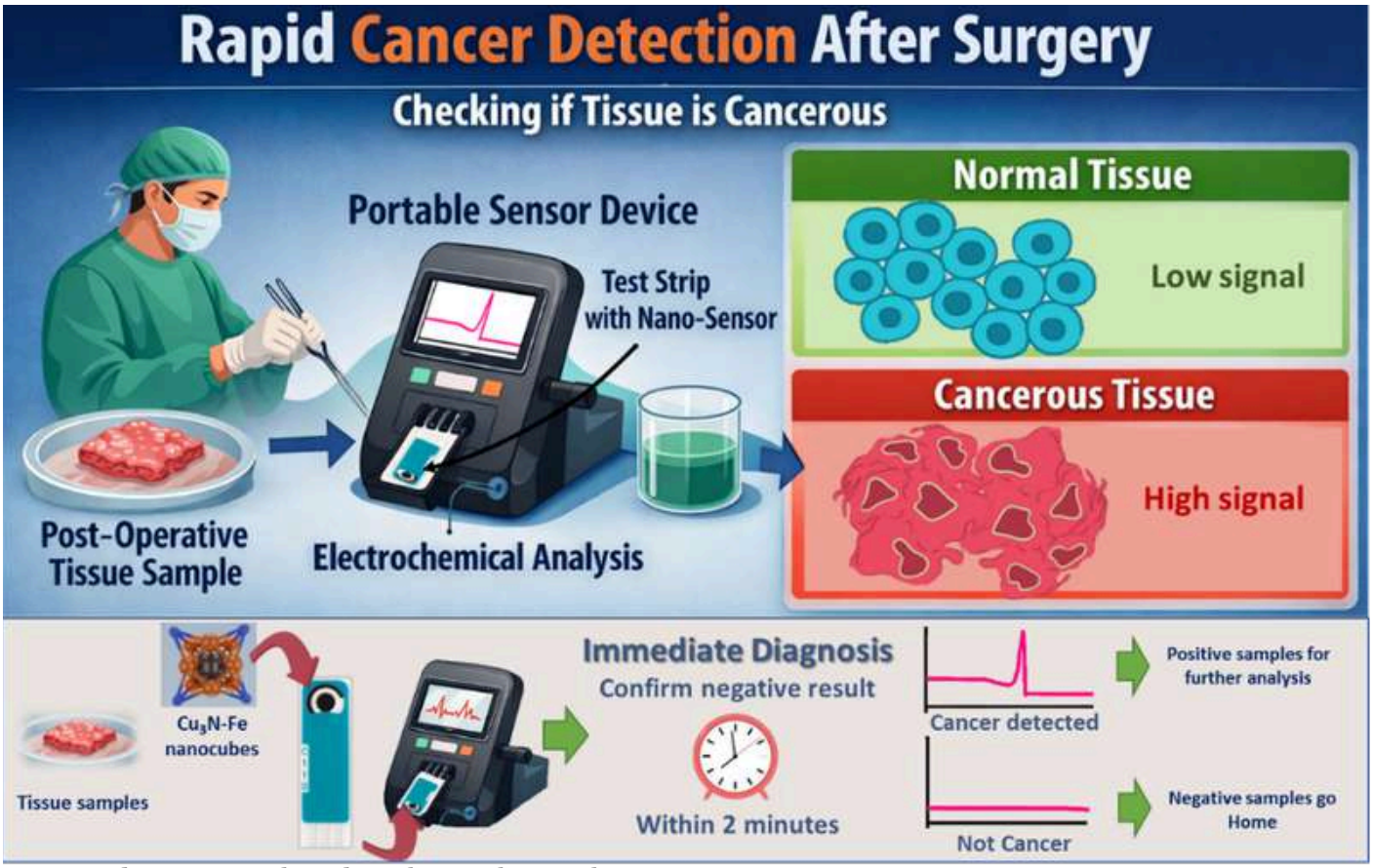
differentiate cancerous tissues from adjacent non-cancerous tissues with a high degree of accuracy. While these findings are still part of an early-stage investigation, they highlight the potential of nanomaterial-based electrochemical platforms as rapid diagnostic tools for cancer screening and biopsy analysis. Beyond the specific system we developed, I believe this work reflects a broader transformation occurring in the field of biomedical diagnostics. Traditionally, diagnostic technologies have focused on identifying genetic mutations or protein markers associated with disease. While these approaches remain essential, metabolic biomarkers offer an additional and often faster route to detection. Cellular metabolism responds rapidly to disease states, and these biochemical changes can often be measured using relatively simple analytical tools. By combining metabolic biomarkers with advanced nanomaterials, we can create highly sensitive sensors that operate in real time. Nanomaterials are uniquely suited for this purpose. Their extremely high surface-to-volume ratios, tunable electronic properties, and ability to be engineered at the atomic scale allow researchers to design materials with tailored catalytic and sensing capabilities. Over the past decade, advances in nanotechnology have enabled the development of a wide variety of sensing platforms based on metal nanoparticles, carbon nanostructures, semiconductor nanocrystals, and hybrid nanocomposites. These systems can detect a wide range of biological targets, including nucleic acids, proteins, metabolites, and pathogens. However, the true impact of these technologies will depend on their ability to move beyond laboratory demonstrations and into practical clinical applications. In many parts of the world, especially in resource-limited settings, access to advanced diagnostic facilities remains limited. Point-of-care diagnostic devices that are portable, inexpensive, and easy to use could dramatically improve early detection and treatment outcomes. Electrochemical biosensors offer several advantages for such applications: they are low-cost, require minimal sample preparation, and can be integrated into compact electronic devices. Smartphone-based readout systems, miniaturized potentiostats, and wireless data transmission could allow diagnostic results to be obtained and shared instantly. Such systems could be especially valuable in rural healthcare environments where centralized laboratories are not readily accessible. Artificial intelligence and data-driven approaches will also play an increasingly important role. As sensing technologies generate larger and more complex datasets, machine learning algorithms can help identify patterns, improve diagnostic accuracy, and predict disease progression. The integration of nanotechnology, biosensing, and computational analysis may ultimately lead to highly personalized diagnostic systems tailored to individual patients.

> *"What if we could reveal within minutes whether a piece of tissue is cancerous, simply by detecting subtle chemical signals released by cells? Our research in nanotechnology suggests that this idea is quickly becoming a reality."*

For young researchers entering this field, I believe the most important lesson is the value of interdisciplinary thinking. Modern biomedical challenges rarely fall within a single discipline. Progress often emerges at the intersection of chemistry, physics, biology, materials science, and engineering. In our own work, advances in nanomaterial synthesis, electrochemistry, and cellular biology all contributed to the development of the sensing platform. Cultivating the ability to communicate and collaborate across these fields is essential. tform. Cultivating the ability to communicate and collaborate across these fields is essential. Finally, researchers should remember that the ultimate goal of biomedical innovation is to improve human health. Technologies that are elegant in the laboratory must also be practical in real-world settings. Designing affordable, scalable, and accessible diagnostic solutions will be critical for addressing global health challenges in the decades ahead. Nanomaterial-based biosensors hold tremendous promise for transforming the landscape of medical diagnostics. By exploring their properties of

| EXPERT OPINION |

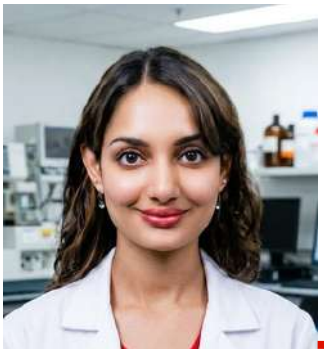


engineered nanomaterials and combining them with sensitive detection strategies, we can begin to develop rapid, point-of-care tools capable of identifying disease-related biomarkers within minutes. While significant work remains before such technologies become widely available in clinical practice, the progress achieved so far demonstrates that the future of diagnostics may lie in small, intelligent materials capable of delivering powerful insights into the biology of disease. The coming decade will likely witness rapid advances in nanotechnology, biosensing, and digital healthcare. If researchers continue to collaborate across disciplines and focus on translating scientific discoveries into practical solutions, we may soon see a new generation of diagnostic tools that bring fast, affordable cancer detection directly to the patient's bedside.

Dr. Chowdhury's contributions to this field are reflected in his publication in Materials Horizons, titled "Cu3N–Fe nanocube-based electrochemical sensing of cancer metabolites with minute-scale response time." This work presents a novel electrochemical biosensor based on iron-doped copper nitride (Cu3N–Fe) nanostructures for the rapid detection of hydrogen peroxide (H_2O_2), a key metabolic biomarker associated with cancer cells.

| EXPERT OPINION |

HOW BRAIN SIGNALS SHAPE SOCIAL BEHAVIOUR: LESSONS FROM A TINY WORM



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Areas of Expertise: Neuroscience | Molecular Genetics | Neuropeptide Signaling | Imaging | Behavioral Analysis

What makes a living being "social"? From flocks of birds that sweep across the sky to schools of fish that move like liquid silver, the natural world is full of coordinated groups. Individuals respond to one another, forming patterns that appear almost choreographed. Yet beneath these collective movements lies a dynamic chemical balance unfolding inside individual brains. Social behaviour often begins with signals that shape how an animal senses and responds to the world around it. In humans the answer is layered with culture, cognition, and experience. Yet the foundations of social interaction may lie in far simpler biological systems. Across species, from insects to mammals, conserved neurochemicals such as serotonin influence mood, motivation, and social behaviour. Understanding how these signals are regulated inside the brain may reveal fundamental rules that shape how animals interact with one another. One of the most powerful systems for studying the roots of behaviour is a tiny nematode worm called Caenorhabditis elegans. Barely a millimetre long, this worm carries a nervous system of just 302 neurons. By comparison, the human brain contains nearly a hundred billion. Yet the worm's behaviour is far from simple. It explores its surroundings, senses chemical cues, and changes its movement depending on food availability and internal state. Because every neuron in its nervous system has been mapped and its genes can be manipulated with precision, *C. elegans* provides scientists with a remarkable opportunity to trace how genes shape neural circuits and how those circuits generate behaviour. Our recent work began with a deceptively simple question: why do some animals gather together while others remain dispersed?

> "Look closely, and you'll see that every 'us' is actually a 'them' a billion chemical signals deciding whether to stay together or to drift apart"

Under normal conditions, worms spread out across a bacterial lawn while feeding. Dispersal allows individuals to access food efficiently and reduces competition with neighbours. During the course of an unrelated experiment, however, a mutant strain of worms behaved very differently. Instead of spreading out, these animals remained tightly clustered at the edge of the food source. Even when food was available nearby, they continued to aggregate in dense groups.

At first glance, the behaviour looked almost accidental. Biological experiments often produce irregular patterns that disappear when conditions change. But the clustering persisted. It appeared repeatedly across experiments and across generations of worms. What initially seemed like a curiosity began to look like a consistent behavioural trait. The question soon shifted from observation to mechanism. What could cause animals to remain together when dispersal would clearly be more advantageous? The answer turned out to lie in neuromodulation. Neural circuits do not rely only on fast electrical signals passing from neuron to neuron. They are also shaped by chemical messengers that adjust

how circuits respond to incoming information. These molecules, known as neuromodulators, influence behavioural states that can last seconds, minutes, or even longer.

Serotonin is one of the most well-known neuromodulators. In humans it regulates mood, appetite, and sleep. In simpler organisms it influences behavioural states such as roaming and dwelling. When serotonin levels change, animals often shift from exploratory behaviour to more stationary activity. The mutant worms in our study appeared to be locked into one such state. Genetic analysis revealed that the animals lacked a functional copy of a gene called CASY-1. This gene encodes a synaptic protein related to the calsyntenin family found across many species, including humans. Although its molecular role had been studied in other contexts, its involvement in social behaviour had not been explored.

Further experiments showed that losing CASY-1 disrupted communication between two neuromodulatory systems. One system involved serotonin, which promotes dwelling and reduced movement. The other involved a neuropeptide called pigment dispersing factor, or PDF, which normally counterbalances serotonin signalling and encourages animals to move more freely. In healthy worms, these signals maintain a dynamic balance that allows animals to switch between exploring and feeding. In the mutants, that balance tipped. Serotonin signalling became dominant, pushing the animals toward a persistent dwelling state. Instead of spreading across the food source, the worms gathered together. What looked like social behaviour was emerging from a shift in internal brain chemistry. To understand how the behaviour of individual worms produced these group patterns, movement data were analysed using computational models developed in collaboration with physicists. The models revealed how subtle changes in movement could ripple through a population. When one worm slowed down and remained in place, nearby worms were more likely to encounter it and pause as well. Over time these local interactions generated stable clusters that resembled swarming. This principle appears throughout the natural world. Complex patterns often emerge not because individuals coordinate their actions deliberately, but because simple behavioural rules are repeated across many individuals. Similar phenomena can be seen in desert locusts, where serotonin signalling helps trigger the transition from solitary insects into enormous migrating swarms. Despite vast differences in size and brain complexity, the underlying neuromodulatory signals appear remarkably conserved. Another striking insight came from experiments that allowed neural activity to be controlled in real time. Using optogenetics, a technique that activates neurons with pulses of light, it became possible to manipulate the worm's behavioural state within seconds. When specific neurons were stimulated, aggregated worms immediately spread apart across the plate. When neural activity was suppressed, animals that usually disperse began to cluster together. The transformation could occur almost instantly. These experiments revealed how rapidly behavioural states can shift when neural signalling changes. Patterns that appear stable at the level of a group may actually arise from dynamic processes unfolding inside individual brains.

The broader significance of these findings lies not in the behaviour of worms alone, but in the principles they reveal. Many animals rely on neuromodulators to adjust how neural circuits respond to environmental information. Small differences in how these signals are regulated can lead to profound differences in behaviour. Social behaviour therefore emerges from an interplay between individual neural states and interactions with others. Each animal carries its own internal chemistry, shaped by genes, environment, and experience. When individuals encounter one another, these internal states combine to produce patterns that extend beyond any single organism. From this perspective, collective behaviour becomes less mysterious. What appears as coordinated activity across a group may begin with molecular events inside individual neurons. The nervous system of C. elegans may be tiny, but the questions it helps answer are vast. By tracing how genes influence neural circuits and how those circuits shape behaviour, small model organisms reveal principles that extend far beyond their size. How do brains generate the behaviours that allow individuals to coexist, cooperate, and compete within a social world?

Dr. Sahi's contributions to this field are reflected in the publication in Proceedings of the National Academy of Sciences of the United States of America (PNAS) (2026), titled "Neuromodulation of swarming behavior in Caenorhabditis elegans: Insights into the conserved role of calsyntenins" (DOI: 10.1073/pnas.2520029123). This study provides important insights into how neuromodulatory mechanisms regulate collective behavior, highlighting the conserved role of calsyntenin proteins in controlling swarming dynamics.

| EXPERT OPINION |

MENTORED BY WISDOM, INSPIRED BY NATURE

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| Scientific Profile | | Organization Link | | Research Lab Page |

Areas of Expertise: Health Professions Education | Teaching Innovation | Mentorship | Medical Microbiology | Nanotechnology and Medicinal Plant Research

In general, when students join a university, they are allotted mentors to help them navigate and adapt to the new educational ecosystem. Mentees face various challenges during their university days. Mentors can derive inspiration from nature's wisdom to guide the mentees in manoeuvring through these challenges.

The first challenge faced by mentees is identity confusion in a new campus, like a young elephant wanting to observe, imitate, and wander safely. At this point, the mentor plays more of a role-model, leading the mentee along a new, unexplored path (programme). Like a matriarch, mentors need to understand that mentees need time, and clarity seeps in slowly after exposure. Guided exploration on which books and references to use is a key need.

Secondly, mentees struggle to bridge the skill–expectation gap, especially in health sciences and technology programmes. In nature, tiger cubs stalk clumsily long before mastering the hunt. Mentors need to emphasize the fact that mastery follows repeated failures. Repeated practice before performance helps mentees ace practical examinations.

Thirdly, some mentees do not want to collaborate with their classmates and prefer to study independently. This resembles the behaviour of a lone wolf separated from the pack, which is generally less productive and more vulnerable. Like an alpha female wolf, mentors have an intentional role in integrating mentees into groups and networks. Peer study groups help mentees overcome anxiety and build the confidence to face examinations.

Fourth, certain mentees show overdependence or learned helplessness, like a baby monkey that clings tightly to its mother (mentor) even when capable of independent movement. A mentor's role is that of a mother monkey to encourage a needed separation at times to allow independent decision-making. Excessive protection delays independence, and such mentees may become a burden to mentors if not corrected at the appropriate time.

> *"Mentorship, like nature's wisdom, guides students through confusion, failure, independence, and growth, helping them evolve step by step into confident and capable individuals."*

Fifth, mentees may experience information or activity overload. They behave like young rabbits that respond to every sound in the jungle and are constantly alert to predators, leading to panic. Mentors can help them process the curriculum in bits and pieces. Too much input can be overwhelming, especially for slow learners. Mentors have a pivotal task in helping mentees filter priorities and focus attention by teaching time-management skills and study strategies.

Sixth, mentees sometimes experience emotional vulnerability due to burnout or failure in examinations. Mentors can bring hope by helping mentees understand that repeating a semester or taking an academic break is not a disaster. Sometimes, withdrawal is necessary for self-healing. An injured or exhausted bear's retreat to its den to recover is not perceived as a sign of weakness. Such retreat is necessary for rest, reflection, and an effective bounce back.

"If I have seen further, it is by standing on the shoulders of giants" is a famous quote by Sir Isaac Newton. Mentors should provide such a platform and comfort for mentees to evolve. Mentees need to use the accumulated knowledge and wisdom of their mentors and build progress steadily and consistently in small steps.

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THE ARCHITECTURE OF A SUPERFOOD: DECODING THE RICE BRAN OIL BLUEPRINT

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| Scientific Profile | | Organization Link | | Research Lab Page |

Areas of Expertise: Plant Stress Physiology | Molecular Biology| Epigenetics & Crop Biofortification

When most people think of rice, they see a white grain a primary source of energy for half the planet. But as a botanist, I see the "gold" that we often throw away: the bran. This thin, brown outer layer is a concentrated reservoir of nutraceuticals, most notably Rice Bran Oil (RBO). RBO is uniquely rich in γ-oryzanol and tocols, compounds that act as natural shields against cholesterol and oxidative stress. Yet, for decades, the genetic "blueprint" that determines why one rice variety produces more oil than another has remained a mystery.

Our recent work, published in Planta (2026), sought to solve this mystery by looking into the heart of India's genetic diversity. We investigated nearly 200 diverse rice genotypes from the Chhattisgarh germplasm one of the world's most significant collections of indigenous landraces. What we found was a staggering natural variation: some varieties contained over 21% oil and 14,000 ppm of γ-oryzanol. In landraces like Vikram TCR (21.8% oil) and Ambemohar mutant-1 (>14,000 ppm γ-oryzanol), we found nature's blueprint for a superfood. These aren't just numbers; they represent the raw material for a public health revolution.

To find the genes responsible, we used Genome-Wide Association Mapping (GWAS), a method that allows us to scan the entire rice genome for "markers" associated with high oil content. Our analysis revealed two critical "logistics hubs" on Chromosomes 1 and 10. Specifically, we identified a cluster of six Lipid Transfer Protein (OsLTP2) genes. Imagine these as a fleet of microscopic delivery trucks, shuttling fatty acids and lipids across membranes to be stored in the grain. In high-oil varieties, these trucks appear to be more efficient or more numerous.

> *"The rice grain is not just a source of calories; it is a biological factory, and the way we tune its genetic machinery determines whether it remains a simple staple or becomes a 'heart-healthy' superfood."*

Perhaps the most striking discovery was on Chromosome 12, related to γ-oryzanol. We identified a CXE carboxylesterase an enzyme that we believe acts as a "molecular brake." In varieties with lower antioxidant levels, this enzyme likely breaks down γ-oryzanol as fast as it is made. By identifying the "low-brake" versions of this gene in landraces like Ambemohar mutant-1, we now have the molecular targets to "release the brake" in our high-yielding commercial varieties.

This research shifts our perspective from traditional breeding to "precision biofortification." We are no longer guessing which plants to cross. We can now use these SNPs (Single Nucleotide Polymorphisms) as genetic GPS coordinates to navigate the breeding process.

For India, the stakes are high. Despite being the world's second-largest producer of rice, the country remains heavily dependent on edible oil imports. By transforming rice bran from a low-value byproduct into a high-value nutraceutical resource, we can address two critical pillars of national security.

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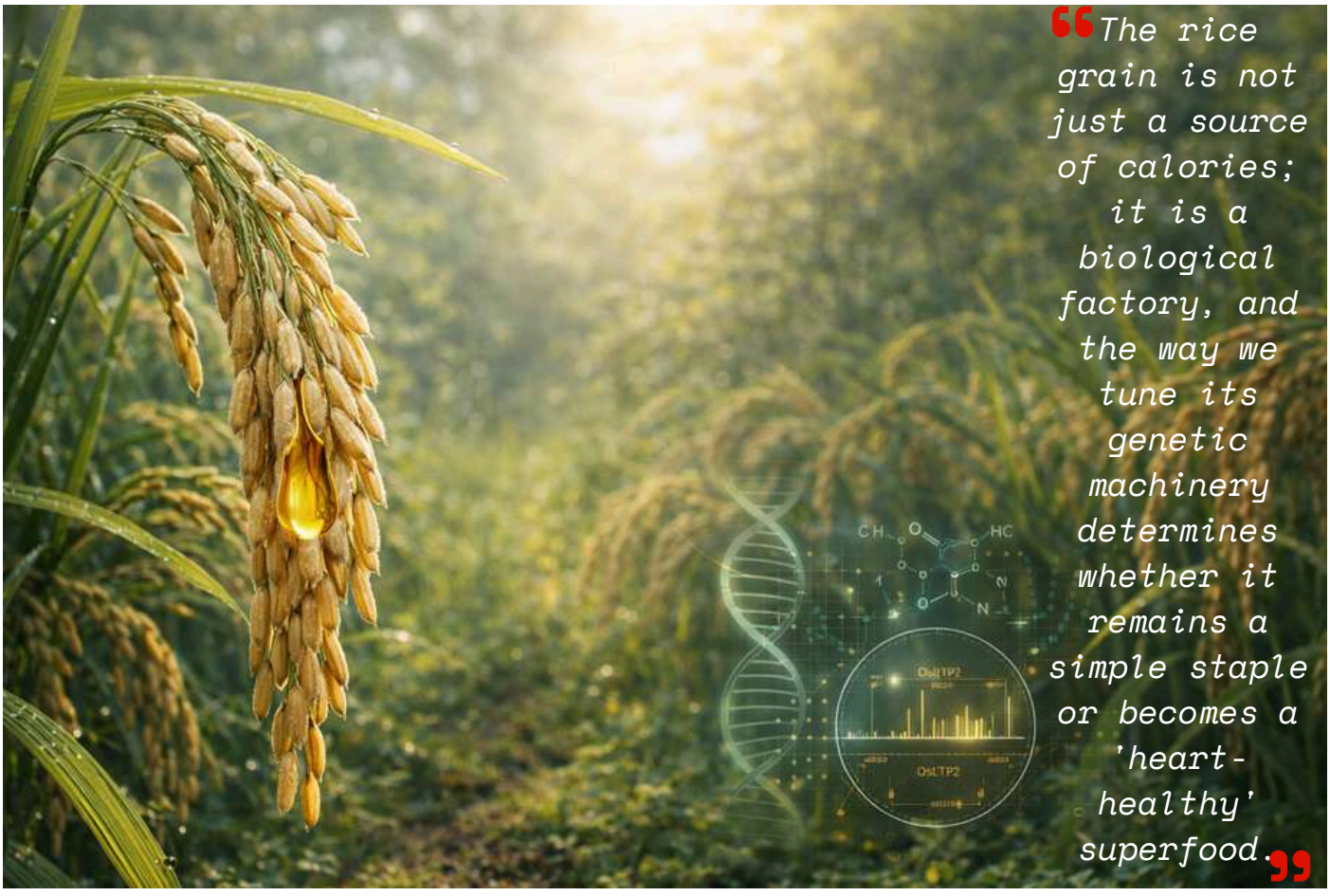
This approach can enhance nutritional security by helping combat “hidden hunger” through the inclusion of heart-healthy fats in everyday diets, while simultaneously strengthening economic security by reducing import dependence and moving toward self-sufficiency in edible oils.

The next frontier lies in integrating these genomic insights with climate resilience. As we move toward a future of unpredictable stress, our goal is to ensure that the rice of tomorrow is not only high-yielding but also nutritionally dense and environmentally robust. The "heart-healthy" rice variety is no longer a theoretical concept it is a roadmap we are actively drawing, one gene at a time.

Dr. Peer’s contributions to this field are reflected in the publication in Planta (2026), titled “Genome-wide association mapping of rice bran oil content and γ-oryzanol reveals candidate genes for lipid biosynthesis and transport” (DOI: 10.1007/s00425-026-04922-2). This study provides important insights into the genetic basis of rice bran oil composition, identifying key candidate genes involved in lipid biosynthesis and transport.



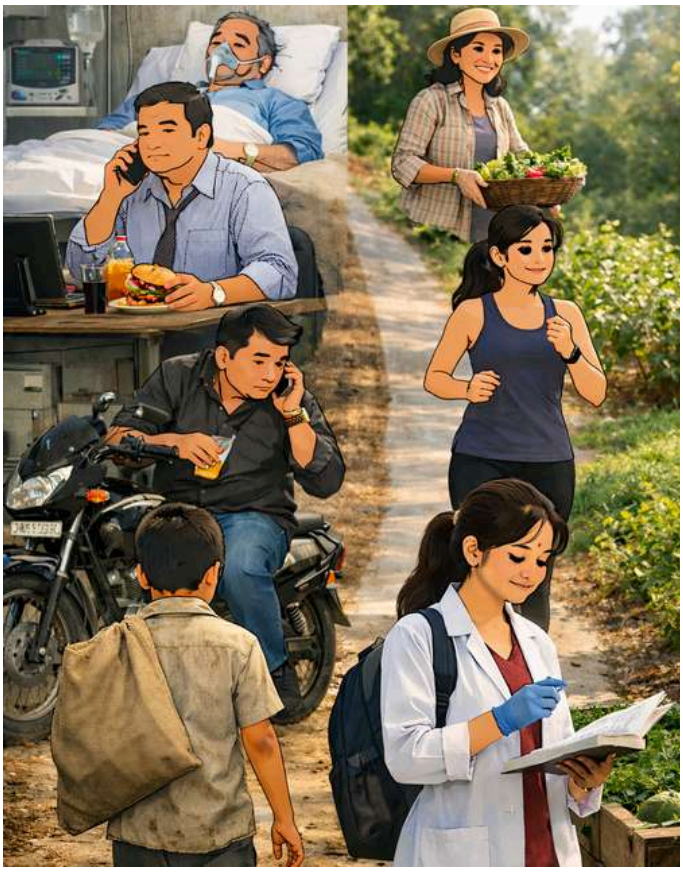
SCIENCE STORIES RESEARCH & EXPLORATIONS

Behind every discovery lies a story of curiosity, perseverance, and wonder. Science unfolds through relentless research and bold explorations into the unknown. These are the journeys that shape our understanding of the world—and beyond.

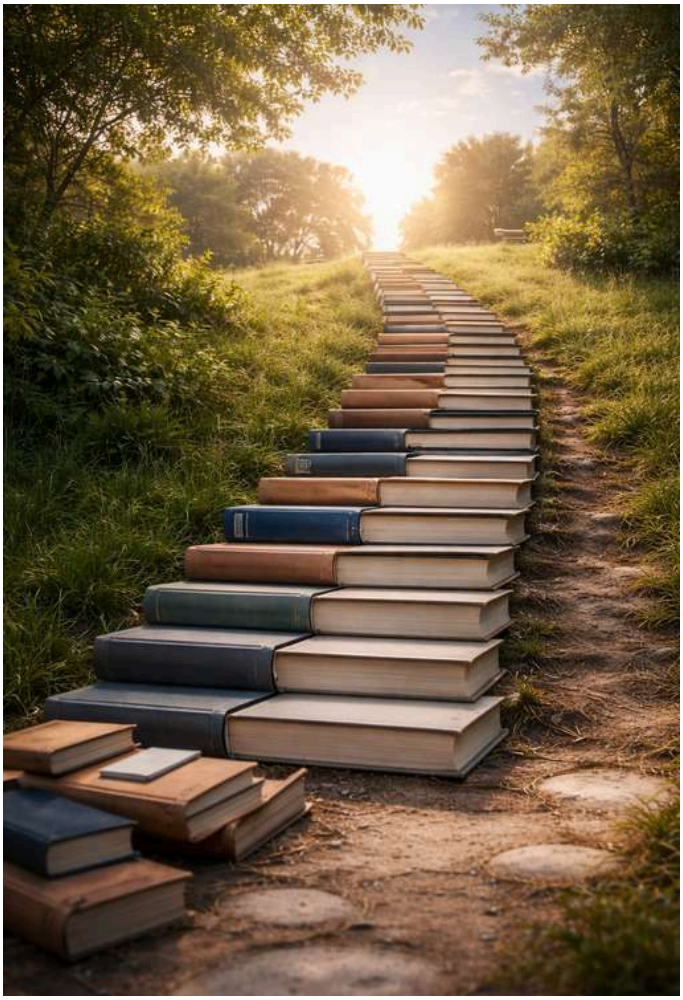
| By Dr. Jnana Ranjan Prusty

THE SECRET TO A LONGER LIFE

In a small town in India, two children grew up in neighboring houses. Their names were Suresh and Anjali. Both came from modest families and spent their childhood playing together and attending the same village school. Their parents believed that hard work could change their future, but their circumstances shaped their lives differently. As they grew older, Suresh's family faced financial pressure. His father lost his job, and the family needed income. Because of this, Suresh stopped studying after a few years of school and began working. He worked in farms, small shops, and later in a transport company in a nearby city. Over time, Suresh earned good money and improved his family's financial condition.



However, Suresh never continued his formal education. He had little knowledge about health, nutrition, or disease prevention. His job involved long hours of sitting and irregular meals. Like many workers around him, he began smoking and occasionally drinking alcohol. Years later, Suresh developed health problems such as high blood pressure and diabetes, which are common non-communicable diseases (NCDs) seen among adults. Anjali's life followed a different path. Her parents believed



education was the key to a better life. Even though they were not wealthy, they ensured she stayed in school. Anjali completed secondary education and later college. Through her studies, she learned about health, nutrition, and the importance of physical activity.

Eventually, Anjali became a teacher. She did not become extremely wealthy, but she lived a stable and healthy life. Because of her education, she understood the importance of preventive healthcare, balanced nutrition, and avoiding risky habits like smoking. Years later, scientists began studying a serious problem in India premature adult mortality, meaning deaths that occur between ages 15 and 59. India contributes a large share of global adult deaths, with nearly three million deaths each year in this age group. Researchers used data from the India Human Development Survey (IHDS) conducted between 2004–05 and 2011–12, which followed more than 129,000 adults. By tracking individuals over time, they studied how educational attainment and household economic status influence the risk of death.

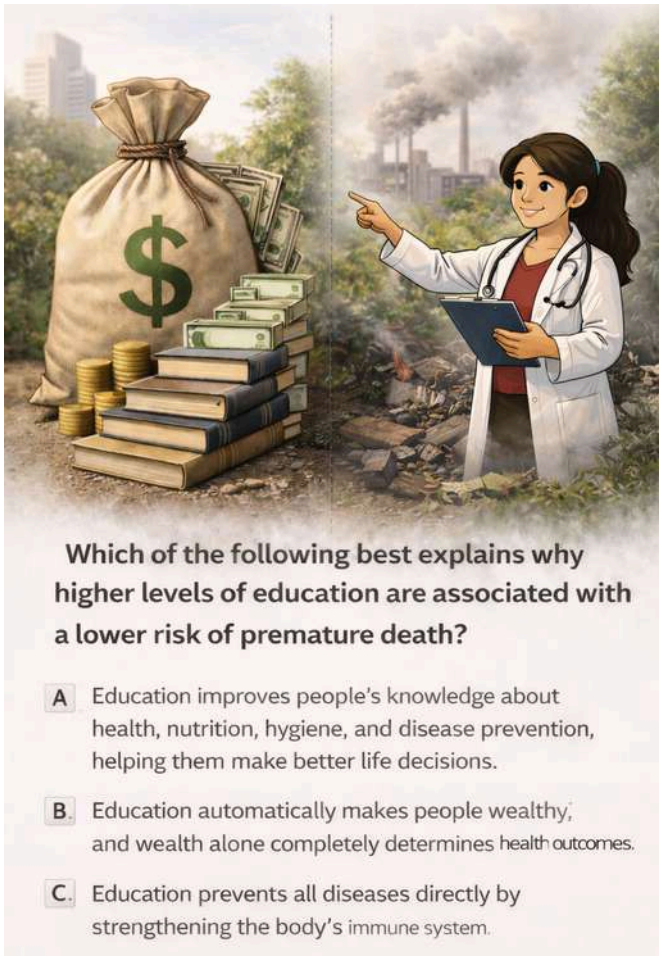
| By Dr. Jnana Ranjan Prusty

At first, it seemed obvious that wealth should help people live longer because richer households can afford better food and healthcare. But the results were surprising. Using multilevel logistic regression analysis, researchers found that although both education and wealth reduce mortality risk, education has a much stronger protective effect.Adults with upper secondary education were about 40–50% less likely to die prematurely compared with those with no education. Improvements in household wealth status also reduced mortality risk, but the effect was smaller. In many cases, a well-educated person from a middle-income household had a lower risk of death than a less-educated person from a rich household.

Education affects health in several ways. It improves knowledge, decision-making ability, and awareness of health risks. Educated individuals are less likely to smoke or drink excessively and more likely to seek medical care early. Education also provides safer jobs and healthier living environments.The study also found community-level education effects. In communities where people were more educated, mortality risks were lower, especially for women. Knowledge about healthy behavior spreads within communities and benefits everyone.

Interestingly, the research showed that wealth alone does not always protect health. In some cases, wealthier individuals experienced higher risks of diseases like cardiovascular disease, obesity, and diabetes, often due to sedentary lifestyles and unhealthy diets. The lives of Suresh and Anjali reflect these findings. Suresh achieved financial stability but lacked the health knowledge that education provides. Anjali, although not extremely wealthy, benefited from education that helped her maintain healthier habits and better life decisions. The lesson from this research is clear: economic growth alone is not enough to improve health outcomes. Education is one of the most powerful tools for reducing premature adult mortality. For India and many low- and middle-income countries, investing in quality education can significantly improve population health and help people live longer, healthier lives. In the end, the most valuable resource a society can give its people is not only wealth, but education and knowledge.

When communities invest in education, they not only build careers but also build healthier generations. Awareness spreads from one person to another, creating a ripple effect of better choices, improved lifestyles, and stronger societies. In this way, education becomes a foundation not just for success, but for a longer and healthier life. It also empowers individuals to support others, creating a more informed and resilient community. This collective strength helps societies grow sustainably and face future challenges with confidence.



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| By Dr. Priyangana Deb

THE VILLAGE OF NEW BEGINNINGS AND THE MYSTERY OF THE HOT SUN

In a peaceful village called Anandpur, people believed that every newborn child was a blessing from nature. The village was full of green fields, small houses, and children playing under big mango trees. In this village lived Dr. Amrita, a kind and curious scientist who loved understanding how nature affects human life.

Dr. Amrita often visited the village clinic where babies were born. She enjoyed looking at the birth records and learning about the health of mothers and newborns. She would carefully note patterns, compare seasons, and sometimes even speak with mothers to understand their experiences during pregnancy. One day, while carefully studying the clinic's records, she noticed something interesting.

Around the world, there is a natural pattern in births. Usually, slightly more boys are born than girls. For every 100 girls, about 105 boys are born. Scientists have observed this pattern in many countries for a long time. But in some recent years in Anandpur, Dr. Amrita noticed something unusual. During very hot years, the number of baby boys born seemed a little lower than usual. The difference was small, but it made her curious. "Could the hot weather be influencing this?" she wondered.

To find the answer, Dr. Amrita joined a group of scientists from many countries. Together they collected information about millions of births from places in Africa and India. They wanted to understand whether temperature during pregnancy could influence whether a baby is born a boy or a girl.

Dr. Amrita later gathered the villagers in the community hall and explained the study in simple words. "When a baby grows inside the mother," she said gently, "many things can influence its development, nutrition, health, environment, and even temperature."

The scientists studied two important types of information. First, they examined birth records, which showed whether babies were boys or girls. Second, they collected weather data, which showed how hot the temperature was during different months of pregnancy. By combining these two types of information, the scientists could see whether extreme heat during pregnancy affected birth outcomes.

| By Dr. Priyangana Deb

After carefully studying about five million births, the researchers discovered something interesting. When the weather was very hot during pregnancy, the number of baby boys born became slightly lower. This did not mean boys stopped being born. It simply meant that a few more girls were born compared to boys during very hot periods.

Dr. Amrita explained this using a simple example that everyone in the village could understand. “Imagine two young plants growing in a field,” she said. “One plant is a little more delicate than the other. If the weather becomes very harsh, too hot or too dry, the delicate plant might struggle more.” Scientists believe something similar can happen during pregnancy. Studies show that male fetuses (baby boys before birth) can sometimes be more sensitive to environmental stress, including extreme heat. Because of this, during very hot conditions, male fetuses may have a slightly higher chance of not surviving the early stages of pregnancy compared to female fetuses.

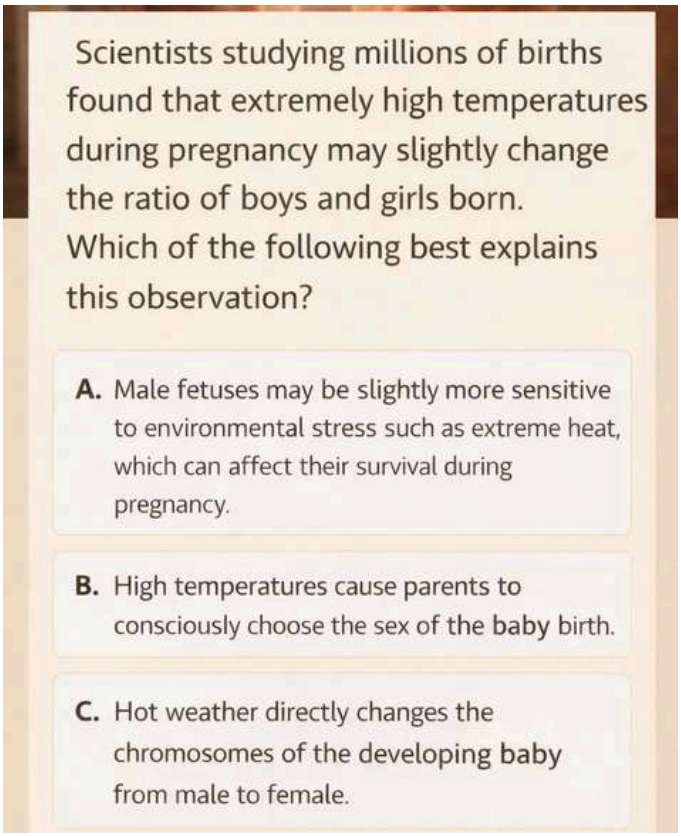
She paused for a moment and added another thought. “Heat does not act alone,” she explained. “When temperatures rise, it can also affect water availability, nutrition, and overall comfort of the mother. If a mother becomes dehydrated or stressed due to heat, it may indirectly influence the baby’s development.” She also explained that the human body works hard to maintain a stable internal temperature, but extreme heat can put extra pressure on this balance. Over time, repeated exposure to very high temperatures may increase stress on both the mother and the developing baby.

However, Dr. Amrita reassured everyone that these changes are very small and most pregnancies remain healthy. “We are simply learning how nature and the environment gently influence human biology,” she said. The scientists also discovered something else important. The timing of heat exposure matters. Heat during certain months of pregnancy seemed to affect the developing baby more than heat at other times. This means the baby’s development can be sensitive to environmental conditions during specific stages of growth.

One farmer raised his hand and asked, “Why is this discovery important for us?” Dr. Amrita smiled and replied, “Because our planet is becoming warmer due to climate change. If temperatures continue to rise, extreme heat may become more common.

Understanding how heat affects pregnancy helps doctors and communities prepare and protect mothers and babies.”

The villagers realized that the research was not only about boys and girls. It was about how deeply human life is connected to nature. Dr. Amrita’s work helped everyone understand that even small environmental changes can influence human health in quiet ways. From that day onward, whenever the bright sun shone over Anandpur, the villagers remembered the lesson they had learned. The sun gives life, warmth, and energy but it also reminds us that our environment and our health are closely connected. And as seasons passed, the people of Anandpur became more aware and careful. They started sharing this knowledge with neighboring villages, ensuring that mothers stayed safe during extreme heat. In this way, science quietly became a guiding light, helping the community live in harmony with nature.



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| By Dr. Priyanka

KRISHNA AND THE MOON DREAM

Krishna was a curious boy who lived in a small town in India. Every night he loved to look at the sky. The stars, the Moon, and the planets always made him wonder about space. One evening he asked his science teacher, Dr. Pallavi, “Ma’am, how do countries send spacecraft to the Moon and Mars? It must cost a lot of money.” Dr. Pallavi smiled and said, “Yes, Krishna. Space missions can be very expensive. But India has shown the world that big achievements can happen even with limited money if we use smart ideas.”
Krishna became very interested. So Dr. Pallavi began to tell him a story.

Many years ago, India wanted to explore space. But India did not have as much money as some powerful countries. Nations like the United States and Russia had very large space budgets. Their missions often cost billions of dollars. Because of this, many people believed that India could not compete in space exploration.

But Indian scientists had a different way of thinking. They believed that success in space does not always depend on spending huge amounts of money. Instead, it depends on smart planning, efficient engineering, and clear goals. This idea is called frugal innovation. Frugal innovation means doing important work in a simple and efficient way without wasting resources. Scientists focus only on what is necessary for the mission. They avoid unnecessary complexity and expensive features. Dr. Pallavi explained that the Indian Space Research Organisation (ISRO) followed this approach very carefully.

Before starting a mission, scientists ask important questions. What is the main purpose of the mission? What information do we want to collect? What is the simplest way to achieve this goal? By asking these questions, scientists design missions that are efficient and affordable. One famous example is the Mars Orbiter Mission, also known as Mangalyaan, launched by India in 2013. Sending a spacecraft to Mars is extremely difficult. Many countries had tried and failed several times. But India succeeded on its very first attempt.

Krishna looked surprised. “First attempt? That sounds incredible!” Dr. Pallavi nodded. “Yes. And the mission cost only about 74 million dollars, which is much cheaper than many other Mars missions.” Krishna laughed. “That is even less than the cost of some movies!” “Exactly,” said Dr. Pallavi. “That is why the world admired India’s achievement.”

But India did not stop there. Later, Indian scientists planned another mission called Chandrayaan-3. The goal was to land a spacecraft on the Moon, especially near the Moon’s south pole. This region is very interesting for scientists because it may contain frozen water and

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important scientific information.

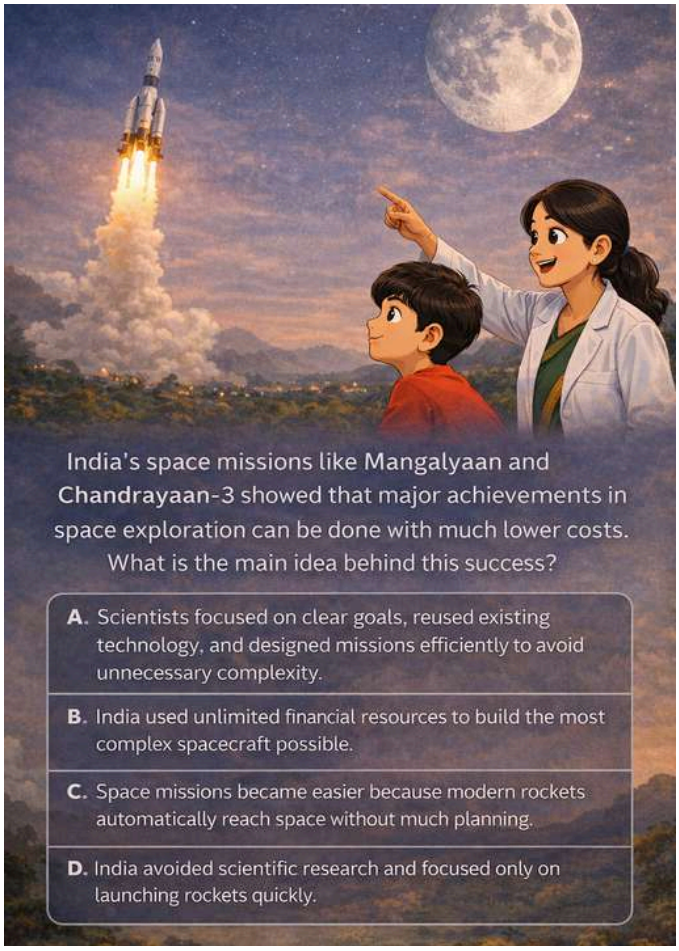
Again, ISRO scientists followed their frugal innovation approach. They reused technologies from earlier missions, designed simple but effective systems, and carefully planned every step. Finally, in 2023, the spacecraft successfully landed on the Moon. People across India celebrated with great joy. India became the fourth country in the world to achieve a soft landing on the Moon. Even more exciting, India became the first country to land near the Moon's south pole.

Krishna's eyes became bright with excitement. "So India showed that great space missions do not always need huge money," he said. "That is right," Dr. Pallavi replied. "Smart thinking can sometimes be more powerful than big budgets." She also explained that India's success gives hope to many other countries. Many developing nations want to use space technology for communication, weather prediction, disaster monitoring, and scientific research. But they often believe that space exploration is too expensive.

India's example shows that with creativity, teamwork, and careful planning, even countries with limited resources can build successful space programs. This idea helps democratize space exploration. That means space should not belong only to rich nations. More countries can participate and benefit from space technology.

Krishna looked up at the Moon again. For the first time, he did not see space as something impossible. Instead, he saw it as a place where smart ideas, determination, and teamwork could make dreams come true. And deep inside his heart, Krishna started dreaming that one day he might help build a spacecraft that travels far beyond the Moon. Because sometimes, the greatest journeys begin with a simple question and a curious mind.

As he walked home under the glowing Moon, Krishna felt a new sense of purpose. He promised himself to study hard and keep asking questions. Maybe one day, he would not just look at the Moon but help India reach even farther into the universe. As he stood under the night sky, Krishna felt a deep sense of possibility. He imagined scientists working together, solving problems step by step, just like puzzles. He realized that learning science was not only about books, but about curiosity and courage to try new ideas. Krishna promised himself that he would study hard, keep asking questions, and never be afraid of challenges. Maybe one day, he would contribute to a mission that explores distant planets, helping humanity understand the universe even better.



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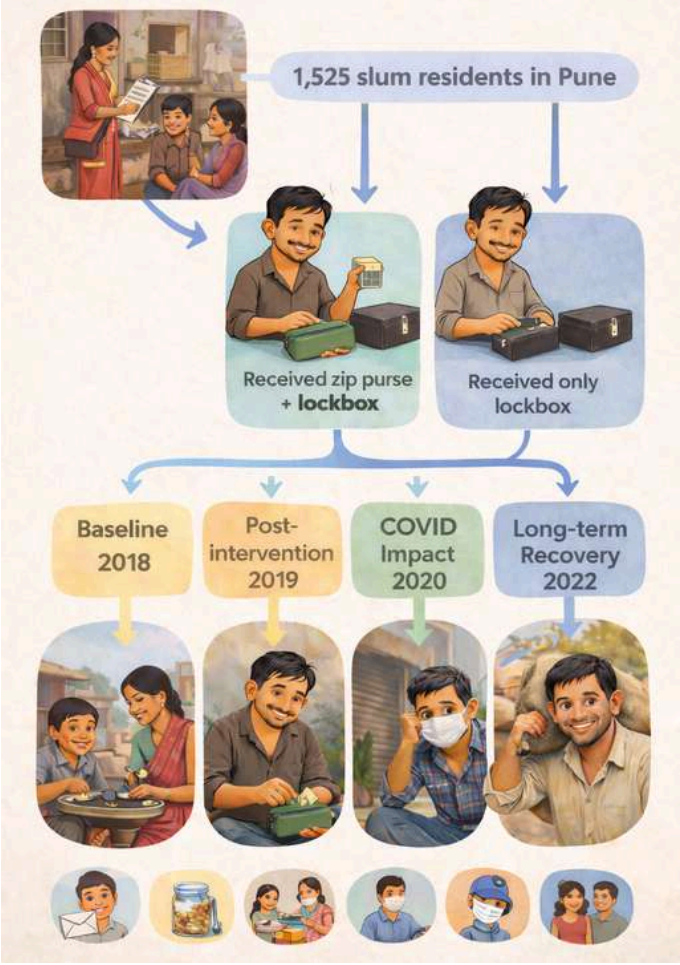
| By Dr. Sourav Kumar

MAHESH'S JOURNEY-SAVING MONEY AND SURVIVING COVID-19

Mahesh is a 32-year-old man who lives in a small slum settlement in Pune, India. Like many people in his community, Mahesh works hard to earn money through informal jobs such as construction work and daily labor. His income is not fixed, and some days he earns well while other days he earns nothing. Mahesh lives with his wife and two children. Their family survives on limited income, so saving money is very important for them. However, saving is not easy because unexpected expenses and small daily temptations often make it difficult.

Mahesh became part of a research study that wanted to understand how people like him manage money and how events such as the COVID-19 pandemic affect their lives. The researchers interviewed Mahesh and many other people living in slums in Pune. At the beginning of the study, more than 1,500 individuals were interviewed. These people were adults who earned at least some income and had the potential to save a little money every month.

During the first interview, the researchers asked Mahesh many questions about his life. They asked about his age, education, job, income sources, and family members. They also asked about how much money he spends on food, transport, health, and other household needs. Mahesh explained that his family spends most of their money on food and basic necessities. Sometimes he also spends money on small items like snacks or tea from roadside shops. These small expenses seem harmless, but over time they reduce the money he could save.



The researchers were especially interested in Mahesh's saving habits. They asked where he keeps his savings and how much he saves each month. Mahesh said that sometimes he keeps money at home because it is easy to access. However, keeping money at home also makes it easy to spend it quickly. Some people in his community save money in banks or post offices, but not everyone has easy access to these services.

As part of the study, Mahesh was given a simple tool to help him save money. Some participants received a portable saving device called a zip purse along with a lockbox. The idea was that if people keep their savings in a

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separate and secure place, they may be less tempted to spend it on unnecessary items. Mahesh started using this purse to keep small amounts of money aside whenever he could. This small change helped him think more carefully about spending and saving.

The study continued for several years, and the researchers interviewed Mahesh again in different rounds. The second round of interviews happened about a year later to see if the saving device changed people's behaviour. Many questions were repeated so that the researchers could compare Mahesh's answers over time and understand whether his savings increased.

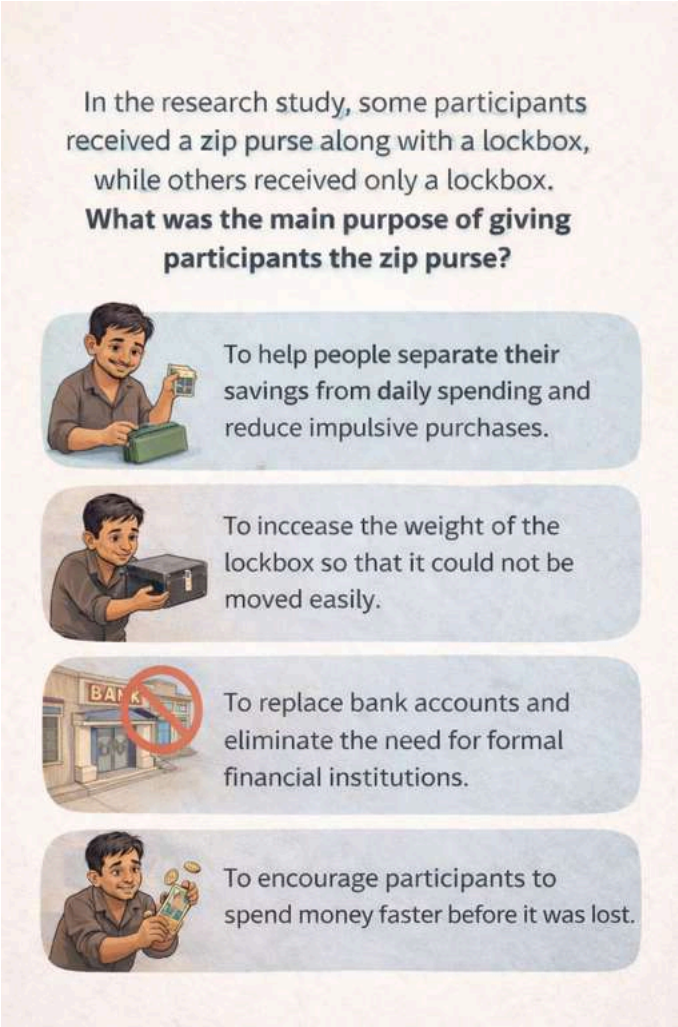
Then something unexpected happened the COVID-19 pandemic began. Lockdowns were introduced across India, and many workers like Mahesh suddenly lost their jobs or faced reduced work opportunities. Because of travel restrictions and safety concerns, the researchers could no longer visit people's homes. Instead, they conducted the next interviews by phone.

During the phone interviews, Mahesh shared how the pandemic affected his life. His work became irregular, and his income decreased. Sometimes he worried about how to buy food for his family. The researchers also asked questions about health, knowledge about COVID-19, and whether Mahesh received help from the government or other organizations during the crisis. Many families in his community faced similar challenges.

Two years after the pandemic began, the researchers interviewed Mahesh again to see how his life had changed. Some people had started working again, but recovery was slow. Many households were still struggling to rebuild their savings. Mahesh explained that even small savings were helpful during difficult times because they allowed his family to manage sudden expenses.

Mahesh's story represents the experiences of many low-income families living in urban slums. Through this long-term study, researchers were able to understand how saving behaviour works among poor households and how economic shocks like COVID-19 affect their livelihoods. The information collected from Mahesh and others helps policymakers design better programs that encourage saving, improve financial security, and support vulnerable communities during crises.

In simple words, Mahesh's journey shows that small saving habits can make a big difference, especially when families face unexpected challenges.



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| By Dr. Avijit Das

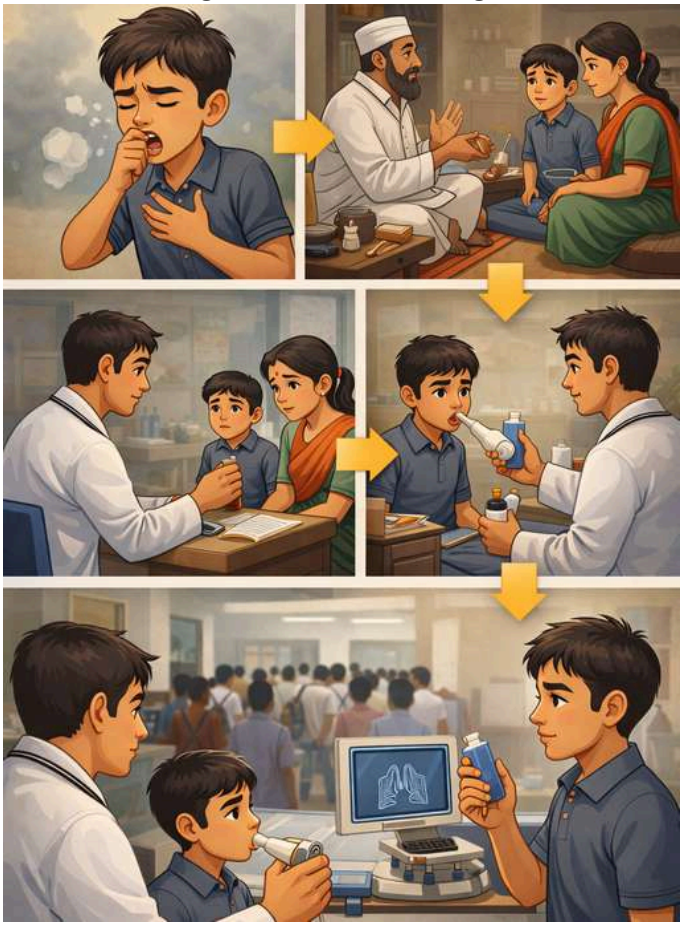
ARJUN'S BREATH: A STORY OF LIVING WITH ASTHMA

Arjun is a 13-year-old boy who lives with his parents in a crowded neighborhood in Delhi. Like many children his age, Arjun loves playing cricket with his friends in the evening. But sometimes, while running on the field, he suddenly feels tightness in his chest. His breathing becomes fast and difficult, and he starts coughing. When this happens, Arjun has to sit down and wait until he can breathe normally again.

At first, Arjun's parents did not understand what was happening. They thought it was just a common cold or a temporary cough. Sometimes they took him to a nearby clinic, where doctors gave him cough syrup or antibiotics. The medicines helped for a short time, but the problem kept coming back. Arjun's parents were worried, but they were also afraid of hearing a serious diagnosis.

Finally, one day, they visited a respiratory specialist in a city hospital. After examining Arjun carefully, the doctor explained that Arjun had asthma, a long-term condition that affects the lungs and makes breathing difficult. The doctor told them that asthma can be managed with proper treatment, and many people with asthma live normal, active lives.

However, when Arjun's parents heard the word "asthma," they felt scared. In their community, many people believe asthma is a very serious disease. Some even think it can affect a person's future. Arjun's mother worried that if others knew about his condition, people might treat him differently. Because of this fear, she asked the doctor if he could avoid telling relatives about the diagnosis.



Finally, one day, they visited a respiratory specialist in a city hospital. After examining Arjun carefully, the doctor explained that Arjun had asthma, a long-term condition that affects the lungs and makes breathing difficult. The doctor told them that asthma can be managed with proper treatment, and many people with asthma live normal, active lives. He also explained that asthma is not an infection but a condition where the airways become sensitive and inflamed, making it harder for air to move in

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and out of the lungs.

However, when Arjun's parents heard the word "asthma," they felt scared. In their community, many people believe asthma is a very serious disease. Some even think it can affect a person's future. Arjun's mother worried that if others knew about his condition, people might treat him differently. Because of this fear, she asked the doctor if he could avoid telling relatives about the diagnosis.

This kind of misunderstanding about asthma is common in India. Many families feel ashamed or worried when someone is diagnosed with asthma. Even some doctors hesitate to use the word "asthma" when talking to patients because they know families may not accept it easily.

The doctor explained to Arjun and his parents that asthma can be controlled with the right treatment. He recommended using an inhaler, which helps deliver medicine directly into the lungs. This medicine reduces swelling in the airways and prevents asthma attacks. But Arjun's parents were unsure. They had heard from neighbors that inhalers could be harmful or addictive. Because of these beliefs, they were hesitant to let Arjun use one.

The doctor patiently explained that these ideas were myths. Inhalers are actually one of the safest and most effective ways to treat asthma. Without proper treatment, asthma attacks can become more frequent and severe. Over time, untreated asthma can lead to serious lung damage.

Another challenge Arjun faced was the environment around him. The air in Delhi is often filled with pollution from traffic, factories, and dust. Doctors say that every year thousands of people in the city die due to air pollution. For children with asthma, polluted air can make breathing problems worse.

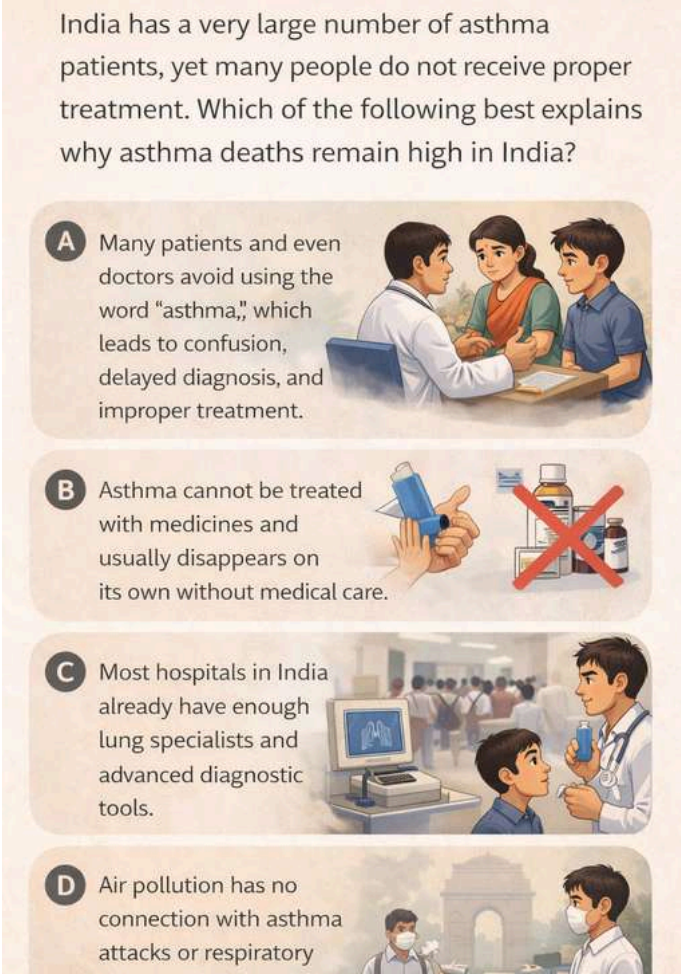
At home, Arjun's family tried to make small changes to help him breathe better. They kept windows closed during days when pollution was high and encouraged Arjun to avoid outdoor activities when the air quality was poor. Slowly, with proper treatment and care, Arjun's asthma became more manageable.

Arjun also learned something important from his doctor. The doctor told him about famous athletes who have

Arjun also learned something important from his doctor. The doctor told him about famous athletes who have asthma but still compete at the highest level. This helped Arjun feel more confident. He realized that having asthma did not mean he had to stop dreaming.

Today, Arjun still carries his inhaler when he goes out to play cricket. Sometimes he needs to pause and take a breath, but he does not let asthma stop him from enjoying life. His parents have also become more aware of the disease and now help others in their community understand that asthma is treatable.

Arjun's story is similar to the experience of millions of people in India who live with asthma. Experts estimate that about 35 million Indians have asthma, yet many are not diagnosed properly or do not receive the right treatment. Misunderstanding, lack of awareness, and limited access to medical care make the problem worse.



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| By Dr. Poulami Chakraborty

THE COLORFUL FOREST: HOW MATE COPYING KEEPS EVOLUTION DIVERSE

Once upon a time, in a colorful forest, there lived a group of small birds called Silverwing finches. These birds were famous for their beautiful feathers. The male birds had different feather colors some had bright red feathers, some had blue feathers, some had golden feathers, and others had green feathers. The female birds had an important job: they had to choose which male they would mate with.

In the beginning, every female bird made her decision independently. Some liked the bright red males because they looked strong. Some preferred blue males because their feathers shone beautifully in the sunlight. Others liked the rare golden feathers because they looked special. Because each female had her own preference, many different feather colors continued to exist in the forest.

One day, a young female finch named Lina was watching other birds carefully. She noticed something interesting.

When a female bird chose a male, other females nearby started paying attention to that same male. Lina wondered, “Maybe those females know something I don’t. If many birds choose that male, maybe he must be a good choice.”

Soon Lina tried something new. Instead of choosing only based on her own opinion, she started watching what other females were doing. When she saw several females choosing a bright red male, she thought, “Maybe red feathers are popular for a reason.” So she also chose a red male.

Other young females began doing the same thing. They started copying the choices of other females. This behavior spread through the forest. The birds called this behavior “mate copying.”

At first, nothing dramatic happened. There were still red, blue, golden, and green males in the forest. But slowly, something interesting began to occur. When a red male was chosen once, other females saw it and copied the choice. That made red males appear even more popular. The more they were chosen, the more others copied them. It was like a chain reaction.

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However, the story did not end with only red males dominating the forest.

One year, a blue male named Rio was chosen by a few females. Other females noticed and started copying that choice too. Soon blue males also became popular. In another part of the forest, a golden male named Sol was chosen, and some females copied that as well. Because females were observing different choices in different places, multiple feather colors remained popular at the same time.

The forest became a fascinating place where several feather colors continued to exist together.

An old wise owl who lived in the forest watched this behavior for many years. One evening, the owl gathered the young birds and explained what was happening.

“Long ago,” the owl said, “females chose mates only based on their personal preference. But now you also use social information you observe what others choose. This copying behavior changes how the population evolves.”

The owl continued, “If copying becomes very strong, everyone may follow the same trend, and one feather color could take over the entire forest. But if copying is very weak, then every bird only follows her own preference, and the system behaves like it did before.”

The young birds listened carefully.

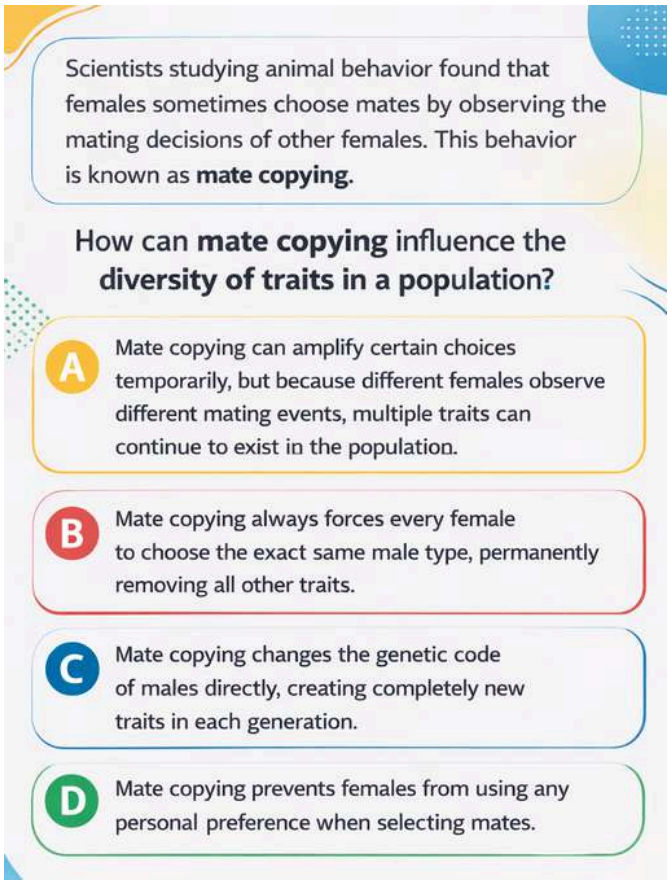
“But when copying is moderate,” the owl said, “something beautiful happens. Different groups of birds follow different trends. Because of this, many feather colors survive together. This is called phenotypic diversity.”

The owl also explained that copying only works when birds can observe others mating. If birds are isolated and cannot see others’ choices, then copying cannot happen. But in the lively forest where birds watch each other closely, social learning becomes powerful.

Years passed, and the Silverwing forest remained full of colorful birds red, blue, golden, and green. The diversity of feathers made the forest vibrant and beautiful.

The young birds eventually understood an important lesson: evolution is not only shaped by biology but also by behavior and social learning. Sometimes animals do not decide alone. They watch, learn, and copy others. And surprisingly, this simple behavior can help maintain diversity in nature.

And so, the Silverwing forest remained a shining example of how social influence and mate copying can shape evolution and preserve many different traits in a population.



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By Mrinal Kashyap

UNDERSTANDING EVERY BRAIN

In a research institute in Delhi, a neuroscientist named Dr. Meera was studying how the human brain works. She had always been fascinated by the brain, how people think, learn, remember, and feel emotions. Every day she worked with a large

brain scanner called an MRI machine, which allowed scientists to see activity inside the brain. Many volunteers came to the lab, most of them university students from the nearby campus. They participated in experiments where scientists observed how their brains reacted to different tasks.

One day, while looking at her research data, Dr. Meera began to wonder about something important. Most of the volunteers in her studies were young, educated people from cities. They often had similar lifestyles, similar education, and similar daily routines. But India is a huge country with millions of people living in very different environments some in busy cities, others in villages, mountains, forests, or coastal areas. People also have different diets, jobs, education levels, and cultural traditions. Dr. Meera asked herself an important question: "If we only study people from cities, can we really understand how the human brain works for everyone?"

At a scientific conference, Dr. Meera met another researcher named Dr. Carlos, who had the same concern. He explained that many brain studies around the world mainly involve people from Western, educated, industrialized, rich, and democratic societies. Scientists call these populations "WEIRD populations." Even though these studies provide useful information, they represent only a small part of the global population. Billions of people live in very different conditions, and their experiences might shape their brains in different ways.

Dr. Carlos told Dr. Meera that the world is changing quickly. People today live in environments very different from those of past generations. Cities are expanding, technology is everywhere, people spend more time using smartphones and computers, diets are changing, and pollution is increasing. All these factors lifestyle, technology, education, environment, and social conditions can influence brain development and mental health. To truly understand the human brain, scientists must study people from many different backgrounds and environments.

Inspired by this idea, Dr. Meera decided to start a new project. She wanted to study brain activity not only in cities but also in villages and remote communities. However, she quickly discovered a big problem. The large MRI machine in her laboratory was extremely expensive, heavy, and required special facilities. It could not be easily transported to other locations. Many rural areas simply did not have such advanced equipment.

Fortunately, Dr. Meera and her team learned about a smaller and more portable technology called EEG (electroencephalography). EEG devices measure electrical signals in the brain using small sensors placed on a person's scalp. Unlike MRI machines, EEG equipment can be lightweight, portable, and much less expensive. This meant scientists could carry the equipment to schools, clinics, and community centers in different regions. This also allowed them to include participants who had never been part of scientific studies before, making research more inclusive and representative of real-world diversity.

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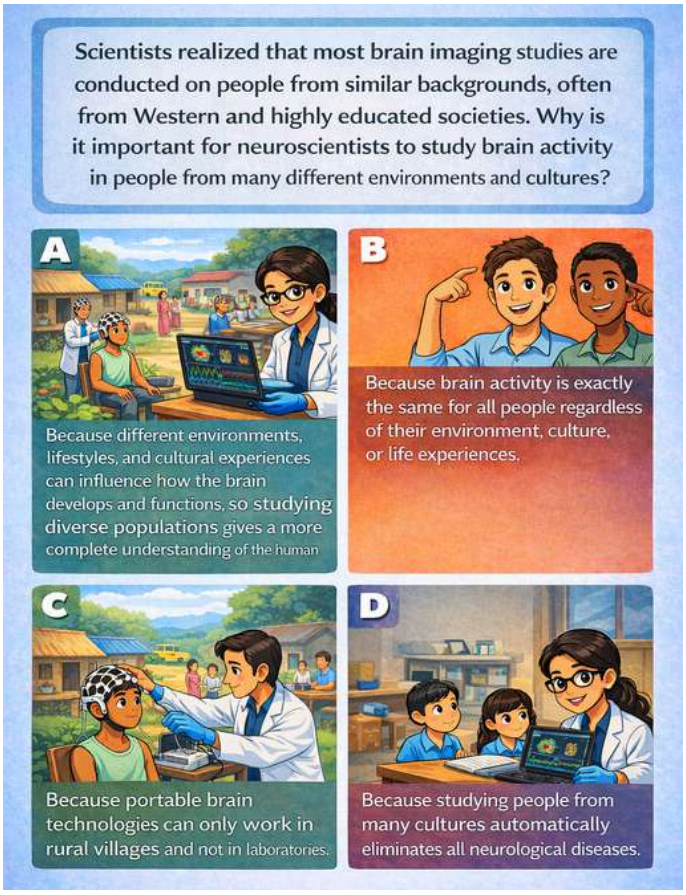
Soon Dr. Meera and her team began traveling to different parts of the country. In one village, they studied how children's brains responded to learning activities in a rural school. In another community, they examined how daily activities like farming and outdoor work influenced attention and memory. They also collected information about people's diet, sleep patterns, education, environment, and lifestyle, because all these factors could influence brain function.

Over time, the team realized that studying diverse populations gave them much richer insights into the human brain. They saw how different life experiences shaped how people learn, think, and respond to stress. Some environments seemed to strengthen certain cognitive abilities, while others created different challenges.

But Dr. Meera knew that this work could not be done by one laboratory alone. She began collaborating with scientists, doctors, and universities in many countries. Together they built large research networks that collected brain data from thousands of people across different regions and cultures. These collaborations also helped train local researchers and build scientific capacity in different parts of the world.

Dr. Meera always remembered the lesson she learned early in her career: the human brain is shaped not only by biology but also by environment, culture, and life experiences. To truly understand the brain, scientists must study people from many different communities and lifestyles.

Through portable technologies, global collaboration, and inclusive research, scientists like Dr. Meera are working toward a future where brain science represents all of humanity, not just a small group of people.



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BUILDING BETTER ZINC BATTERIES FOR A GREENER FUTURE

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| Scientific Profile |
| Organization Link |
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What are aqueous zinc-ion batteries, and why are scientists interested in them today?

In response to global climate change, rechargeable batteries have a pivotal role in industrial decarbonization and the energy transition to a sustainable energy storage landscape. Owing to the high demand of electric vehicles and consumer electronics, in the last couple of decades lithium-ion batteries (LIB) have exhibited impressive performance and thus captured the whole market; however, scarcity, complicated extraction processes, and safety issues call for new types of rechargeable batteries that allow cleaner, safer, and more efficient energy storage solutions. Aqueous zinc-ion batteries (AZIBs) offer a rechargeable and sustainable energy storage system with good capacity (gravimetric: 820 mA h g-1 and volumetric: 5854 mA h cm-3), low production cost, and high safety. It could provide an ideal technology for stationary and large-scale such as grid-scale energy storage. Additionally, AZIBs can be used in flexible batteries for wearable electronics and biomedical applications. AZIBs comprise Zn metal as an anode, which is abundant, low cost, and safe to handle, and transition metal oxides such as manganese or vanadium oxide, Prussian blue analogues, and organic compounds as a cathode. Unlike LIBs, where toxic and flammable organic solvents are used as electrolytes, AZIBs use water-based electrolytes, preventing fire hazards common in LIBs. Because of their safety, low cost, and sustainability, AZIBs are gaining strong interest as next-generation energy storage systems.

What are the main problems that currently limit the performance or lifetime of zinc batteries?

Aqueous zinc ion batteries (AZIBs) face critical challenges primarily driven by water- based electrolytes, including limited operating voltage due to low water decomposition voltage (1.23 V), severe zinc dendrite formation, hydrogen evolution reaction (HER), surface passivation (corrosion), and cathode dissolution. These issues cause short circuits, low coulombic efficiency, poor cycling stability, and limited energy density. On the anode side, non-uniform deposition of Zn, known as Zn-dendrites, occurs during charging, while at the anode-electrolyte interface, HER leads to the corrosion of Zn metal during charging, discharging, and rest periods. In the cathode, as expected, zinc ions (Zn2+) would act as primary charge carriers during (de)intercalation in the host materials; however, protons (H+) are found to be co-carriers in some cases. Even proton storage may become predominant at high rates and lower potentials. Proton co-insertions create problems for prolonged cycling as it produces hydroxyl (OH-) anions via water decomposition, which increases the pH to facilitate the formation of unwanted layered zinc hydroxide sulphate (ZSH) depositing on the cathode (anode) surfaces. Structural instability and capacity fading of the cathode, particularly metal (Mn and V) oxides are due to irreversible reactions leading to phase change and dissolution of redox-active materials in electrolytes during stripping/plating.

Your research talks about "molecular materials." In simple words, what are these molecules and how do they work inside a battery?

Molecular materials include small molecules or their self-assembled structures, gels, polymers, supramolecular architecture, hydrogen-bonded organic frameworks (HOFs), covalent organic frameworks (COFs), metal organic frameworks (MOFs), ionic liquids, organic–inorganic hybrid materials, biomolecules such as vitamins, proteins, polysaccharides, inorganic molecules, etc. which are generally built from functional molecules via a "bottom–up" approach that retains their properties down to the molecular scale.

Enhancement of Zn/Zn2+ reversibility largely relies on the cooperative functions of all components of the battery, such as cathode, anode, electrolytes, and separators. Any hindrance in the synchronizations of the functional components leads to shortening of the life cycle and capacity fading of the battery. Molecular materials have multitudes of functionalities that can enhance the lifetime of the battery in several ways, such as modifying electrode surface, solvation structure, desolvation kinetics, and ionic conductivity, and alleviating the side reactions and HER at the electrode and electrolyte interface.

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BUILDING BETTER ZINC BATTERIES FOR A GREENER FUTURE

For example, a small organic molecule, 4-methyl pyridine N-oxide, having a zincophilic bipolar head and hydrophobic tail can make a Zn complex with a polar end by replacing solvated water molecules, thereby changing the solvation structure, ion transport, desolvation kinetics, and Zn deposition, while the hydrophobic side has repulsive and antifouling properties, reducing water activity at the electrode-electrolyte interface, which results in suppressed HER and side reactions for homogeneous 3D Zn plating (Figure 1). Notably, molecular materials not only assist in achieving uniform Zn2+ nucleation and deposition at the anode but also stabilize the cathode by suppressing active material dissolution, facilitate Zn2+ ion intercalation/deintercalation, and enhance reaction reversibility. Nevertheless, their functions at different locations largely rely on their functional groups, redox properties, size, and concentration.

How can adding tiny amounts of special molecules improve the stability of a zinc battery?

"Small is better and beautiful," as is observed for single atom catalysts (SACs) which involve individual metal atoms (e.g. Pt, Fe, Ni, Co) on a supporting substrate and can offer exceptional catalytic activity and selectivity over analogous heterogeneous catalysts having bigger particle sizes. Intriguingly, trace amounts, even 5 mM concentration of additive molecules in the electrolyte have an enormous impact on changing the electrode surface, solvation structure, and breaking the intermolecular H-bonding between water molecules (chaotropic molecules), thereby, reducing water activity at the electrode-electrolyte interface and inhibiting HER. Small molecules make a screening layer on the electrode surface, creating a local lean water environment and helping to generate homogeneous electric flux and control uniform Zn deposition via promoting 3D surface diffusion, resulting in dendrite-free Zn plating/stripping. Notably, HER is associated with the number of solvated water molecules in the first sphere of Zn2+ (primary) solvation sheath; complexation with small molecules reduces the number of solvated water molecules coordinated to Zn2+, thereby, reducing the chance of decomposition of water dramatically. This lean water electrolyte, electrodes (both cathode and anode), and separators are beneficial for better performance of AZIBs. Nevertheless, water has a paradoxical effect as too little water can affect the ionic conductivity and increase the viscosity, resulting in shortening of lifetime. Additionally, decomposition of additives together with electrolytes at the electrode surface generates solid interphases (SEI for anode and CEI for cathode), which protect the electrodes from corrosion in contact with electrolytes.

One issue mentioned in the research is dendrite formation. What exactly are dendrites, and why are they dangerous for batteries?

Dendrites are needle-like Zn microstructures that grow on the anode during charging due to uncontrolled metal deposition, particularly under fast charging conditions. In AZIBs, the anode and cathode are physically separated by a porous membrane called a separator, which serves as a container for electrolyte, makes contacts, and regulates the ion transport and electric field distribution, preventing a short circuit between the electrodes and ensuring the efficient battery operation. During fast charging, rapid nucleation creates uneven deposition of Zn and tips of the uneven surface act as a charge collector for further growth, resulting a 2D dendrite (tree-like structure) growth that penetrates the separator, causing internal short circuits and battery failure, and sometimes it may even lead to thermal runaway and fire risks. A micro-short circuit is also possible from dendrites, which impairs the stable battery performance. Secondly, dendrites are not tightly bound to the Zn anode, and thus, during stripping, it can be detached and float in the form of isolated islands in the electrolyte, which results in "dead" metal deposits. This "dead" Zn may not take part in electrochemical reactions, causing capacity loss. Thirdly, owing to a higher specific surface area than a planar homogeneous Zn deposit, dendrites promote unwanted side reactions, making an unstable battery. However, the main factors of dendrite formation are concentration gradient and electric field. The onset of dendrite formation is likely related to the uneven contour of the Zn anode surface, where tiny protrusions induce the formation of tips by altering the local electric field distribution; a higher electric field and increased charge density in the tip region attract more Zn2+ ions to be preferentially deposited, leading to self-propelled rampant dendritic growth. Due to this uncontrolled nucleation and growth, local ion concentration gradients change, and large ion depletion restricts homogeneous ion diffusion and enhances

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dendritic growth.

How do these molecular additives help prevent corrosion and unwanted reactions in the battery?

Molecular materials having polar functional groups such as hydroxyl, carboxylate, amide, sulphonic acid, etc can chemically adsorb onto the Zn anode surface, blocking direct contact between water molecules and the anode. This surface adsorption forms a protective, water-repelling film on the Zn surface, reducing water activity at the electrode-electrolyte interface and thereby preventing corrosion, HER, and unwanted side reactions. Electrode surfaces coated with porous covalent organic frameworks (COFs) perform well, as porous COFs facilitate Zn2+ diffusion, lower charge-transfer resistance, and promote efficient desolvation by interacting with Zn2+ ion, resulting in smooth and stable plating/stripping. The carbonized coating is found to improve surface wettability and acts as an effective barrier against HER and corrosion, significantly enhancing cycling stability. While inorganic layers offer mechanical strength and stability, organic coatings provide flexibility and chemical tunability, and each alone faces inherent trade-offs. However, coating with hybrid materials is synergistically beneficial, as it combines the functional tunability of organic components with the structural stability of inorganic frameworks. Thus, by leveraging the complementary strengths of MOFs, polymers, and inorganic components, organic-inorganic hybrid coatings can offer uniform Zn2+ flux with reduced dendrite formation while providing mechanical and chemical resilience under long cycling. Furthermore, a solid electrolyte interphase (SEI) layer is formed from the decomposition of molecular additives, metal salts and solvent onto the anode surface and protects it from corrosion, thereby providing a stable electrode.

If this technology improves, where could we see these zinc batteries being used in real life? For example in renewable energy or electric devices?

The development of electrochemical energy storage, in particular, aqueous batteries, is a pressing need for providing clean and sustainable energy to societal resilience. For example, lead-acid batteries, in which aqueous H2SO4 is used as the electrolyte, have still been being used in many power sources, including starting-lighting-ignition in vehicles and household power storage for last 160 years, although they have several limitations such as low energy density (30-40 Wh kg-1), low cycle life, and toxic materials for the environment. AZIBs have unparalleled advantages over lead acid batteries, liquid flow batteries, and other aqueous metal ions (Na+, K+, Mg2+, Ca2+, and Al3+) batteries for large-scale energy storage. Advantages of AZIBs mainly stem from the Earth's natural abundancy (around 300 times than that of Li), a highly safe aqueous-based electrolyte, and the beneficial features of non-toxic Zn metal such as high theoretical capacity of 820 mAh g-1, low redox potential (-0.76 V vs standard hydrogen electrode), and high stability in the humid and oxygen atmosphere. In the context of the sustainable energy landscape, intermittent renewable energy such as solar and wind energy are good options to store; however, these are weather dependent, e.g., wind performs well when solar does not, thus combining both could provide steadier power curves, requiring grid-scale energy storage that can bridge the gaps and supply when needed. AZIBs could be the ideal technology for grid-scale energy storage and also for wearable and flexible electrochemical energy storage devices.

Finally, what are the next big challenges or research directions scientists are working on to make zinc batteries practical for the future?

Despite the tremendous development in enhancing the AZIBs' performance in the last couple of years, as evidenced by a plethora of publications and patents, the AZIB is not ready for practical application due to several reasons such as low energy density (30 Wh kg-1), which has to be greater than 200 Wh kg-1; poor cycle life (required: 5000 cycles at both low and high current rates: 0.2 – 2C), low Coulombic efficiency (required: over 99.99%); self-discharge rate (minimizing to less than 1% / day); low capacity retention (should be more than 80%); and operating temperature (range: -30 to 50 ºC). These problems originate from various components of AZIBs, such as stability and capacity of cathode, Zn anode stability, separators, and most importantly electrolytes. Holistic development of all parts can only mitigate all issues simultaneously as all parts work synergistically like interconnected gears. For example, ideal electrolyte additives can propel both cathode and anode by offering

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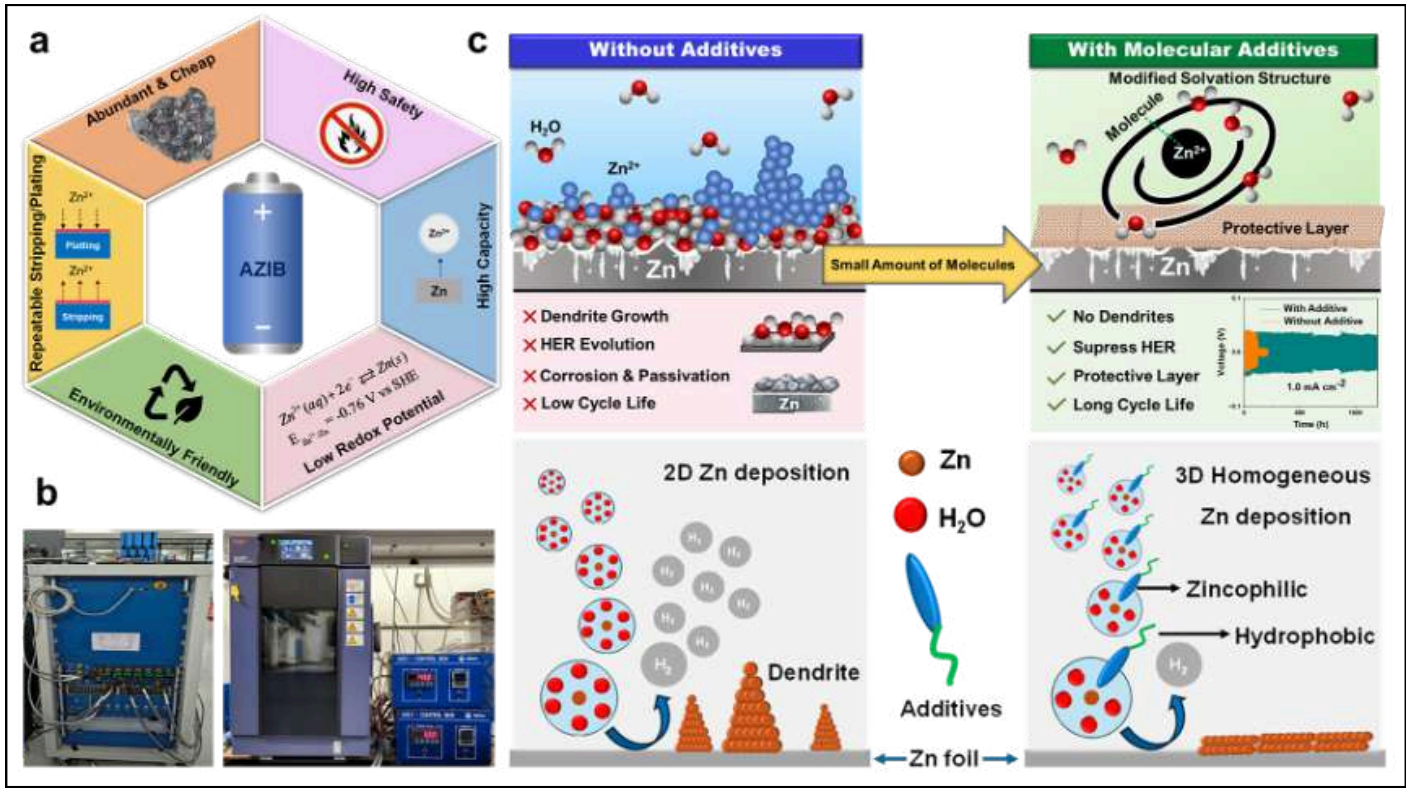

Figure 1. (a) Advantages of aqueous zinc-ion batteries (AZIBs), (b) Batteries tester at ambient temperature (left) and at variable temperatures (right), (c) Schematics depicting the effect of molecular additives on the performance of AZIBs.

multiple functionalities such as stable electrode-electrolyte interface, interphase formation, preventing corrosion, HER, side reactions, and dendrite formation; modify solvation structure, ion transport, desolvation kinetics, and Zn deposition; and enhancing Zn/Zn2+ reversibility and capacity. Notably, it is highly imperative to focus on increasing the Coulombic efficiency of the Zn anode while applying for grid-scale energy storage. The unveiling of new multifunctional additives could be possible by utilizing machine learning (ML) coupled with generative artificial intelligence (AI), which can substantially expedite the process by minimizing trial-and -error-based experiments. Furthermore, a deep dive into understanding the charge storage and capacity fading mechanisms is extremely important through advanced characterization techniques like combinations of in situ cryo-EM, cryo-XPS, and electrochemical quartz crystal microbalance (EQCM). Additionally, since it is a new technology evolving very rapidly, the standard protocols for large-scale production have not yet been established, particularly critical parameters such as depth of discharge (DOD), state of charge (SOC), self-discharge, calendar life, loading of active mass, N/P (capacity ratio of negative to negative to positive electrode) ratio, and current density. Moreover, cost-effectiveness is of paramount importance for grid-scale energy storage, determining the viability of large-scale deployment. Finally, in light of sustainability, battery recycling possibility should be taken into account as well as biodegradable and ecofriendly materials should be prioritized as energy materials for making a circular economy with reduced environmental impact.

Dr. Bhunia's contributions to this field are reflected in the publication in Small (2026), titled "Enhancement of Zn/Zn^{2+} Reversibility Using Molecular Materials in Aqueous Zinc-Ion Batteries" (DOI: 10.1002/smll.202513372). This study provides important insights into improving the reversibility and performance of aqueous zinc-ion batteries through the use of molecular materials.

| SCIENCE DESK |

SCREENING TO DETECT THE NEED FOR EARLY INTERVENTION IN INFANTS

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Areas of Expertise: Cognition & Neurorehabilitation | Stroke & Motor Recovery| Sensory Processing & ADHD |Geriatrics & Fall Prevention

What does "screening for early intervention in infants" mean in simple words?

"Screening for early intervention in infants" means checking babies for signs of developmental delays or disabilities, like autism or cerebral palsy. This is usually done for babies from the age group of about 4 months to 18 months. A child with developmental delay might be slow in completing all his expected activities and milestones like rolling, head control, sitting independently, grasping toys, reaching out for things that catch their attention, pulling on to furniture to stand up etc. The delay might also include their social behaviour, their communication, the way they understand their surroundings as well. The goal is to catch issues early and provide treatment, therapies or support to help them develop and growth in an age-appropriate way.

Why is it important to check a baby's development during the first few months or years of life?

It is very important to monitor a baby's development during the first few months and years of life. Early screening helps in identifying any developmental concerns, such as autism, cerebral palsy, hearing loss, or cognitive delays, especially when a baby is not showing age-appropriate behaviors. Detecting these issues early allows for timely intervention, ensuring that the child receives the necessary treatment and support as soon as possible. Early intervention plays a crucial role in improving the child's ability to develop brain function, language, and motor skills, ultimately enhancing their quality of life and independence. Additionally, it helps reduce stress for parents and caregivers by providing guidance and practical strategies to support the child's development at home as they grow.

What are some early signs that a baby might need extra support or medical attention?

Certain early signs may indicate that a baby needs extra support or medical attention, and timely screening can help identify potential health or developmental issues. These include a lack of physical milestones, such as not attempting to roll over by 4–5 months, not sitting independently by 7–8 months, or not standing or walking by 18 months. Delays in motor control, such as poor head control by 6 months, can also be a concern. In addition, limited response to sounds, absence of vocalization by 6–8 months, or lack of gestures like pointing by 12 months may indicate communication delays. Social signs, such as poor eye contact, lack of interaction, or unusual behaviors like aggression, agitation, or repetitive actions such as hand flapping, may also suggest the need for further evaluation. Identifying these signs early allows for appropriate intervention and support, improving the child's developmental outcomes.

At what age should infants be screened for developmental or health problems?

Infants should be screened for developmental and health problems at specific stages to ensure early identification and support. General developmental screening is typically recommended between 4 and 10 months of age, while screening for Autism Spectrum Disorder (ASD) is usually conducted between 18 and 24 months. In addition, regular paediatric check-ups at key milestones such as 1, 2, 4, 6, 9, and 12 months provide important opportunities to monitor a child's growth and development and identify any concerns early.

What kinds of tests or observations do doctors use to screen infants?

Doctors use a combination of tests and observations to effectively screen infants for developmental and health concerns. These include standardized developmental screening tools such as questionnaires like the Ages & Stages Questionnaire (ASQ) and the Parents' Evaluation of Developmental Status (PEDS). Physical examinations are also conducted to assess reflexes, muscle tone, and overall growth. In addition, hearing tests such as Otoacoustic Emissions (OAE) and Auditory Brainstem Response (ABR) are used to evaluate auditory function, while vision checks help assess eye movement and response to visual stimuli. Parental input is also important, as caregivers provide valuable insights into the baby's behavior and developmental milestones.

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If a problem is detected early, what types of help or treatments are available for the child?

If a developmental or health problem is detected early, a range of interventions can be used depending on the specific condition. These may include therapies such as speech, occupational, physical, or behavioral therapy tailored to the child's needs. Early Intervention Programs (EIPs) provide structured and personalized support during the early years to promote better development and quality of life. In some cases, medications may be prescribed to manage conditions such as seizures or ADHD, while surgical interventions may be recommended if required. Additionally, special education services and Individualized Education Plans (IEPs) can offer customized learning support in group or individual settings based on what best suits the child's growth. Family support, including counseling, resources, and guidance, also plays a crucial role in helping caregivers effectively support the child's development.

How can parents at home notice if their baby's development is delayed?

As mentioned earlier, babies are expected to achieve certain developmental milestones at specific ages, and delays in these milestones may indicate the need for assessment. Parents should be attentive to signs such as the baby not attempting to roll over by 4–5 months, not responding to sounds, or not making any vocal sounds by 6–8 months. Concerns may also arise if the baby is unable to sit independently by 7–8 months or lacks head control by 6 months. Social and communication delays, such as poor eye contact, lack of interaction, or not pointing or gesturing by 12 months, are also important indicators. Additionally, if a child is not standing or walking by 18 months, shows aggressive or agitated behavior when interacting with peers, displays repetitive actions like hand flapping, or does not show curiosity about their surroundings, it may be advisable to seek a professional evaluation.

What advice would you give to parents about supporting healthy growth and development in their babies?

There are several simple yet effective ways parents can support healthy growth and development in their babies. Regular interaction, such as talking, reading, and responding to a baby's cooing and babbling, helps build communication skills. Encouraging play and exploration by providing a stimulating and interactive environment supports cognitive and sensory development. Physical activity, including tummy time and movement-based play, helps strengthen muscles and coordination. Establishing healthy habits, such as a balanced diet appropriate for the child's age, adequate sleep, and a consistent routine, contributes to overall well-being and brain development. Most importantly, providing love, care, and emotional support helps build strong bonding and a sense of security, which are essential for a child's development.

Can early intervention really change a child's future development and learning ability?

Early intervention can make a significant difference in a child's growth, development, and overall recovery trajectory. Research shows that timely support can enhance cognitive abilities, helping children improve problem-solving and learning skills. It also strengthens social development by improving communication and the ability to build healthy relationships. In addition, early intervention supports emotional growth, enabling children to better cope with challenges, reduce anxiety, and manage stress. Over time, these benefits contribute to increased independence, boosting self-confidence and allowing children to function more autonomously in their daily lives.

What message would you like to give to parents about the importance of early screening and timely support for infants?

Early screening and providing early intervention as a result can help your child recover at a faster pace with minimal disabilities. Do not wait too long to screen your baby if you doubt there is something wrong or different about them. If you catch the issue early, the baby has the chance to recover live their full potential like any other healthy child. You are their biggest advocate and support, so trust your instincts and reach out for help whenever you need it. Your baby's future is worth it!

| SCIENCE DESK |

TURNING SUGAR INTO A SUSTAINABLE SOLUTION FOR WATER PURIFICATION

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| Scientific Profile |
| Organization Link |

Areas of Expertise: Sustainable Catalysis | CO_2 Reduction & Conversion | Waste-Derived Nanomaterials | Water Treatment & Remediation

What problem were you trying to solve with this research? Why is pollution from medicines and chemicals in water a concern today?

In this work, we wanted to address a very practical problem: the growing presence of pharmaceutical and industrial organic contaminants in water. Medicines and related chemicals reach rivers, lakes, and wastewater streams through human excretion, improper disposal, hospital discharge, and industrial effluents. Even when present at low concentrations, these compounds can persist in the environment, affect aquatic organisms, reduce water quality, and raise concerns for long-term human and ecosystem health. Our goal was therefore to develop a simple, low-cost, and sustainable material that could remove such pollutants efficiently from water.

Your study uses something very interesting sugar and a traditional clay pot. How did you get the idea to use such simple materials for making an advanced scientific material?

The idea came from a sustainability-driven research approach. In many cases, advanced materials are made using expensive precursors, specialized reactors, and complicated processing steps, which can limit large-scale use. We wanted to explore whether a high-performance adsorbent could be prepared from something inexpensive, widely available, and familiar. Sugar is a rich carbon source, and a traditional clay pot is a simple, heat-resistant vessel that can support carbonization in a low-cost way. In that sense, the study was also an attempt to connect indigenous materials and practical scientific innovation.

Can you explain in simple words what a carbon aerogel is and why it is useful for cleaning polluted water?

A carbon aerogel can be thought of as an extremely light, sponge-like carbon material filled with a very large number of tiny pores. Because of this porous structure, it has a very high surface area, which means there are many places where pollutant molecules can attach. This makes it especially useful for water purification. In addition, carbon aerogels are chemically stable, lightweight, and effective for trapping different kinds of organic contaminants.

How exactly do you make this material from sugar? Could you briefly describe the process in a way that non-scientists can understand?

The process is surprisingly simple. First, sugar is dissolved in a small amount of water to make a concentrated syrup-like solution. This solution is then heated in a traditional clay pot at high temperature, where the sugar transforms into a lightweight black carbon framework. After cooling, the material is washed to remove any unwanted residues and then dried. The final product is a porous carbon aerogel made from a very common starting material, without the need for complicated drying methods or costly equipment.

What types of pollutants were you able to remove using this material, and why are these pollutants harmful to the environment or human health?

We tested the material against four representative organic pollutants: benzimidazole, benzotriazole, paracetamol, and acetanilide. These were chosen to represent both industrial and pharmaceutical contaminants. Such compounds are important because they can enter water bodies from domestic use, healthcare systems, and industrial activities. Once present in water, they may persist, disturb aquatic ecosystems, and contribute to broader environmental and public-health concerns, especially when contamination becomes continuous or widespread.

How does this aerogel actually capture or remove pollutants from water? What is happening at the scientific level?

At the scientific level, the aerogel works through its porous structure and surface chemistry. Its large surface area provides many active sites where pollutant molecules can be retained. Our adsorption studies showed that the process is mainly governed by electrostatic attraction and surface interactions such as pi-pi interactions between the pollutant molecules and the carbon surface. The kinetic and isotherm analyses further indicated that adsorption largely

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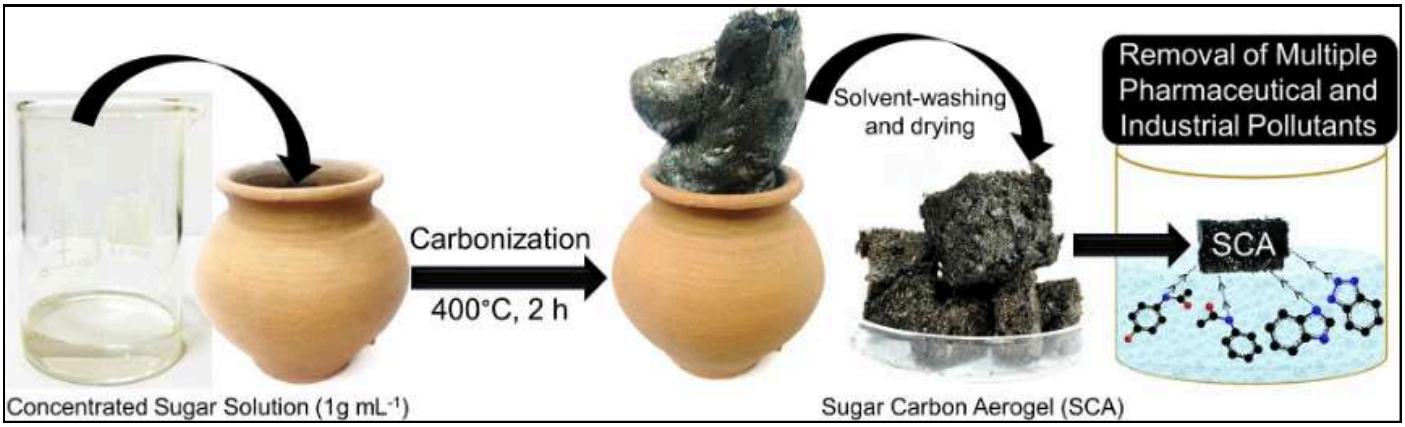

Fig. Schematic representation of the earthen-pot assisted synthesis of sugar carbon aerogel (SCA) and its application in the removal of pharmaceutical and industrial organic contaminants from water.

follows a pseudo-second-order model and the Langmuir isotherm, which suggests a strong surface-driven process with predominant monolayer adsorption.

One important question people may have is about reuse. Can this material be used multiple times, and how efficient is it after repeated use?

Yes, reusability was one of the encouraging outcomes of this study. We found that the aerogel could be regenerated and reused for up to five adsorption-desorption cycles, with only a gradual decline in performance. In our experiments, the adsorbed pollutants were removed using a mild acidic treatment, after which the material was washed, dried, and reused. This kind of recyclability is important because it improves the practical value of the material and makes it more attractive for real treatment applications.

Finally, how could this research help society in the future? Do you see this technology being used for real water treatment or environmental cleanup?

I believe this research has strong societal relevance because it shows that a useful water-treatment material can be produced from inexpensive and accessible resources. The simplicity of the synthesis makes it attractive not only from a scientific perspective but also from a practical one. With further optimization, such materials could be used in wastewater polishing, treatment of pharmaceutical and industrial effluents, and decentralized water-cleaning systems. Since the material also performed well in spiked and real wastewater samples, the study provides a promising proof-of-concept for future environmental cleanup technologies.

Dr. Kaushik's contributions to this field are reflected in the recent publication in Langmuir (2026), titled "Earthen-Pot Assisted Carbon Aerogel Synthesis for the Adsorption of Multiple Organic Contaminants" (DOI: 10.1021/acs.langmuir.5c05991). This study presents an innovative and sustainable approach for synthesizing carbon aerogels using an earthen-pot-assisted method, demonstrating their effectiveness in adsorbing a wide range of organic contaminants and advancing low-cost solutions for environmental remediation.

| SCIENCE DESK |

TINY MATERIALS POWERING TOMORROW'S ENERGY AND ELECTRONICS

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| Scientific Profile |
| Organization Link |
Areas of Expertise: Nanocomposites & Dielectrics | Energy Storage Materials | Photocatalysis | Sustainable Materials

What inspired you to study these tiny materials, and why are they important for future technologies?

My interest in these materials comes from a broader curiosity about how materials behave at extremely small scales. When materials are reduced to the nanoscale, their properties can change in remarkable ways compared to their bulk counterparts. These differences often create opportunities for new scientific discoveries and technological innovations. Transition metal chalcogenides are particularly exciting because they combine a unique layered structure with tunable electrical, optical, and chemical properties. Researchers around the world are studying them to develop improved energy storage systems, efficient catalysts for clean energy production, and advanced electronic devices. By understanding how their structure influences their properties, we can design materials that perform better and are more sustainable for future technologies.

In simple terms, what are transition metal chalcogenides, and what makes them special compared to other materials?

Transition metal chalcogenides are compounds formed by combining a transition metal element, such as molybdenum, tungsten, titanium, or vanadium, with a chalcogen element like sulfur, selenium, or tellurium. One of the most distinctive features of these materials is their layered crystal structure. Each layer consists of a transition metal atom sandwiched between two chalcogen atoms, forming a stable sheet only a few atoms thick. These sheets stack together to form the bulk material, but the forces holding the layers together are relatively weak. Because of this structure, scientists can isolate individual layers, creating 2D materials like graphene. These ultrathin layers exhibit fascinating properties such as tunable semiconducting behavior, strong catalytic activity, and unique optical responses. These characteristics make transition metal chalcogenides highly attractive for a wide range of scientific and technological applications.

Your research focuses on very thin materials. Why does making materials thinner change their properties?

When materials become extremely thin, sometimes only one or a few atomic layers thick, their physical behavior changes significantly. At this scale, the movement of electrons and the interactions between atoms are strongly influenced by quantum mechanical effects. Another important factor is surface area. In very thin materials, a larger proportion of atoms is located at or near the surface This increases the number of active sites available for chemical reactions, which is especially useful for catalytic applications. Also, the electronic structure of the material can change as the number of layers decreases. For example, some transition metal dichalcogenides shift from indirect to direct bandgap semiconductors when reduced to a single layer, which greatly enhances their optical and electronic performance. These changes make ultrathin materials extremely valuable for nanotechnology.

How can these tiny materials help improve energy technologies like batteries or hydrogen production?

Transition metal chalcogenides are being widely explored for their potential in energy-related applications. In battery technologies, their layered structure allows ions such as lithium, sodium, or zinc to move efficiently between layers. This property can improve energy storage capacity and enable faster charging and discharging processes. Researchers are also investigating their stability and conductivity to design better electrode materials. In hydrogen production, these materials can function as catalysts for the hydrogen evolution reaction during water splitting. Catalysts help accelerate chemical reactions, and certain transition metal chalcogenides have demonstrated strong catalytic activity while being significantly less expensive than traditional noble-metal catalysts like platinum. This makes them promising materials for large-scale renewable hydrogen generation.

Can these materials help make electronic devices smaller, faster, or more efficient? If yes, how?

Yes, these materials have strong potential to transform modern electronics. Because transition metal chalcogenides can be fabricated as atomically thin layers, they allow engineers to design electronic components at extremely small dimensions. Their semiconducting properties make them particularly attractive for building next-generation transistors, which are the fundamental components of

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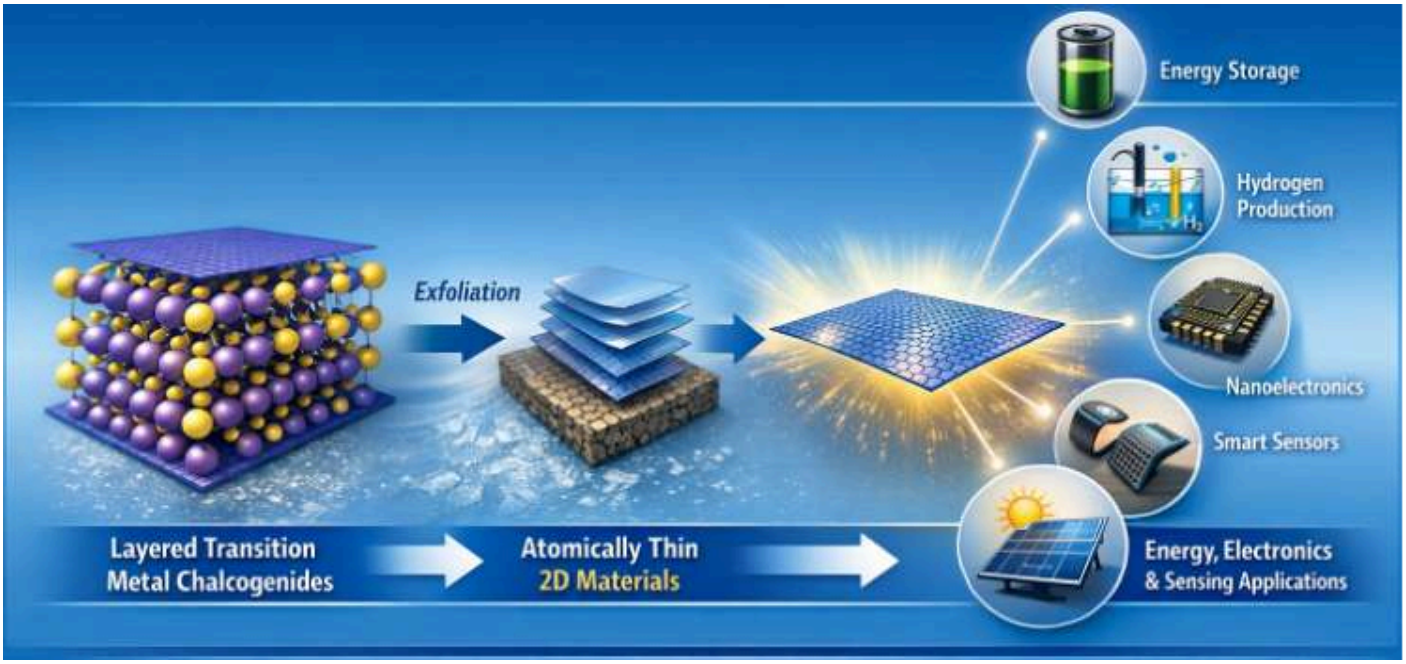

electronic circuits. In addition, their flexibility allows them to be integrated into bendable or wearable electronic devices. Also, their optical and electronic properties enable applications in photodetectors, light-emitting devices, and advanced sensors. As research is progressing, these materials could help create electronic systems that are both more powerful and more energy efficient.

What are some real-world applications where we might see these materials used in the future?

In the future, transition metal chalcogenides could play an important role in several advanced technologies. They may be used in high-performance batteries and supercapacitors that store energy more efficiently. They could also serve as catalysts for hydrogen production and other clean energy processes. In electronics, they may enable flexible devices, transparent circuits, and highly sensitive sensors. In addition, their optical properties make them promising materials for photodetectors and next-generation optoelectronic devices. As research and engineering efforts continue, these materials may gradually move from laboratory studies to commercial technologies.

What are the biggest challenges scientists face when developing and using these advanced materials?

Despite their exciting potential, several scientific and engineering challenges remain. One major challenge is producing these materials in large quantities with consistent quality and controlled thickness. Many current synthesis methods are suitable for laboratory research but need further development for industrial-scale manufacturing. Another challenge is controlling structural defects and variations in composition, which can strongly influence the performance of the material. Researchers across the globe are also working on improving the stability of these materials and integrating them effectively into real devices. Addressing these challenges requires collaboration between chemists, materials scientists, physicists, and engineers.

What exciting discoveries or technologies do you expect to see in this field over the next 10 years?

Over the next decade, the field of 2D materials is likely to grow rapidly. We can expect significant progress in both fundamental understanding and practical applications. Researchers may develop highly efficient catalysts for green hydrogen production, advanced battery materials with higher energy density, and flexible electronics integrated into everyday devices such as wearable health monitors. We may also see breakthroughs in nanoscale sensors and optoelectronic technologies. As our ability to control materials at the atomic level improves, these tiny materials could become key components in future energy systems and electronic technologies.

Dr. Jaidka's contributions to this field are reflected in the publication in Small (2026), titled "Structure–Property–Application Correlations of Early Transition Metal Chalcogenides: A Dichalcogenide-Centered Perspective" (DOI: 10.1002/smll.202508246).

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Answers here – don't peek!

Q1

What is the main purpose of antibacterial coatings on medical devices?

A. Improve color
B. Prevent infections
C. Increase weight
D. Store energy

Q2

What disease is COPD related to?

A. Brain
B. Lung
C. Heart
D. Bone

Q3

What do intelligent reflecting surfaces control?

A. Heat
B. Sound only
C. Direction of waves
D. Water flow

Q4

Where can metasurfaces be useful?

A. Cooking
B. Communication systems
C. Painting
D. Farming

Q5

Why is FeS_2 important in solar cells?

A. Reflects light
B. Absorbs sunlight well
C. Blocks energy
D. Produces sound

Q6

What is the main role of nanocomposites in cancer therapy?

A. Change DNA
B. Deliver drugs safely
C. Stop breathing
D. Increase heat

Q7

What is a major issue in zinc-ion batteries?

A. Heat loss
B. Dendrite formation
C. Color change
D. Weight increase

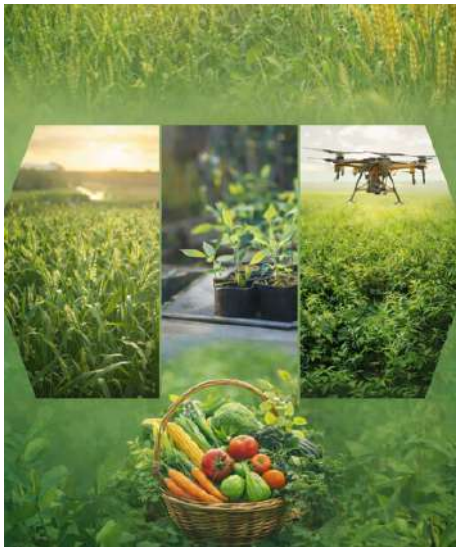
Q8

Why is arsenic detection important?

A. Improves taste of water
B. Prevents water contamination health risks
C. Changes color
D. Adds minerals

DISCOVERY HIGHLIGHTS

PLANT SCIENCE, CROP INNOVATION & FOOD SECURITY



A TINY GENE WITH A BIG ROLE IN RICE GROWTH AND YIELD

Rice yield depends on plant traits such as plant height, number of tillers (side shoots), and number of seeds. Scientists have discovered a gene called KRP3 that plays an important role in controlling these traits in rice plants. The study showed that when the KRP3 protein changes or becomes unstable, rice plants grow differently. Their height, number of tillers, and seed production are affected. This means KRP3 helps maintain healthy plant growth and good productivity. Researchers also found that another protein called MPK3 protects KRP3 by adding a small chemical tag through a process known as phosphorylation. When this tag is present, KRP3 stays stable. Without it, the protein is quickly destroyed inside the cell. By controlling how fast cells divide and grow, the MPK3–KRP3 system helps shape rice plant structure and grain yield.

Banerjee G. et al., Plant Biotechnology Journal, 2026.

HOW PLANTS SENSE WARM TEMPERATURES TO GROW

As global temperatures rise, plants must adjust their growth to survive. Understanding how plants sense and respond to heat is important for developing crops that can tolerate climate change. In a recent study, scientists discovered that special proteins called LRB E3 ubiquitin ligases help plants respond to warm temperatures in Arabidopsis, a model plant used in plant research. These proteins act like molecular managers that control the stability of other important growth proteins. The researchers found that LRB proteins maintain the right amount of a growth-promoting protein called PIF4, which helps plants elongate and grow in warmer conditions. At the same time, LRB proteins remove another protein called HY5, which normally slows down growth. By balancing these two proteins, LRBs help plants adjust their growth when temperatures increase. §This discovery reveals an important mechanism plants use to sense heat and adapt their growth, which could help scientists develop crops that grow better in a warming climate.

Singhal C. et al., Science Advances, 2026.

NANOTECHNOLOGY, FUNCTIONAL MATERIALS & MOLECULAR ENGINEERING

HIDDEN TOXICITY OF MICROPLASTIC–NANOMATERIAL HYBRIDS

Microplastics are now widely found in water, soil, and even inside living organisms. Scientists are increasingly concerned about how these tiny plastic particles interact with other materials in the environment. In a recent study, researchers discovered that when microplastics combine with graphene oxide, a commonly used nanomaterial, they form a hybrid particle that can be more harmful to cells. The scientists tested this hybrid using macrophages, important immune cells that protect the body from harmful substances. The results showed that the graphene oxide–microplastic hybrid strongly attached to the cells and entered them, reducing cell survival. Compared with microplastics or graphene oxide alone, the hybrid caused greater cell damage, fat accumulation, mitochondrial stress, and programmed cell death (apoptosis). Computer simulations also showed that these particles interact with important cellular proteins involved in oxidative stress and cell survival. This research highlights the potential health risks of microplastic–nanomaterial combinations and stresses the need for careful environmental monitoring.

Sinha A. et al., Materials Today Bio, 2026.

DISCOVERY HIGHLIGHTS

NANOMATERIAL SHOWS POWERFUL ABILITY TO CONVERT HEAT INTO ELECTRICITY

Turning waste heat into useful electricity is an important goal in energy research. Scientists use special materials called thermoelectrics that can convert temperature differences directly into electrical energy. However, developing materials that efficiently block heat while allowing electricity to flow remains a major challenge. In a recent study, researchers developed a nanostructured material called $Ag_{0.8}Sb_{1.2}Te_{2.2}$ using a simple solution-based synthesis method. This method produced extremely small crystal structures, only about 5–20 nanometers in size, forming unique nanoscale domains inside the material. These tiny structures scatter heat-carrying vibrations known as phonons, drastically reducing thermal conductivity to extremely low levels, similar to the way heat moves through glass. At the same time, the material maintains strong electrical properties. As a result, the material shows excellent thermoelectric performance, efficiently converting heat into electricity across a wide temperature range. This discovery could help develop new technologies for energy harvesting from waste heat in electronics, vehicles, and industrial systems.

Das A. et al., Journal of the American Chemical Society, 2026.

SMART MOLECULAR SYSTEMS & OPTICAL MATERIALS

NEW FLUORESCENT NANOCARRIER ENABLES REAL-TIME TRACKING OF GENE THERAPY

Delivering genes and RNA into cells is a key strategy in modern medicine, especially for treating diseases such as cancer. Scientists often use tiny branched molecules called dendrimers to carry these genetic materials into cells. However, most dendrimers are not fluorescent, making it difficult to track their movement during drug delivery. In a recent study, researchers developed a new type of far-red fluorescent dendrimer built around a naphthalene diimide (NDI) core. Because the dendrimer itself glows, scientists can track how genes and RNA enter and move inside cells in real time. The new NDI G3 dendrimer successfully packaged DNA, protected it from degradation, and delivered GPX4 siRNA efficiently into cells. When combined with the drug FINO2, it strongly increased the death of colon cancer cells through a process called ferroptosis. This discovery provides a promising platform for traceable gene therapy and advanced cancer treatments.

Moorthy H. et al., Materials Horizons, 2026.

NEW STUDY REVEALS SELF-ASSEMBLING NANOSTRUCTURES THAT EMIT POLARIZED LIGHT

Scientists are exploring new materials that can emit circularly polarized light, which is important for advanced technologies such as optical devices, sensors, and next-generation displays. In a recent study, researchers discovered a unique way to create light-emitting nanostructures through a process called supramolecular polymerization, where small molecules self-assemble into larger organized structures. The team studied a molecule called O-NMI-1, which gradually transformed from tiny particles into nanotapes and finally crystalline nanorods over about two days. These nanorods formed through hydrogen bonding and showed strong light emission with circular polarization, meaning the light waves rotate in a specific direction. Interestingly, the strength of this polarized light increased as the nanostructures evolved over time.The researchers also found that a small structural change in a similar molecule prevented this behavior, highlighting how tiny molecular differences control light emission. This discovery provides new insights into designing advanced light-emitting materials and supramolecular nanostructures.

Karmakar Y. D. et al., Small, 2026.

DISCOVERY HIGHLIGHTS

ENVIRONMENTAL SCIENCE, POLLUTION & SUSTAINABILITY

ANIMAL WASTE–DERIVED BIOCHAR EFFICIENTLY REMOVES ANTIBIOTIC POLLUTION FROM WATER

Antibiotic contamination in water bodies is an emerging environmental concern. Drugs such as chloramphenicol, commonly used in medicine, can enter rivers and groundwater and may affect ecosystems and human health. Finding sustainable ways to remove these pollutants from water is therefore important. Researchers developed a biochar-based nanocomposite from goat manure, transforming animal waste into a useful material for water purification. The material, known as GMBCZIF-67, has a highly porous structure with a large surface area, allowing it to effectively capture antibiotic molecules from water. Laboratory experiments showed that the material could remove up to 99.38% of chloramphenicol from contaminated water. The adsorption process occurs when antibiotic molecules attach to active sites on the material's surface. The material also worked efficiently in tap water conditions and remained effective after several reuse cycles, highlighting its potential for sustainable wastewater treatment.

Das D. et al., Bioresource Technology, 2026.

MACHINE LEARNING HELPS PREDICT HOW BIOCHAR REMOVES ANTIBIOTICS FROM WATER

Sulfonamide antibiotics are widely used in medicine and agriculture, but their presence in water bodies is becoming a growing environmental concern. These compounds persist in the environment and may contribute to the rise of antimicrobial resistance. Biochar, a carbon-rich material produced from biomass, is considered a promising adsorbent for removing such pollutants from water. Researchers used machine learning models to predict how effectively biochar can remove seven different sulfonamide antibiotics from water. By analyzing molecular properties of the antibiotics, structural features of biochar, and operating conditions, the models were able to estimate adsorption performance with very high accuracy. Among the tested models, gradient boosting showed the best performance. The analysis also revealed that biochar surface area plays the most important role in adsorption efficiency, followed by factors such as initial pollutant concentration and biochar dosage. This approach provides a faster and more efficient way to design biochar materials for wastewater treatment.

Jha D. K., Bioresource Technology, 2026.

ARTIFICIAL INTELLIGENCE & COMPUTATIONAL SYSTEMS

LIGHT-ACTIVATED WATERMARKS COULD PROTECT FUTURE ELECTRONIC CHIPS

Counterfeit electronic chips and intellectual property theft are growing problems in modern electronics. Protecting integrated circuits (ICs) from copying requires advanced security technologies. Researchers developed a neuromorphic watermarking system using special phototransistors made from two-dimensional siloxene nanosheets. These devices behave similarly to biological brain synapses and respond to ultraviolet (UV) light signals. The system creates a hidden digital watermark that can only be activated using specific UV light pulses with precise intensity, duration, and timing. Without the correct light pattern, the watermark remains locked and invisible. This multi-layer activation makes it extremely difficult for counterfeiters to copy or reverse engineer the chip. The flexible transistor design also

DISCOVERY HIGHLIGHTS

allows the technology to be integrated into wearable electronics and advanced devices. This approach introduces a new strategy for protecting electronic hardware and intellectual property in next-generation secure electronics.

Banerjee R. et al., Small, 2026.

ARTIFICIAL INTELLIGENCE ACCELERATES PREDICTION OF MOLECULAR STRUCTURES

Understanding how molecules arrange themselves into clusters is important for fields such as materials science, atmospheric chemistry, and nanotechnology. However, predicting the most stable structures of molecular clusters can be computationally expensive and time-consuming. Researchers developed a machine learning–assisted strategy called LOGOS (Local-to-Global Optimization Strategy) to speed up the prediction of molecular cluster structures. The approach uses deep learning algorithms to identify patterns in smaller molecular clusters and then predict how larger clusters may form. The model analyzes molecular electrostatic potential patterns and suggests new possible binding sites where molecules can attach. The predicted structures are then optimized to identify the most stable arrangements. When tested on carbon dioxide clusters, the method accurately reproduced known minimum-energy structures while requiring much less computational effort.This approach could help scientists design new materials and understand molecular interactions more efficiently.

Ramteke G. R. et al., Journal of Chemical Information and Modeling, 2026.

EARTH SYSTEM SCIENCE & CLIMATE DYNAMICS

MOISTURE MOVEMENTS HELP EXPLAIN SHORT-TERM CHANGES IN THE INDIAN MONSOON

The Indian summer monsoon controls rainfall for millions of people, influencing agriculture, water resources, and the economy. However, rainfall can change significantly within weeks, creating active and dry phases during the monsoon season. Researchers studied how moisture and atmospheric energy move through the atmosphere to influence rainfall patterns across India. Using long-term regional climate data from the IMDAA reanalysis (1981–2020), scientists analyzed key processes such as moist static energy, water vapor levels, and vertical air motion that affect tropical rainfall. The study found that horizontal movement of moisture and energy plays a major role in creating rainfall anomalies over central India. These processes may allow scientists to predict certain rainfall changes about 7–10 days in advance. The findings also highlight limitations in current climate models, especially in representing moisture feedback during the monsoon. This research improves understanding of monsoon dynamics and short-term rainfall prediction.

Mohan T. S. et al., Science of the Total Environment, 2026.

RISING AIR POLLUTION AND CLIMATE CHANGE RESHAPE THE INDUS–GANGES–BRAHMAPUTRA REGION

The Indus–Ganges–Brahmaputra (IGB) basin is one of the most densely populated and climate-sensitive regions in the world. Rapid urbanization, industrial growth, and land-use changes are increasing environmental pressure on this critical river system. Researchers analyzed high-resolution environmental data from 2010 to 2023 to understand how air pollution and climate variability are changing across the region. The study found a steady rise in major pollutants such as $PM_{2.5}$, sulfur dioxide, nitrogen dioxide, carbon monoxide, and ozone, indicating growing human influence. The analysis also revealed rising temperatures and changing rainfall patterns, with strong links between warming trends and increasing pollution levels. Interestingly, pollutant levels dropped sharply during the COVID-19 lockdown in 2020, highlighting the impact of human activity on air quality. These findings emphasize the need for strong environmental monitoring and policy measures to protect the health and climate stability of the IGB basin.

Banerjee A. et al., Environmental Research, 2026.

DISCOVERY HIGHLIGHTS

HYDROLOGY & GROUNDWATER SCIENCE

HIDDEN GEOLOGICAL PATTERNS INFLUENCE SAFE DRINKING WATER IN THE GANGA BASIN

Groundwater in the Ganga River basin is a major source of drinking water for millions of people in South Asia. However, many shallow aquifers contain harmful elements such as arsenic and manganese, which pose serious health risks. Understanding where safe groundwater exists is therefore crucial for public health. Researchers investigated how underground geological variations influence the presence of arsenic- and manganese-safe groundwater. By analyzing borehole data, groundwater samples, and sediment samples across different regions of the basin, the study revealed that the structure and composition of subsurface sediments strongly affect contaminant distribution. The research showed that changing redox conditions in underground layers control how iron, arsenic, and manganese move in groundwater. In some zones, overlapping chemical reactions create short "windows" where water remains safe.These findings help explain why safe and contaminated groundwater can occur very close to each other and provide important guidance for sustainable groundwater management in the Ganga basin.

Bhowmik T. et al., Science of the Total Environment, 2026.

NEW DATASET MAPS SOIL MOISTURE ACROSS INDIA FOR OVER FOUR DECADES

Soil moisture plays a crucial role in agriculture, drought monitoring, and water management, especially in monsoon-dependent countries like India. However, existing satellite observations often provide only short-term records and measure moisture only near the surface. Researchers developed a high-resolution dataset of root-zone soil moisture for India covering the period 1981–2024. The dataset was created by combining land-surface model simulations with satellite observations using machine learning techniques, particularly Random Forest regression. The system integrates information on precipitation, temperature, evapotranspiration, and soil moisture simulations to estimate moisture levels up to one meter below the ground surface. Validation tests showed strong agreement with satellite measurements and ground observations.The dataset can help scientists better understand drought patterns, agricultural productivity, and climate variability across India.

Chuphal D. S. et al., Scientific Data, 2026.

WILDLIFE ECOLOGY & CONSERVATION SCIENCE

LOCAL ECOLOGICAL KNOWLEDGE HELPS TRACK HIDDEN WILDLIFE SPECIES

Many wildlife species are difficult to observe because they are rare, nocturnal, or highly secretive. These "cryptic species," such as pangolins, are among the most threatened animals in the world due to illegal hunting and habitat loss. Scientists are increasingly exploring whether knowledge from local communities can help improve conservation efforts. Researchers studied forest-dwelling communities in Assam, India, to understand how local ecological knowledge can contribute to pangolin conservation. Through interviews with local residents, the study documented observations about species presence, habitat use, and population trends. The results showed that local people especially older community members often possess reliable knowledge about the occurrence of these hidden animals. However, the study also revealed challenges, including the persistence of illegal hunting and wildlife trade. The research highlights the

DISCOVERY HIGHLIGHTS

importance of combining scientific data with community knowledge to develop more effective conservation strategies.

Konwar A. et al., Ambio, 2026.

URBAN BIRDS REVEAL HIDDEN AIR POLLUTION IN INDIAN CITIES

Air pollution in cities releases harmful chemicals known as polycyclic aromatic hydrocarbons (PAHs). These compounds are produced during fuel burning, vehicle emissions, and industrial activities, and are known for their toxic and cancer-causing properties. However, their impact on urban wildlife is not always well understood. Researchers examined six species of birds from Ahmedabad, India, to investigate how these pollutants accumulate in urban ecosystems. Using a high-precision HPLC method, scientists measured 15 priority PAH compounds in bird tissues such as the liver, kidney, and muscles. The results showed that all 37 birds studied contained at least one PAH compound, indicating widespread exposure to pollution. Among the species, the Blue Rock Pigeon (Columba livia) showed the highest accumulation levels. Because pigeons live close to human environments, the study suggests they could serve as bioindicators of urban air pollution.These findings highlight the importance of monitoring pollution through wildlife to better understand long-term environmental risks in cities.

Nambirajan K. et al., Science of the Total Environment, 2026.

BIOMEDICAL ENGINEERING & REGENERATIVE MEDICINE

3D BIOPRINTING METHOD ALIGNS COLLAGEN FIBERS TO BUILD STRONGER ARTIFICIAL TISSUES

Creating artificial tissues that mimic the structure of natural human tissues is a major challenge in regenerative medicine. Many tissues in the body such as cartilage, cornea, and muscles have aligned collagen fibers, which give them strength and direction-specific properties. Traditional bioprinting methods often struggle to reproduce this precise alignment. Researchers developed a new step-ladder printing (SLP) technique that improves how collagen fibers align during 3D bioprinting. The method uses specially designed channels that guide the flow of collagen as it is printed, helping fibers arrange in the same direction. The printed structures showed better fiber alignment and improved tissue-like properties compared with conventional printing methods. The aligned collagen also guided the growth of cells along the same direction. Using this technique, scientists successfully created transparent corneal tissues and cartilage structures with properties similar to natural tissue.

Namil. I. et al., Small, 2026.

NANOFIBER DRESSING HELPS HEAL INFECTED BURNS BY FIGHTING BACTERIA AND INFLAMMATION

Treating burn wounds is challenging because infections and long-lasting inflammation can slow down the healing process. To address this problem, researchers developed a multifunctional nanofibrous wound dressing that can simultaneously control bacterial infection and reduce inflammation. The dressing is made using a core–shell nanofiber structure combining two polymers: polycaprolactone and chitosan. These fibers carry two drugs ciprofloxacin, an antibiotic that kills bacteria, and flurbiprofen, an anti-inflammatory medicine. The special fiber design allows the drugs to be released slowly over time, providing prolonged protection and treatment. Laboratory tests showed strong antibacterial activity against Staphylococcus aureus and Escherichia coli, along with good compatibility with human skin cells. In animal studies, the dressing significantly improved healing of infected burns by promoting skin regeneration, blood vessel formation, and collagen recovery. This nanofiber dressing offers a promising approach for advanced burn wound treatment.

Kamboj M. et al., Biomaterials Science, 2026.

DISCOVERY HIGHLIGHTS

SMART MATERIALS, SOFT ROBOTICS & RESPONSIVE SYSTEMS

SOFT MATERIAL COMBINES SHAPE-SHIFTING AND SELF-PROPELLING MOTION

In nature, many organisms can both change shape and move on their own to adapt to changing environments. Creating synthetic materials that can perform both functions has been difficult because the mechanisms required for motion and shape change often conflict with each other. Researchers developed a soft composite material called BALCEH, which combines a liquid crystal elastomer with a hydrogel network. This unique structure allows the material to change shape in response to different stimuli such as humidity, temperature, or solvents. At the same time, the material can move across liquid surfaces through solvent-driven Marangoni propulsion, where differences in surface tension generate motion. By adjusting the fuel composition and geometry, scientists can even control the direction of movement. The material also shows switchable surface properties, becoming either water-repelling or oil-repelling depending on its structure. This multifunctional design could enable next-generation soft robots and adaptive smart materials.

Giri P. et al., Nature Communications, 2026.

LIGHT-DRIVEN BIONIC ROBOTS BUILT FROM ADVANCED NANOMATERIALS

Soft robots inspired by living organisms are attracting attention because they can move, bend, and adapt to complex environments. However, creating materials that respond quickly and efficiently to external signals remains a major challenge. Researchers developed a photoresponsive hybrid material made from tellurium nanoparticles, molybdenum disulfide (MoS_2), and graphene. When exposed to near-infrared (NIR) light, the material rapidly converts light into heat, reaching temperatures of about 85 °C within seconds. This heating triggers fast bending and movement in the soft structure. Using this system, scientists built a bionic soft robot shaped like a dragonfly, capable of controlled wing movement and flexible bending when illuminated. The hybrid material showed strong photothermal conversion and rapid response, enabling wireless actuation without physical connections. The study demonstrates how nanomaterial hybrid structures can power light-controlled soft robots, opening possibilities for future soft robotics, bioelectronics, and intelligent machines.

Salian R. D. et al., ACS Applied Materials & Interfaces, 2026.

NANOGENERATOR FOR SELF-POWERED SMART SYSTEMS

Smart materials that can generate energy and sense touch at the same time are becoming important for next-generation electronics and soft robotic systems. However, designing devices that are flexible, efficient, and durable especially in harsh conditions like water remains a challenge. Researchers developed a 3D-printedflexible triboelectric nanogenerator (3D-NPTENG)using a double piezoelectric composite made of $NaNbO_3$ and PVDF-HFP. The device combines piezoelectric and triboelectric effects to convert mechanical energy, such as finger tapping, into electrical energy. The 3D-printing approach allows a scalable, cost-effective, and poling-free fabrication process. The system shows high performance, generating up to 228 V output voltage and a power density of 1.5 W/m^2, with a fast response time of 7 ms. It also demonstrates strong sensitivity to pressure and long-term durability, maintaining stable performance over 7000 cycles, even under continuous mechanical stress. Importantly, the material is waterproof, enabling operation in both terrestrial and underwater environments. This work highlights how advanced 3D-printed smart materials can enable energy harvesting, sensing, and human–machine interaction (HMI) in a single system, opening new possibilities for wearable electronics, soft robotics, and intelligent devices.

Sarkar D. et al., Advanced Materials Technologies, 2026.

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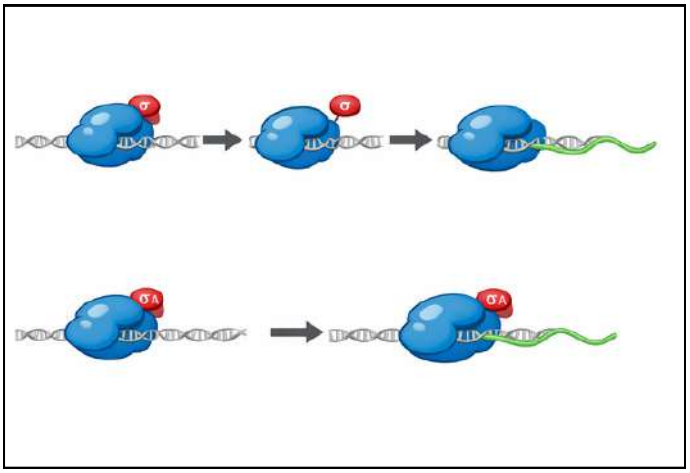


Indian Scientists Challenge a 50-Year-Old Rule of Bacterial Gene Regulation

For nearly five decades, biology textbooks have explained bacterial gene regulation using the σ (sigma) cycle. According to this model, sigma factors bind to RNA polymerase to start transcription and then detach once RNA synthesis begins. This idea was largely based on studies of the bacterium Escherichia coli. A new study by researchers from the Bose Institute (India) and Rutgers University (USA) has now challenged this long-accepted rule. Their research, published in Proceedings of the National Academy of Sciences (PNAS), shows that in the bacterium Bacillus subtilis, the sigma factor σA remains attached to RNA polymerase throughout the transcription process instead of detaching. Using modern techniques such as biochemical assays, chromatin immunoprecipitation, and fluorescence imaging, scientists observed sigma factor behavior in real time. The results suggest that the traditional sigma cycle is not universal for all bacteria. This discovery could improve our understanding of bacterial gene regulation, potentially helping scientists develop new antibiotics and engineered microbes for biofuels, biodegradable plastics, and therapeutic compounds.

Tewary, A., Sengupta, S., Mukherjee, S., Hazra, N., Ebright, Y.W., Ebright, R.H., & Mukhopadhyay, J. (2026). Study on sigma factor dynamics in bacterial transcription. Proceedings of the National Academy of Sciences (PNAS). https://doi.org/10.1073/pnas.2503801122

India Launches Indigenous 30 kW Integrated Drive System for Electric Vehicles

India has launched an indigenously developed 30 kW Wide Band Gap (WBG)-based Integrated Drive System (IDS) to support the growth of electric vehicles (EVs). It was developed by C-DAC Thiruvananthapuram in collaboration with IIT Madras and Lucas TVS under the National Mission on Power Electronics Technology (NaMPET).The new system combines the electric motor and inverter into a single compact unit, improving efficiency and power density compared to traditional EV drive systems. The 30 kW system is suitable for electric passenger vehicles, including compact cars and fleet mobility services.Developing this technology in India will reduce import dependence, lower costs, and strengthen the domestic EV supply chain, while also creating opportunities for MSMEs in power electronics manufacturing. The system has been successfully tested and is now ready for commercialization and large-scale deployment, supporting India's vision of Aatmanirbhar Bharat in electric mobility.

Press Information Bureau (PIB), Government of India. MeitY Launches 30 kW Wide Band Gap (WBG)–Based Integrated Drive System to Boost Electric Vehicle Adoption, 2 March 2026.

SCIENCE IN FOCUS

Rapid Diagnostic Kit Developed in India to Detect Childhood Diarrhea

The Technology Development Board (TDB) under the Department of Science and Technology (DST), Government of India, has supported BabyCue Private Limited, Cuttack (Odisha) to develop a rapid diagnostic platform for childhood diarrhea. The project focuses on commercializing an indigenous product called the DiaCue Diagnostic Kit, which can quickly distinguish between bacterial and non-bacterial diarrhea in children. The DiaCue kit uses Lateral Flow Assay (LFA) technology combined with gold nanoparticle based color detection. A small stool sample is mixed with a buffer and applied to a test strip. Within minutes, visible colored lines appear on the strip, indicating whether the infection is bacterial or non-bacterial. This simple and low-cost diagnostic system can be used in rural clinics and field settings without requiring advanced laboratory equipment. The technology was developed with support from NIPER Hyderabad and clinically validated at ESIC Hospital Hyderabad. The innovation aims to improve early diagnosis, reduce unnecessary antibiotic use, and strengthen primary healthcare in India.

Press Information Bureau (PIB), Government of India. TDB-DST Supports BabyCue Pvt. Ltd. for Development of Rapid Diagnostic Platform for Childhood Diarrhea, 9 March 2026.

Magnetic Nanosheets Offer a New Path for Efficient Hydrogen Energy

Scientists in India have developed a new nanomaterial that could help improve clean hydrogen energy production. A research team from the Institute of Nano Science and Technology (INST), Mohali, an autonomous institute of the Department of Science and Technology (DST), created quasi-2D tellurium (α-Te) nanosheets with unique magnetic properties. When bulk tellurium is converted into ultra-thin nanosheets, the surface reveals unpaired electron spins that generate an emergent ferromagnetic state. This unusual magnetic behavior can be controlled through strain and electric fields. The material also shows strong coupling between magnetism and ferroelectricity, producing a powerful magnetoelectric effect. Researchers found that this property can significantly improve the hydrogen evolution reaction (HER), a key process in water electrolysis used for producing green hydrogen. By lowering the required voltage and speeding up the reaction, the nanosheets could help make hydrogen production more energy-efficient.The study connects spintronics, nanoelectronics, and green hydrogen technologies, offering potential applications in energy systems, smart sensors, and next-generation electronic devices.

Mandal D. & Saini D., Advanced Materials, 2026; Press Information Bureau (PIB), Government of India, 10 March 2026.

| SCIENCE IN FOCUS |

SCIENCE IN FOCUS

AI-Powered Smart Yoga Mat Receives Government Support for Commercialization

The Technology Development Board (TDB) under the Department of Science and Technology (DST), Government of India, has provided financial support to Wellnesys Technologies Pvt. Ltd., Bengaluru, to commercialize its innovative product, the YogiFi Smart Yoga Mat. The project, titled "YogiFi Smart Sensor Fabric Mat Commercialization with Autonomous and Self-Reliant Systems," aims to scale up indigenous manufacturing of an AI-powered wellness technology developed in India. The YogiFi Smart Yoga Mat integrates advanced sensors with artificial intelligence to monitor yoga postures in real time. Through a connected mobile application, users receive instant posture feedback, guided yoga sessions, and detailed performance analytics. By combining modern digital technology with the traditional practice of yoga, the system promotes preventive healthcare and digital wellness. The initiative supports India's vision of Aatmanirbhar Bharat, encouraging homegrown deep-tech startups to develop globally competitive products. The support from TDB will help expand manufacturing and accelerate the global reach of this AI-enabled wellness technology.

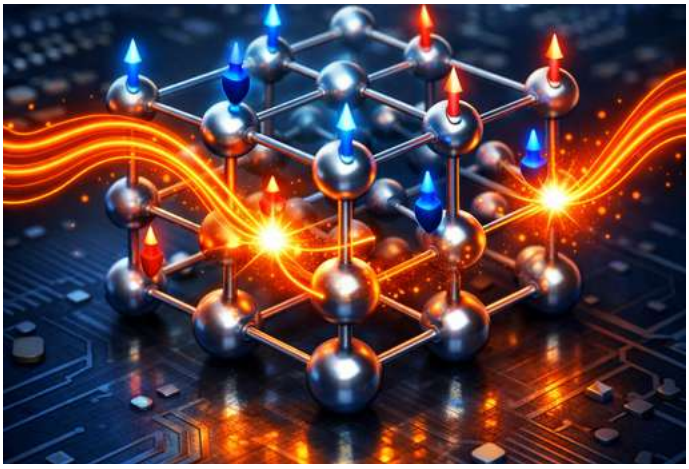
Press Information Bureau (PIB), Government of India. TDB-DST Supports Wellnesys Technologies Pvt. Ltd. for Commercialization of AI-Powered Smart Yoga Mat, 10 March 2026.

India Supports Development of Indigenous Satellite Docking and Refueling Technology

Technology Development Board (TDB) under the Department of Science and Technology (DST), Government of India, has provided financial assistance to OrbitAID Aerospace Pvt. Ltd. to develop an indigenous system for on-orbit satellite docking and refueling. The project, titled "Development of Docking and Refueling Systems for In-Space Life Extension of Satellites," aims to strengthen India's growing private space technology ecosystem. OrbitAID is developing advanced satellite servicing technologies that allow satellites in orbit to be refueled, extending their operational life without launching replacement satellites. A key component of the project is the Standard Interface Docking and Refueling Port (SIDRP), a system designed to enable autonomous docking and safe propellant transfer between satellites in space. Using advanced guidance, navigation, and sensor systems, a servicing satellite can approach a target satellite, dock securely, and transfer fuel. This technology can significantly reduce mission costs and improve satellite lifecycle management. The project will support the development and testing of the system for future in-space servicing missions, contributing to sustainable space operations and strengthening India's capabilities in advanced space technologies.

Press Information Bureau (PIB), Government of India. TDB-DST Supports OrbitAID Aerospace Pvt. Ltd. for Development of Indigenous On-Orbit Satellite Docking and Refueling Technology, 12 March 2026.

SCIENCE IN FOCUS



New Insights into Heat Flow in Magnetic Semiconductors Could Improve Future Electronics

Scientists have uncovered how heat travels through magnetic semiconductors, materials that are important for technologies such as spintronics, magnetic memory, and quantum devices. The discovery helps solve a long-standing puzzle in condensed matter physics and may improve thermal management in advanced electronic systems. A research team led by Prof. Bivas Saha at the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru, studied chromium nitride (CrN), a magnetic semiconductor used in electronic coatings and devices. Unlike conventional semiconductors where heat conductivity decreases with temperature CrN shows an unusual increase in thermal conductivity at higher temperatures. Using advanced temperature-dependent inelastic X-ray scattering experiments, the researchers observed how phonons (lattice vibrations) interact with magnetic spin fluctuations. As magnetic order weakens at higher temperatures, phonon lifetimes increase, allowing heat to travel more efficiently. These findings could help design materials with improved heat control for next-generation electronic, spintronic, and quantum devices.

Saha B. et al., Science Advances (2026). https://doi.org/10.1126/sciadv.adw7332
Press Information Bureau (PIB), Government of India. Solving mystery of heat transport in magnetic semiconductors unveils possibilities in high-performance electronics, 12 March 2026.

India–Singapore Project Advances AI-Powered Plasma Technology for Clean Hydrogen

Technology Development Board (TDB) under the Department of Science and Technology (DST), Government of India, has supported APChemi Pvt. Ltd. for an Indo–Singapore collaborative project aimed at developing advanced clean-energy technology. The project focuses on building an AI-integrated microwave plasma system that can produce CO_2-free hydrogen while simultaneously generating valuable carbon nanomaterials. The technology uses microwave plasma pyrolysis, where methane is split into hydrogen and solid carbon without producing carbon dioxide. The system will also produce advanced materials such as carbon nanostructures and diamond–graphene hybrid materials, which have applications in energy storage, electronics, and advanced manufacturing. Artificial intelligence will monitor and optimize reactor conditions such as plasma temperature, gas flow, and microwave power, helping maximize hydrogen production and improve energy efficiency.The pilot facility is expected to generate about 4 kg of hydrogen and 12 kg of carbon materials per hour, creating a dual-revenue model where high-value carbon products help offset hydrogen production costs. This collaboration between India's APChemi and Singapore-based Commsens aims to accelerate the commercialization of next-generation technologies for clean hydrogen and advanced carbon materials. *Press Information Bureau (PIB), Government of India. TDB-DST Supports Indo–Singapore Collaborative Project for AI-Integrated Plasma System for Clean Hydrogen and Advanced Carbon Materials, 13 March 2026.*

INNOVATIONS & PATENTS

Every great invention begins with a bold idea—and a patent to protect it. Innovations drive progress, and patents turn breakthroughs into lasting impact. From lab benches to the marketplace, this is where creativity meets protection.

| By Dr. Avijit Das

THE TINY TEAM THAT CLEANED THE WATER

In a town where a river once flowed clear and lively, things had slowly begun to change. Foam gathered along the edges, and the water carried an unusual smell. Waste from homes and industries had introduced chemicals like detergents (SDS) and caffeine into the river, making it unsafe for both people and wildlife.

One afternoon, Dr. Ankita, an environmental scientist, stood by the river thinking, "There must be a better, natural way to clean this."

Instead of turning to heavy machinery or chemicals, she turned to something much smaller microorganisms.

Back in her lab, Dr. Ankita studied two special bacteria: Pseudomonas inefficax, which could break down caffeine and Pseudomonas nitritireducens, which could degrade detergent pollutants like SDS

Individually, they were useful. But Dr. Ankita had a new idea what if they worked together?

She carefully combined them to create a microbial team, called a consortium. Before using them, she trained (or "induced") the bacteria so they could adapt and perform more efficiently in polluted conditions.

When this tiny team was introduced into contaminated water, something remarkable happened.

The two bacteria worked in perfect coordination:
One focused on removing caffeine, while the other targeted detergents. Importantly, they did not interfere with each other's work, making the process smooth and efficient.

Within just 6 hours, nearly all the detergent pollution was removed, and most of the caffeine was broken down. What usually took much longer using traditional methods was now happening rapidly and naturally.

Dr. Ankita was amazed. "This is more than just cleaning water," she said. "This is using nature's own tools to restore balance."

Her innovation showed that combining the right microorganisms can create a fast, eco-friendly, and scalable solution for water pollution. It could be applied to rivers, industrial wastewater, and even household waste systems. Soon, plans were made to test this method in larger water bodies and real river systems. Communities nearby felt hopeful as they saw a natural solution emerging. Dr. Ankita believed that such innovations could reduce dependence on harmful chemicals and expensive treatments. By working with nature instead of against it, scientists could protect ecosystems and ensure cleaner water for future generations.

INNOVATION

Reference:

Pardeshi, S. P., & Shede, P. N. (2026). A method for biodegradation of pollutants in contaminated water.

Patent Number: 582661.

| By Dr. Sourav Kumar

The Smart Plug That Guided Rohan

Rohan loved doing things on his own. Even though he was visually impaired, he believed in independence. But one daily task always made him nervous plugging in electrical devices.

One evening, Rohan tried to plug in his phone charger. He carefully searched for the socket with his fingers, but he wasn't sure if he was aligning it correctly. "What if I miss the socket? What if it's damaged?" he thought. The fear of getting shocked always stayed in his mind.

A few days later, his sister brought him a new device. "Rohan, this is a smart plug system designed just for you," she said.

Curious, Rohan picked it up.

As he brought the plug closer to the wall, something amazing happened. The plug started vibrating gently. The vibration was stronger on one side.

"It's guiding you," his sister explained. "Move in the direction of the vibration."

Rohan slowly followed the signal. As he moved closer, he heard a soft beep sound. The closer he got, the clearer the signal became.

Then he felt something new tiny raised dots forming a pattern on the surface of the plug.

"That's Braille feedback," she said. "It tells you the direction too."

Rohan smiled. For the first time, he felt confident.

Inside the system, smart sensors were working silently. They used invisible sound waves to detect the exact position of the socket. A small system even adjusted the socket slightly to match the plug's direction.

As he reached the correct position, the system guided him perfectly and the plug smoothly connected.

But the innovation didn't stop there.

"What if the socket is unsafe?" Rohan asked.

"It checks that too," his sister replied. "It can detect if the socket is burnt or if there's moisture. If something is wrong, it will warn you."

Rohan paused, then plugged in his charger again this time without fear.

"This feels like the plug is talking to me," he said.

His sister smiled. "That's the idea."

From that day on, a simple task became safe and easy. For Rohan, it wasn't just a device it was freedom, confidence, and independence in everyday life.

INNOVATION

Reference:

Kumar, R., & Geda, S. K. (2026). Electrical power delivery system for visually impaired users

Patent Number: 582673.

Development of Low-Temperature Processed Ag-TiO2 Antibacterial Coatings for Medical Devices

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Areas of Expertise: Regenerative Medicine | Cell-Based Therapies | Biomaterials Engineering | Nanomedicine

Biofilm formation over medical devices presents a significant risk in healthcare as it can lead to serious infections, increasing both mortality and morbidity rates in patients. Once a biofilm is established, it becomes very difficult to eradicate, often resulting in ongoing infections that complicate treatment. Many existing methods used to prevent or eliminate biofilms often require harsh conditions that can damage the surfaces and functionality of the medical devices.

To address this issue, we have developed a novel Ag-TiO2 mesoscopic thin film using a sol-gel process combined with low-temperature annealing (80-100°C). This coating is designed as an antibacterial barrier to prevent biofilm formation on various medical substrates, including catheters, glass, latex, and ceramics. The method of creating this thin film is both innovative and cost-effective, demonstrating high efficiency, making it suitable for large-scale production with a 100% success rate for commercialization. Initially, lithium titanium oxide ($Li_4Ti_5O_{12}$) is applied as a thin film using a drop-cast technique, followed by UV treatment to stabilize it. Silver ions are then introduced through an ion-exchange process, transforming it into an unstable $Ag_4Ti_5O_{12}$ thin film. The film undergoes reduction in a sodium borohydride ($NaBH_4$) solution, resulting in a stable Ag-TiO2 thin film.

This Ag-TiO2 coating is particularly effective against biofilm formation and is expected to significantly reduce the incidence of hospital-acquired infections, which are largely caused by bacteria contaminating medical devices. The mechanism by which the Ag-TiO2 coating works involves the release of silver and titanium ions into the surrounding environment. When these ions come into contact with bacterial cells, they disrupt the cells through various means, such as generating reactive oxygen species (ROS), causing DNA damage, and interfering with vital biochemical processes. These actions, along with alterations to the structural integrity of the bacterial cell walls and membranes, limit bacterial growth. Furthermore, this Ag-TiO2 coating is biocompatible, meaning it does not harm or provoke allergic reactions in living tissues, making it a safe option for medical applications. Overall, this innovative coating could play a critical role in reducing infection rates in healthcare settings, benefiting both patients and healthcare workers.

Patent Reference:

Mukherjee, S., Pal, B. N., Pradhan, L., & Hazra, S. (2026). A method for coating of an antimicrobial nanocomposite on devices. Indian Patent No. 575856.

Metabolite Signatures for Early COPD Detection: A New Pathway to Timely Intervention

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| Scientific Profile | | Organization Link | | Research Lab Page |

Areas of Expertise: Proteomics | Biomarker Discovery | Translational Systems Biology | Genomics

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| Scientific Profile | | Organization Link | | Research Lab Page |

Areas of Expertise: COPD | Nanomedicine | Proteomics | Metabolomics | iPSCs

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Areas of Expertise: COPD Proteomics | Metabolomics | Lipidomics

Chronic Obstructive Pulmonary Disease (COPD) is a long-term lung disease that makes it difficult to breathe and worsens over time. It usually develops due to smoking, air pollution, or exposure to harmful fumes. COPD has become one of the most urgent global health challenges of our time. According to the World Health Organization, COPD was the third leading cause of death worldwide, causing 3.23 million deaths in 2019. In India, the impact is even more severe, where COPD is now the second leading cause of death. This high burden is mainly due to air pollution, use of biomass fuels, and smoking.

Despite being so serious, COPD often develops silently. Common diagnostic

Patent Reference:

Sharma, G., Gupta, D. P., & Srivastava, S. (2026). Biomarker panel for detection of chronic obstructive pulmonary disease, method and device thereof. Indian Patent No. 573959.

tools like spirometry (lung function test) and imaging (X-ray or CT scan) may miss the earliest changes happening deep inside the lungs. As a result, treatment is often delayed until symptoms such as breathlessness, chronic cough, and reduced ability to exercise have already become severe. This gap led to the development of a metabolite-based biomarker panel, designed to detect COPD much earlier than traditional methods.

Current diagnostic methods struggle to detect early-stage disease because changes in lung function and structure do not always match the actual progression of COPD. Spirometry results can vary depending on age, sex, location, and even time of day, and may appear normal in the early stages. Imaging tools also cannot easily detect small biochemical changes. In contrast, looking at the body at a molecular level allows us to detect imbalances much earlier, before physical damage becomes visible.

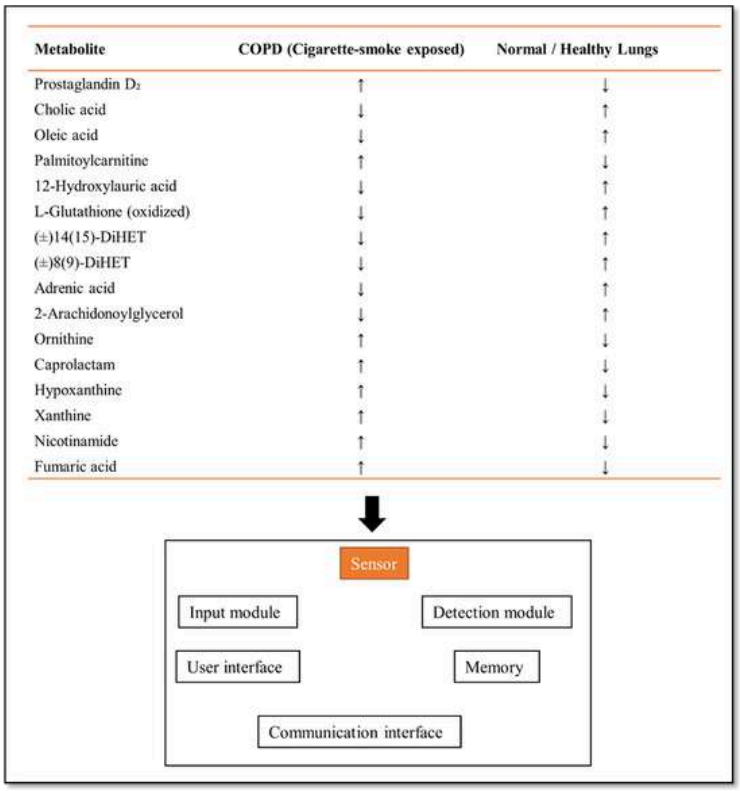
This innovation works by identifying COPD through changes in multiple metabolites—small molecules involved in important biological processes such as inflammation, oxidative stress, fat metabolism, energy production, and nitrogen balance. In COPD patients, certain metabolites like Prostaglandin D_2, Palmitoylcarnitine, Ornithine, Caprolactam, Hypoxanthine, Xanthine, Nicotinamide, and Fumaric acid increase, while others such as Cholic acid, Oleic acid, 12-Hydroxylauric acid, oxidized Glutathione, 14(15)-DiHET, 8(9)-DiHET, Adrenic acid, and 2-Arachidonoylglycerol decrease significantly.

Instead of relying on a single marker, this system looks at the overall pattern of these changes. This makes the test more reliable, sensitive, and accurate. The method is supported by advanced techniques like mass spectrometry and FTIR, which clearly show differences between healthy individuals and COPD patients.

What makes this approach unique is its use of a multi-analyte fingerprint rather than a single biomarker. COPD is a complex disease, and this method captures its multiple biological aspects, improving diagnostic accuracy. The system is also designed to work with a dedicated point-of-care sensor device. This device includes a sample input system, a reaction chamber, optical and electrochemical detection units, onboard memory, a communication interface, and a touchscreen display. This allows fast and easy testing, even outside large hospitals.

In addition, the innovation proposes a ready-to-use assay kit containing probes, standards, reagents, and a calibration system. This makes it suitable for routine screening as well as confirmatory diagnosis. This technology has important benefits for healthcare and society. Early detection of COPD allows timely treatment, which can improve quality of life and slow disease progression. Patients diagnosed early respond better to treatments such as bronchodilators and corticosteroids. It also enables screening at the community level, especially in high-risk and low-resource areas, and can reduce hospital admissions, lowering the financial burden on families and healthcare systems.

In India, where COPD is the second leading cause of death, this innovation could significantly improve respiratory care. Globally, since COPD remains the third leading cause of death, early diagnosis is not just helpful it is essential.



Metabolite profiling of cigarette smoke–exposed COPD lungs compared with normal healthy lungs, highlighting differential up- or down-regulation of key metabolites and a conceptual schematic of a sensor-based detection system integrating input, detection, memory, user, and communication modules for early COPD monitoring.

Patent Reference:

Sharma, G., Gupta, D. P., & Srivastava, S. (2026). Biomarker panel for detection of chronic obstructive pulmonary disease, method and device thereof. Indian Patent No. 573959.

Beamforming with intelligent reflecting surfaces

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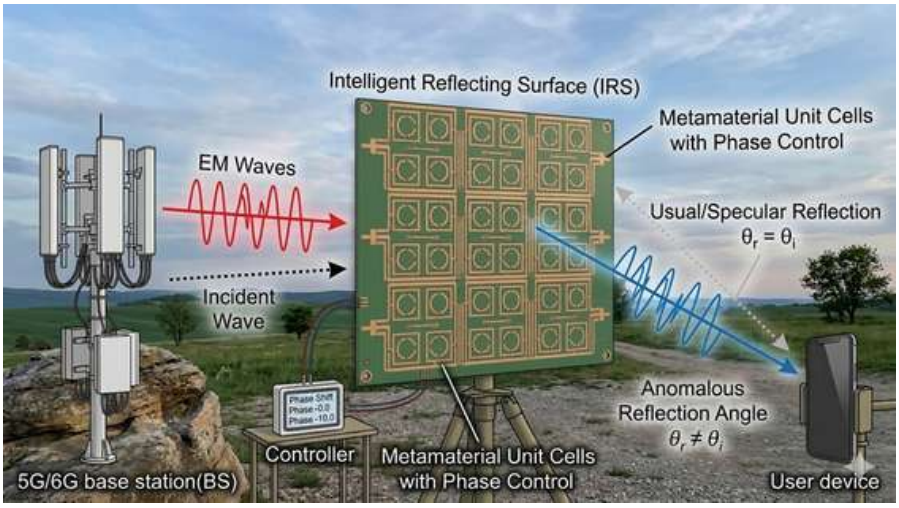
Areas of Expertise: Numerical Electromagnetics | RF Communications | Antenna & Microwave Engineering | Inverse Electromagnetic Systems

In high school, we all learnt the laws of reflection, which taught us that the angle of incidence is equal to the angle of reflection when light hits a mirror. We use this law all the time without really realizing it, for example when we look in the rear view mirror of a car. What if I told you that this law could be modified, that the angle of reflection could be different from the angle of incidence? Well, that's exactly what our invention does. More precisely, we tell you what changes to make to the mirror so that light gets reflected where we want it to go!

To understand this, let's think of the mirror as being made of smaller mirrors, like a chess board. And instead of thinking of light as one ray, let's think of it as many rays hitting each of the smaller mirrors and getting reflected in the usual direction as predicted by Snell's laws. At any point along the light ray, we can describe it by two quantities, amplitude and phase. As the Young's double slit experiment shows, interference between two rays can lead to dark and bright spots. That happens when the phase of each of the rays is equal (bright spots) or 180 degrees out of phase (dark spots). Coming back to the mirror example, when light gets reflected from each of these small mirrors, all the reflection phases are equal. So, all the reflected rays combine in one predictable direction the familiar law of reflection. But, if we could change the reflection phase of each of the smaller mirrors, we could cause constructive interference between the rays to happen in a completely different direction.

Our work focuses on a special kind of light not the visible kind, but radio waves which our cell phones use to talk to each other governed by exactly the same physics. Our mirror is replaced by what we call a metasurface which in turn is composed of smaller unit cells. The reflection phase of each of these cells can be controlled by an electronic diode connected to each cell, and there can be hundreds of diodes on a metasurface. If we imagine the diode states to be ON and OFF, the number of possible combinations of diode states becomes extremely large (with 500 diodes, that's more combinations than atoms in the observable universe), so we can't simply try them all out to figure out which combination will reflect the radio wave in the direction we want. For a realistic metasurface with hundreds of diodes, our algorithm finds the answer in under a second! The key was recognizing a hidden mathematical structure in the problem one that makes the solution fall out elegantly, rather than grinding through every possibility.

We expect our invention to find its way into the next generation of cellular technology, 6G, where such "intelligent" reflecting panels can bend radio waves from base stations to go around buildings and other obstacles. We can even use these ideas to replace parabolic satellite dishes with flat panels. And the best part? The solution came out of staring at mathematics, in particular, how to maximize the sum of complex exponentials on a whiteboard, completely free of AI!



Patent Reference:

Narayanan, S. S., Ganti, R., & Khankhoje, U. K. (2025). Method for computing weights for a beamforming algorithm from an intelligent reflecting surface. Indian Patent No.577627.

From "Fool's Gold" to Future of Solar Power

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NATIONAL INSTITUTE OF TECHNOLOGY MEGHALAYA, SAITSOHPEN, SOHRA, EAST KHASI HILLS, MEGHALAYA, INDIA
| Scientific Profile | | Organization Link | | Research Lab Page |

Areas of Expertise: Thin-Film Deposition | Sputtering & Vacuum Processing | Photovoltaic Materials (FeS_2) | Energy Materials & Nanofabrication

For decades, the solar industry has relied heavily on materials that are either expensive, resource-intensive, or environmentally demanding. As global energy demand accelerates, the question grows louder: *Can we build high-performance solar technology using materials that are abundant, affordable, and scalable?*

Iron disulfide (FeS_2) may be part of the answer. Found naturally as pyrite and marcasite polymorphs, this material is composed of iron and sulfur—inexpensive elements, widely available, and non-toxic. Even more compelling for industry, FeS_2 absorbs sunlight extremely efficiently (better than silicon!), making it a strong candidate for next-generation thin-film solar cells. Yet for years, manufacturing has been the bottleneck. Traditional fabrication methods for FeS_2 thin films require multiple processing stages and extended sulfurization treatment (7-8 hours). These steps increase production time, raise operational costs, and introduce phase non-uniformity in film. In industrial settings, inconsistency means inefficiency — and inefficiency means lost scalability.

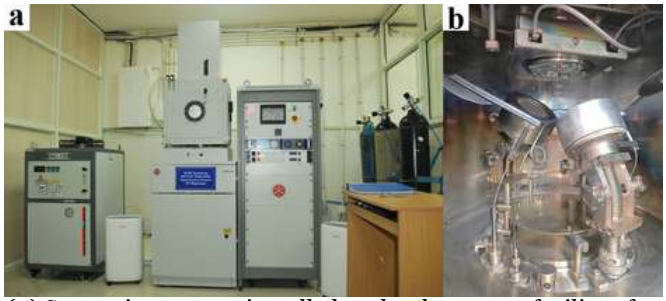
Our recent work addresses this challenge by developing a single-step sputtering-based deposition process that can produce phase-pure FeS_2 thin films in a much simpler and faster way. Using this method, both iron pyrite and iron marcasite thin films can be fabricated within 30 minutes, eliminating the need for prolonged multi-stage processing.

The process takes place inside a high vacuum chamber under controlled environment. In this process, a solid FeS_2 sputtering target is bombarded by energetic argon ions. When these ions strike the target surface, Fe and S atoms are ejected from the material and travel through the vacuum before depositing onto a heated substrate placed nearby. Over time, these atoms accumulate to form a thin film.

One of the key advantages of our method is the ability to control which crystal phase forms during deposition simply by adjusting the growth conditions. When the substrate is heated to around 430 °C and an additional sulfur target is used to provide extra sulfur atoms, the deposited material forms iron pyrite. On the other hand, when the substrate temperature is maintained at around 380 °C and only the FeS_2 target is used, the film naturally forms the marcasite phase without the need for additional sulfur.

This controlled approach allows us to selectively produce either phase using the same deposition system. The resulting thin films show uniform thickness, low surface roughness, high phase purity, minimal impurities, and excellent reproducibility. These characteristics are essential for integrating such materials into real devices and for ensuring reliable performance.

Beyond simplifying the fabrication process, this technique could help accelerate research and development in areas such as renewable energy technologies, low-cost photovoltaics, and catalytic materials. This work provides a practical pathway toward more efficient manufacturing of functional energy materials. Continued research in this direction may help unlock the full potential of iron sulfide compounds for next-generation energy and electronic applications. A material once known simply as "fool's gold" may stands as a viable platform for sustainable energy manufacturing.



(a) Sputtering system installed at the cleanroom facility of NIT Meghalaya, and (b) interior view of the sputtering chamber used for thin-film deposition.

Patent Reference:

Chakraborty R. N., Mahanta D.S., Senthilkumar K. Single-Step Deposition of Phase-Pure Iron Pyrite and Iron Marcasite Thin Film by Sputtering. (2026) Indian Patent Number: 572969.

NOVEL DRUG DELIVERY VEHICLE FOR BETTER CANCER TREATMENT

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| Scientific Profile | | Organization Link | | Research Lab Page |

Areas of Expertise: Polymer Nanocomposites | Biomaterials | Self-Assembly | Biodegradable & Sustainable Polymers

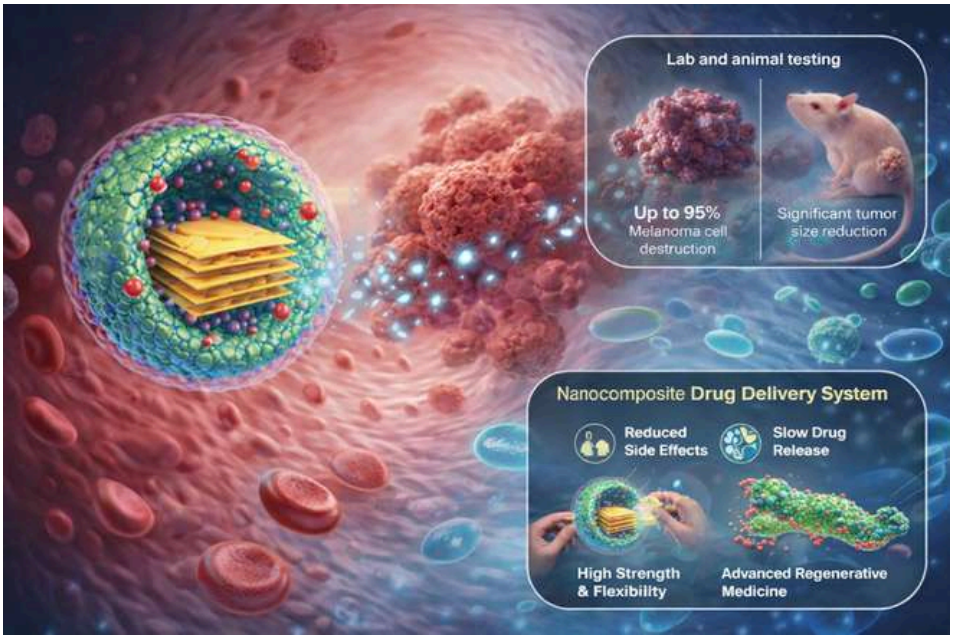
Have you ever wondered why cancer treatment often feels so harsh on the body? In the case of melanoma, a serious type of skin cancer, the medicines used to kill cancer cells can also harm healthy cells. Many anticancer drugs break down quickly in the body, spread everywhere instead of only reaching the tumor, and cause strong side effects like fatigue, nausea, and tissue damage. Because the drug does not stay active for long, patients often need repeated doses. Over time, tumors can also become resistant to treatment. So the big question is: can we deliver cancer medicine in a smarter, safer way?

Our innovation was designed to answer exactly that question. We developed a special "smart" material that works like a tiny medicine carrier. This material is made by combining two components: a layered mineral-like structure that can hold the drug, and a flexible medical polymer that adds strength and stretchability. Together, they form a hybrid nanocomposite a very small but powerful system that can store anticancer drugs and release them slowly over time.

Why is slow release important? Imagine pouring all the medicine into the body at once this can shock healthy tissues and cause side effects. But if the drug is released gradually, the body can maintain a steady and effective level of medicine without sudden spikes. Our system does exactly that. It keeps the drug stable and releases it in a controlled way, helping maintain the right therapeutic level for longer periods. This reduces the need for frequent dosing and improves patient comfort.

What makes this material even more impressive is its strength and flexibility. It can stretch up to 1230% without breaking which is extraordinarily high. This means it is not only useful for drug delivery but also strong enough for applications like bone repair and tissue regeneration.

It can be used in injectable or implantable forms because it remains stable and durable inside the body. But does it really work? In laboratory and animal studies, the results were very encouraging. The system destroyed up to 95% of melanoma cancer cells and significantly reduced tumor size. At the same time, it caused minimal damage to healthy organs. Because the drug is released slowly and stays effective longer, the overall toxicity is reduced compared to conventional chemotherapy.

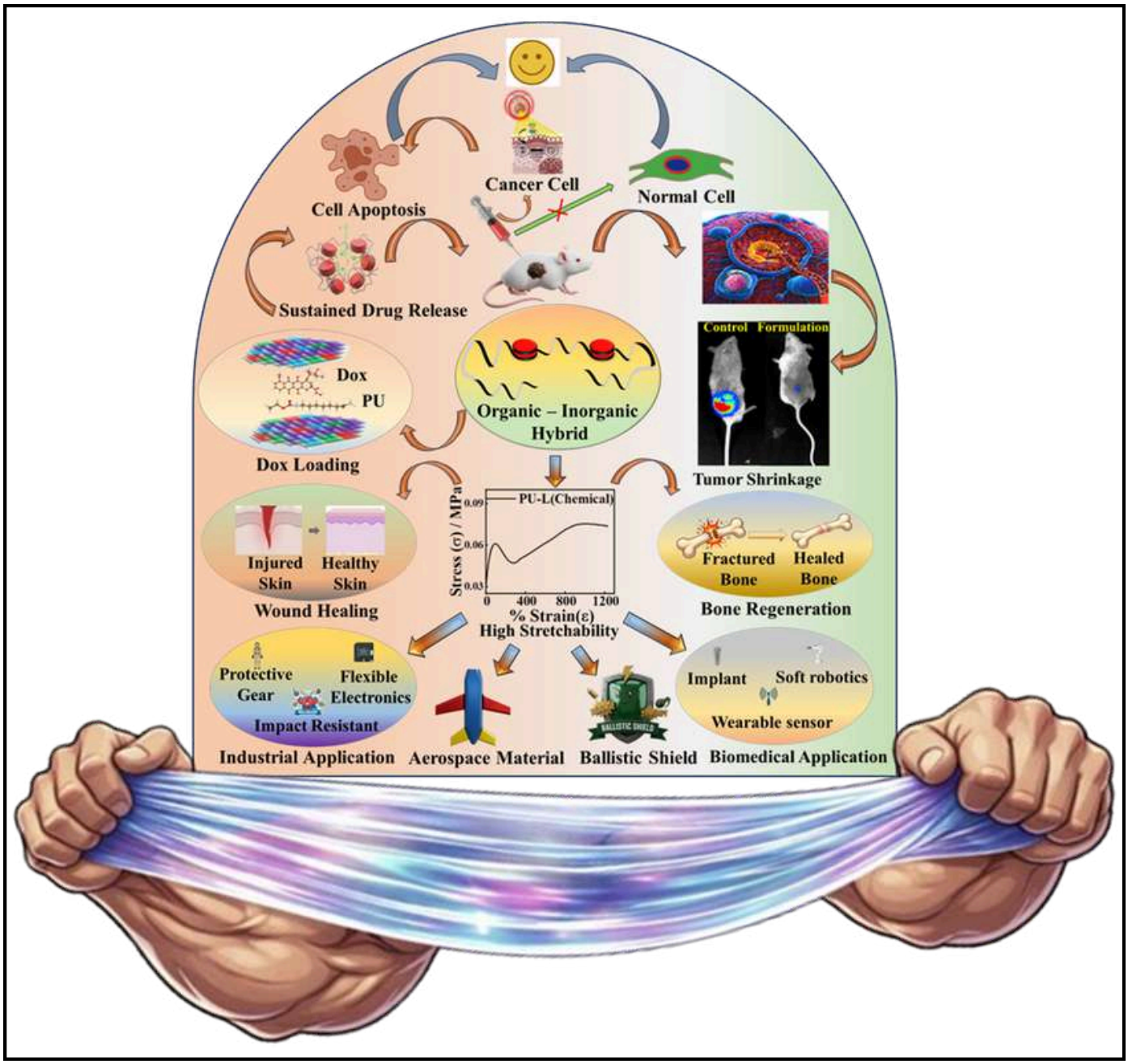


Patent Reference:

Maiti, P., & Maity, S. (2026). A drug delivery vehicle and a method of preparation thereof. Indian Patent Application No. 577328.

This technology is not limited to melanoma alone. The same platform could be useful in wound healing, antimicrobial treatments, and tissue repair. Its adaptable design also makes it suitable for large-scale production, which is important for real-world medical use. In simple words, we created a strong, flexible, and intelligent material that carries cancer medicine more safely and effectively. It releases the drug slowly, reduces side effects, and improves treatment performance. By combining smart drug delivery with mechanical strength, this innovation offers a promising step toward safer cancer therapy and advanced regenerative medicine.

What if future cancer treatments could be both powerful and gentle on the body? This nanocomposite system moves us closer to that possibility.



Patent Reference:

Maiti, P., & Maity, S. (2026). A drug delivery vehicle and a method of preparation thereof. Indian Patent Application No. 577328.

Dr. Aditi Jain, Ph.D.
SCIENTIFIC PARTNERSHIPS MANAGER, INDIA
AMERICAN SOCIETY FOR MICROBIOLOGY, UNITED STATES OF AMERICA

A conversation with Dr. Aditi Jain

When you began your PhD, did you imagine a career beyond the lab, or did this path unfold gradually?

- I began my PhD journey with an open mind, which in hindsight feels quite bold given the societal pressures to have it all figured out. The motivation was always to learn, upskill, and put that knowledge to good use. Around the third year, I started thinking more intentionally about career options post-PhD, paying attention to opportunities and learning from conversations with professors and visitors coming to the Indian Institute of Science (IISc), and those I met at scientific events. One-on-one meetings with my advisor were invaluable in helping me understand what roles would feel like a natural fit for me. I've always believed career choices can evolve, and if something genuinely excites you even if it's unconventional, it's worth taking a leap of faith.

Many researchers feel that stepping away from the bench means stepping away from science. Did you ever feel that tension, and how do you see it now?

- I think context is important here and it really depends on the path you choose. For me, stepping away from the bench didn't feel like leaving science. The best part of roles in the publishing sector is that it's just another way of staying connected to scientific discovery. I do miss the thrill of wet lab experiments, but I take equal pride in contributing to publishing programs and bringing them to India in ways that advocate for regional priorities and needs. It's really about impact, whether that's generating knowledge at the bench or enabling research to reach the world.

Which aspects of your scientific training have been most valuable in your current role outside active research?

- I firmly believe that, apart from technical expertise, people skills can greatly influence both one's workplace experience and career trajectory. I'm grateful to my lab seniors and colleagues who set a strong example of empathetic leadership, mentorship, and excellence in work which is something I continue to draw inspiration from.

You now work closely with global scientific communities. How would you describe the role that scientific societies play in shaping research culture today?

- Scientific societies play an indispensable role in shaping research direction, culture and priorities. They carry a legacy of advancing science to improve our lives through trusted literature and knowledge dissemination. Beyond publishing, societies advocate for issues of global importance, provide evidence-backed feedback to decision makers, and champion ethical standards. They create platforms for networking, mentorship, and career development, with the aim of ensuring that scientists at all stages have access to resources and opportunities.

In your work at the American Society for Microbiology, what have you learned about why partnerships and networks are becoming so critical in modern science?

- I agree that building partnerships and nurturing networks have become critical to modern science because the complexity of today's challenges whether antimicrobial resistance, climate change, or emerging pathogens cannot be solved in isolation. Through my work at an international scientific society like ASM, I've witnessed that collaborations can open doors to diverse expertise, resources, and perspectives that accelerate discovery and innovation, and set

- new standards of scientific excellence. International networks amplify impact by creating platforms for knowledge exchange, enabling scientists to break silos to resolve global issues with collective knowledge.

What opportunities for students and early-career researchers do global societies like ASM offer that are often overlooked, especially in India?

- Global societies like ASM offer a wealth of opportunities for students and early-career researchers, especially in India. Through free ASM membership under the Global Outreach category for anyone affiliated with eligible countries (India is currently on the list), members gain access to career resources, fellowship and travel grant applications, and networking platforms. Programs like the ASM Future Leaders Mentorship Fellowship provide structured guidance to emerging scientists, while initiatives such as the ASM Career Development Grant for Postdoctoral Women offer up to $2,000 for skill-building through courses, lab visits, or conferences. Students can also start ASM Student Chapters at their universities, hosting events like career panels, industry visits, and science fair judging to foster leadership and community engagement. Beyond this, ASM's YouTube channel hosts videos on cutting-edge microbiology and professional development insights. ASM's Science Communication Toolkit is also another valuable resource for researchers to learn how to share their work effectively. The ASM meetings such as the
- ASM Global Research Symposium series are great platforms to showcase one's research work and receive valuable feedback from global experts.

What misconceptions do scientists commonly have about careers beyond academia, particularly roles that sit at the science–policy–community interface?

- One of the common misconceptions I continue to address whenever I'm asked about a career in publishing sector, is that people think such roles are mainly about science communication, and manuscript editing. While communication is an essential component, these roles are far more multidimensional. For instance, in scientific publishing, the job is not just to edit papers; it involves data analysis, peer review management, ethical oversight, community engagement, and creative ways to disseminate published research. Similarly, roles in science policy would require understanding regulatory frameworks, stakeholder negotiation, and translating evidence into actionable guidelines, not only summarizing research. Community-focused positions require program development, advocacy, public speaking and capacity-building, which demand leadership and networking skills beyond technical expertise.

What kinds of experiences during a PhD can genuinely help someone transition into partnership-, outreach-, or policy-focused roles?

- PhD scholars can sometimes become very focused on their own
- world - their thesis, their best poster award, their imaging slot, and their struggles. The ability to think beyond oneself and navigating working relationships within the lab teaches so much about building partnerships. There's no magic bullet for easing the transition to broader roles. It improves over time from learning to work with different personalities and varied working styles. I truly believe, it starts with these basic, and perhaps overlooked experiences.

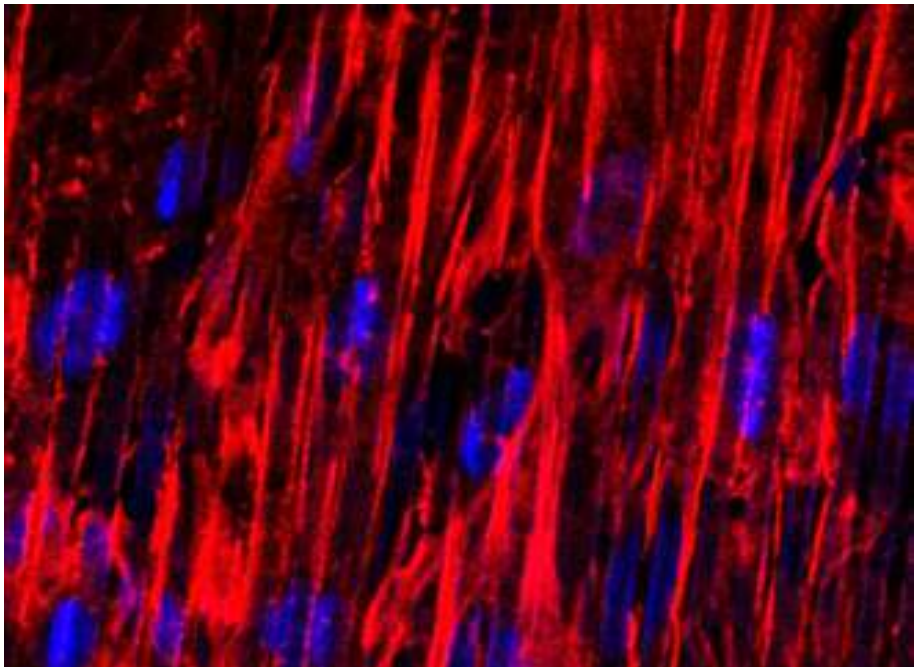
Has working beyond the bench changed how you define success or purpose as a scientist?

- Once, over a lunch discussion with colleagues, someone asked, 'What success means to you?'. I was pleasantly surprised by the different answers, which made me reflect on how everyone finds their own motivation to work harder. I wouldn't say working beyond the bench has changed how I define success, but a series of experiences, personal and professional, certainly have.

- As a PhD student, there's always an underlying pressure to finish the degree, and the uncertainty about the future feels much higher. In contrast, as a working professional, while the challenges are different, there's more emotional clarity and maturity, which allows you to think beyond tangible goals. For me, real success is when people can trust you easily and that trust is what makes everything else possible.

Do you think scientists are adequately trained to think about impact beyond publications? What needs to change?

- I see that times have changed. Earlier, scientists were trained to focus on publications because they're a measurable outcome and that's fine unless it becomes an obsession leading to ethical misconduct. But now, they are investing in science communication, entrepreneurship, and even incorporating policy perspectives into finding solutions, embedding these into training programs. AI, international forums, and global collaborations have drastically expanded scientists' exposure to more impactful ways and reasons for conducting research.



What is one habit or mindset shift that helped you navigate your transition most effectively?

- One habit I cannot advocate enough is nurturing a social circle. Speaking with friends, family, and mentors not only provides support but also helps stay focused on what one can control and not stress over what we cannot.

If a PhD student reading this is uncertain about their future in academia, what is the most important advice you would offer?

- Over a lifetime, career decisions aren't set in stone. One can change paths even after years in a role. No path comes with zero uncertainty and being okay with the unknowns helps alleviate the stress of seeking stability. It's tempting to collect advice from many people, but that often leads to more confusion. It's extremely important to filter out what truly works for you, considering one's own strengths and family commitments.

| OBITUARY |

Madhav Gadgil

THE SCIENTIST WHO GAVE NATURE A VOICE

(1942–2026)

India lost one of its most respected environmental scientists on 7 January 2026, when Madhav Gadgil passed away in Pune at the age of 83. For more than five decades, he worked to understand India's forests, wildlife, and people and to protect them for future generations.

Born on 24 May 1942 in Pune, Gadgil grew up in a family that valued learning. He studied biology at Fergusson College in Pune, completed his master's degree in zoology from the University of Mumbai, and later went to Harvard University, where he earned his PhD in 1969. At Harvard, he was influenced by leading ecologists and developed a strong interest in mathematical ecology and animal behavior. After a short teaching period in the United States, Gadgil returned to India in 1971. He joined the Indian Institute of Science (IISc), Bengaluru, where he would spend more than thirty years building modern ecological research in the country. He founded the Centre for Ecological Sciences at IISc a pioneering institution that trained generations of Indian ecologists. He also helped establish the Centre for Theoretical Studies.

Gadgil believed that ecology was not just about forests and animals. It was also about people. He introduced scientific, quantitative methods to study ecosystems in India and emphasized that humans are an important part of nature, not separate from it. His work connected science with real-life issues such as forest management, biodiversity conservation, and sustainable development.

One of his most important achievements was helping India establish its first biosphere reserve the Nilgiri Biosphere Reserve in 1986. His research in the 1980s played a major role in identifying the ecological importance of the Nilgiri region. This was a turning point in India's conservation history. In 2010, the Government of India appointed him chairman of the Western Ghats Ecology Expert Panel (WGEEP), widely known as the Gadgil Commission. The panel studied the fragile Western Ghats mountain range and recommended that large parts of it be declared ecologically sensitive. His 2011 report sparked national debate. Environmentalists supported his strong conservation measures, while some state governments and groups opposed them. Even though not all recommendations were accepted, the report changed the way India discussed environmental protection.

Gadgil also played an important role in shaping the Biological Diversity Act of 2002 and promoted the idea of People's Biodiversity Registers, encouraging local communities to document and protect their natural resources. He believed that conservation should involve villagers, farmers, and indigenous communities.

Throughout his career, Gadgil published over 250 scientific papers and several influential books. His book This Fissured Land (co-authored with Ramachandra Guha) explored India's ecological history. He wrote in both English and Marathi, making science accessible to ordinary people. He also wrote columns for newspapers like The Hindu and Sakal, sharing stories about nature with the wider public.

His contributions were recognized globally. He received the Padma Shri in 1981 and the Padma Bhushan in 2006 from the Government of India. Internationally, he was honored with the Volvo Environment Prize, the Tyler Prize for Environmental Achievement, and in 2024, the prestigious Champions of the Earth Award from the United Nations.
Beyond science, Gadgil was known for his simplicity and integrity. As a young man, he was also an athlete, holding high jump records during his college days. He was married to noted meteorologist Sulochana Gadgil, who passed away in 2025. He is survived by his children.
Madhav Gadgil's legacy lives on in India's forests, in its environmental laws, and in the many students he mentored. He showed that science can guide society toward wiser decisions. More than a researcher, he was a bridge between knowledge and action a scientist who gave nature a strong and thoughtful voice.
India remembers him not only as an ecologist, but as a guardian of its natural heritage.

By
Rosalind Franklin
Council of Scientific Research
(**RFCSR**)

SCIENCE NEWS & OPPORTUNITIES

"Science News & Opportunities" keeps you updated with the latest scientific breakthroughs and opens doors to exciting careers, scholarships, and research programs.

International Day of Forests: Building a Sustainable Future

01

March 21, International Day of Forests, reminds us that forests are vital to life regulating climate, conserving biodiversity, and supporting livelihoods, water, and food security. They strengthen economies and protect ecosystems, but face growing threats from deforestation and unsustainable practices. Sustainable management, responsible use, and collective action are essential. By protecting forests today, we secure a healthier planet and a sustainable future for all.

World Water Day: Valuing Our Most Precious Resource

02

March 22, World Water Day, reminds us that freshwater is the foundation of life supporting ecosystems, agriculture, industry, and human health. Yet billions still lack safe drinking water, while climate change, pollution, and overuse threaten its availability. Sustainable water management is essential for resilience and equity, requiring protection of ecosystems, efficient infrastructure, responsible use, and integration into climate strategies. By valuing and conserving water today, we can ensure a future where clean water is a universal right.

World Meteorological Day: Observing Today, Protecting Tomorrow

03

World Meteorological Day, observed on March 23, highlights the vital role of weather and climate science in protecting lives and supporting sustainable development. Under the theme “Observing Today, Protecting Tomorrow,” it emphasizes how accurate observations enable early warnings, strengthen climate resilience, and guide informed decision-making. Investing in meteorology and data systems is essential to tackle climate change, extreme weather, and resource challenges, helping build a safer and more sustainable future.

World Tuberculosis Day: Advancing Awareness, Prevention, and Treatment

04

On 24 March 1882, Robert Koch discovered Mycobacterium tuberculosis, transforming medical science and laying the foundation for modern bacteriology. Today, World Tuberculosis Day reminds us that TB remains one of the deadliest yet preventable and curable infectious diseases. Ending TB requires early diagnosis, effective treatment, strong healthcare systems, continued research, and global collaboration to meet the UN goal of elimination by 2030. TB is not only a health issue but also a social and economic challenge. On this day, we reaffirm our commitment to equity, innovation, and collective action toward a TB-free world.

Things YET TO BE DISCOVERED

From the dark depths of our oceans to the farthest reaches of the cosmos, countless mysteries remain unsolved. Science continues to push the boundaries of the known, revealing just how much is still left to uncover. What lies beyond our current understanding may reshape the future of humanity.

PADMA SHRI 2026: INDIA'S SCIENCE & ENGINEERING LEADERS

Dr. A. E. Muthunayagam is a distinguished space scientist and one of the pioneers of India's cryogenic rocket engine development. He played a key role in strengthening India's liquid propulsion systems at the Indian Space Research Organisation (ISRO). His contributions helped advance India's launch vehicle technology, making the country more self-reliant in space missions. He received the Padma Shri for his lifelong dedication to space engineering and national technological development.

Dr. Ashok Kumar Singh is an agricultural scientist and plant breeder associated with the Indian Council of Agricultural Research (ICAR). He has worked extensively on improving crop varieties to increase yield and climate resilience. His research has supported farmers by promoting better seed technologies and sustainable agricultural practices. He received the Padma Shri for strengthening India's agricultural research and food security efforts.

Dr. Chandramouli Gaddamanugu is a technology entrepreneur and innovator known for contributions in engineering solutions and industrial automation. His work has focused on advancing indigenous technology and promoting innovation-driven development. Through his leadership in technical enterprises, he has supported India's growing engineering ecosystem. He received the Padma Shri for his impact on applied science and industrial technology development.

Dr. Gopal Ji Trivedi is a science educator and researcher who has contributed to promoting scientific awareness and grassroots innovation. He has worked to popularize science among students and rural communities, encouraging practical scientific learning. His efforts have helped bridge the gap between laboratory research and public understanding. He was honored with the Padma Shri for advancing science education and outreach.

| SCIENCE YET TO BE DISCOVERED |

PADMA SHRI 2026: INDIA'S SCIENCE & ENGINEERING LEADERS

Prof. Juzer Vasi is an electrical engineer and academic associated with the Indian Institute of Technology Bombay. He has made significant contributions in power engineering and electrical systems research. His work has influenced energy systems, renewable integration, and engineering education in India. He received the Padma Shri for excellence in engineering research and mentoring future technologists.

Dr. K. Ramasamy is a scientist known for contributions in applied engineering research and technical development. His work has supported innovation in manufacturing and industrial processes. Through research and leadership roles, he has helped strengthen India's engineering capabilities. He received the Padma Shri for advancing applied scientific research and promoting technological self-reliance.

Dr. Krishnamurty Balasubramanian is a scientist recognized for contributions to chemical and material sciences. His research has helped improve understanding of molecular systems and advanced materials. Through academic and research leadership, he has strengthened India's scientific infrastructure. He received the Padma Shri for his impact on scientific research and innovation.

Dr. Kumarasamy Thangaraj is a renowned geneticist associated with the Centre for Cellular and Molecular Biology. He is known for groundbreaking research in human genetics, population studies, and rare diseases. His work has helped understand India's genetic diversity and medical conditions. He received the Padma Shri for his outstanding contributions to genetic research and biomedical science.

PADMA SHRI 2026: INDIA'S SCIENCE & ENGINEERING LEADERS

Dr. Prem Lal Gautam is an agricultural scientist who has worked on crop improvement and sustainable farming systems. His research has supported farmers in hill regions by developing improved cultivation practices. He has contributed to strengthening agricultural resilience in challenging environments. He received the Padma Shri for his service to agricultural science and rural development.

Dr. Shubha Venkatesha Iyengar is an aerospace scientist associated with India's space research ecosystem. She has contributed to satellite systems and mission engineering, supporting India's expanding space missions. Her work has strengthened technical capabilities in spacecraft development. She received the Padma Shri for her contributions to aerospace science and engineering.

Dr. Veezhinathan Kamakoti is a computer scientist and academic leader associated with the Indian Institute of Technology Madras. He has contributed to indigenous processor development and cybersecurity research, including India's "SHAKTI" microprocessor initiative. His work promotes technological self-reliance in computing systems. He received the Padma Shri for his contributions to computer engineering and digital innovation.

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Queen Mary University of London London, United Kingdom General Description – include all relevant details from the source Queen Mary University of London invites applications for the...

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The University of Manchester – School of Engineering Manchester, United Kingdom General Description –The School of Engineering at The University of Manchester invites applications for...

Tenure Faculty – Professor / Associate Professor / Assistant Professor

Sardar Patel Institute of Technology Mumbai, Maharashtra, India General Description –Sardar Patel Institute of Technology (SPIT), Mumbai, an autonomous engineering institute affiliated with the University...

Faculty Positions – Multiple Openings (2026)

Chettinad Academy of Research and Education (Deemed-to-be University)Chennai, Tamil Nadu, India General DescriptionChettinad Academy of Research and Education (CARE), a premier deemed-to-be university in Chennai,...

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EMBO Postdoctoral Fellowship – Host Lab of Choice

Research Theme Molecular, cellular, and developmental biology. Project Description The EMBO Postdoctoral Fellowship supports outstanding postdoctoral researchers to conduct advanced experimental life science research in...

Postdoctoral Fellowship – Cold Spring Harbor Laboratory (USA)

Research Theme Molecular biology, genetics, genomics, and neuroscience Project Description CSHL offers postdoctoral positions focused on high-impact experimental research in life sciences. Postdocs are encouraged...

SHOWCASE: SCIENTIFIC RESEARCH

A Researcher Showcase is a platform designed to highlight the innovative work and contributions of researchers across various fields. It provides an opportunity for scholars to present their findings, exchange ideas, and foster collaborations. RFCSR's showcases helps researchers with networking opportunities to celebrate and support academic and scientific progress.

JOIN RFCSR ADVISORS

RFCSR considers science experts' advice & directions as the foremost priority to impact the science research community. The organization maintains strong connections with over twenty thousand PhD and post-PhD experienced scientific researchers, including scientists, advanced researchers, and both national and predominantly international experts across diverse fields of expertise. Nominate the experts to advise RFCSR. Scientific advisors are specifically focused to advise RFCSR to build and initiate innovative activities.

ARE YOU A RESEARCHER ?

JOIN RFCSR ASSOCIATES

Education and research are the foundation of social progress.

A community grows stronger when everyone has equal access to knowledge, quality education, and the benefits of research. At our organization, we believe in creating opportunities where learning and innovation are accessible to all. By associating with us, you'll help bridge the gap—empowering individuals, supporting education, and contributing to a more inclusive and developed society.

JOIN RFCSR MEMBERS

Global Outreach members are individuals currently residing full time in a resource-constrained country studying or working in sciences and research.

SCAN HERE !

BE A PART OF GLOBAL SCIENTIFIC COMMUNITY

ARE YOU A RESEARCHER ?

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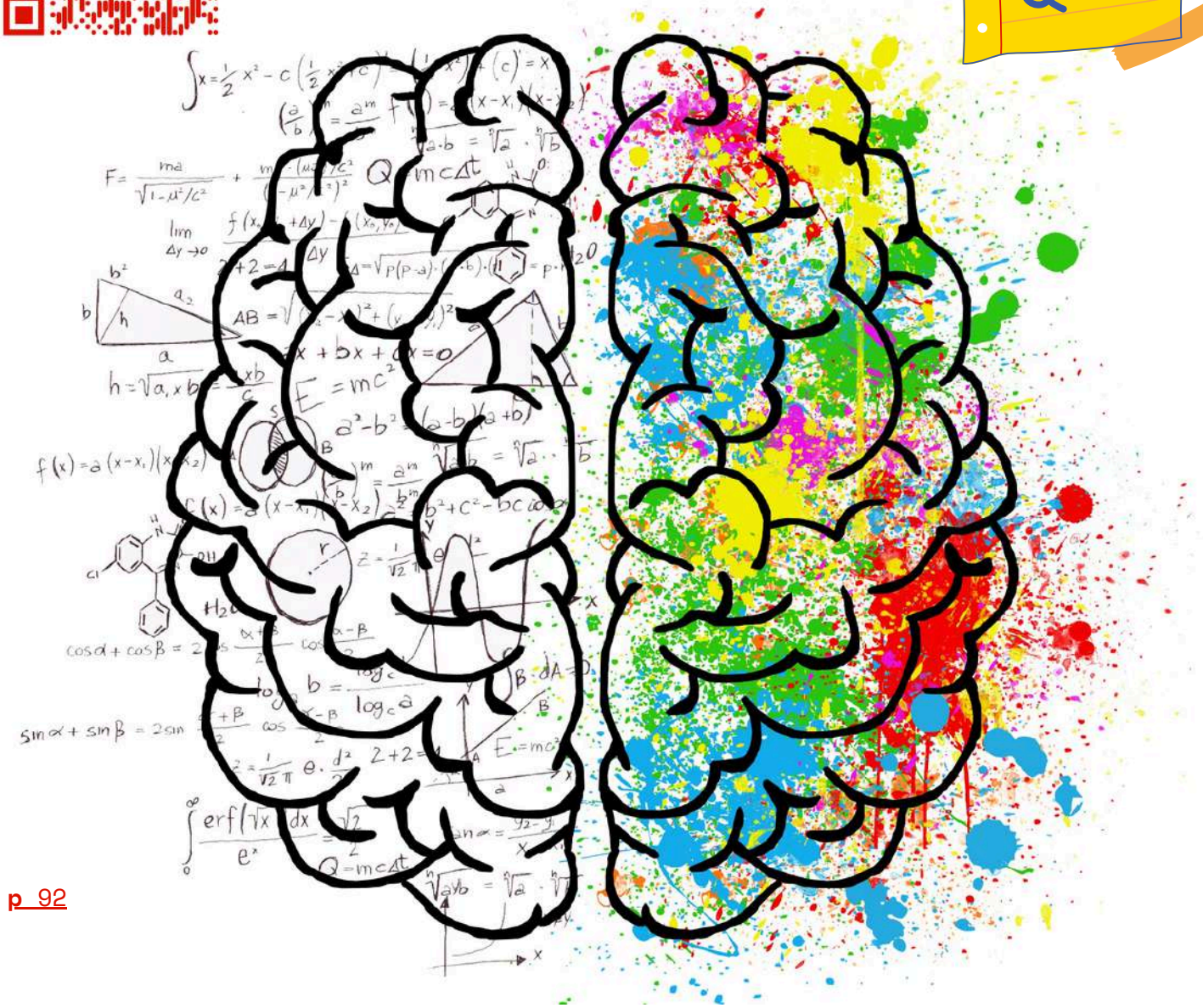
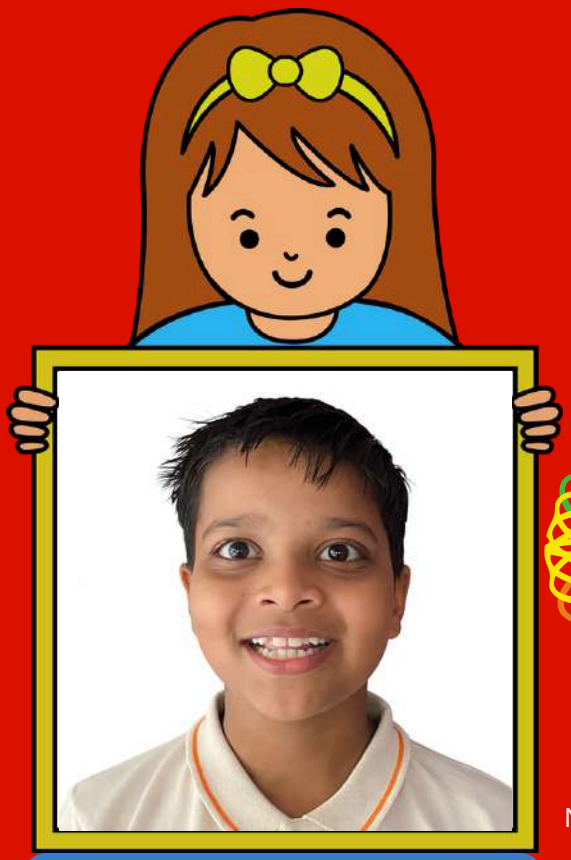
At Rosalind Franklin Council of Scientific Research (RFCSR), we recognize that the pursuit of science is both inspiring and demanding. Alongside the excitement of discovery, researchers often face unique challenges—intense workloads, high expectations, uncertainty about the future, and at times the discouraging experience of non-cooperation within their professional field or the feeling of being stuck in their career path. Such moments can leave even the most dedicated scientists questioning their way forward.

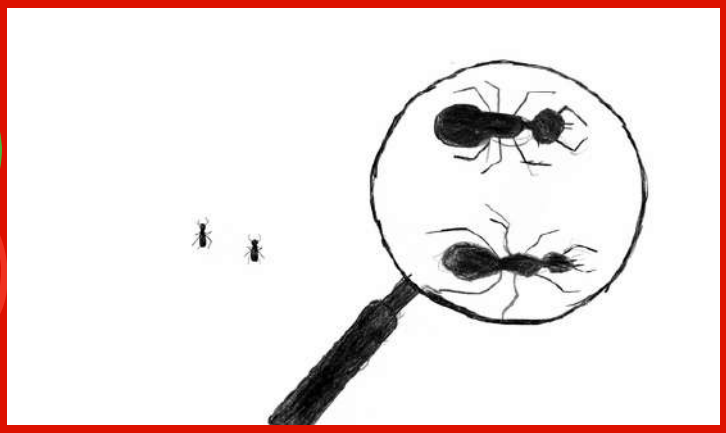
RESEARCHERS LIFELINE RESEARCH HEALTH



p 92

back to school





NAME: **Bighnes Sahoo**

Grade: **4**

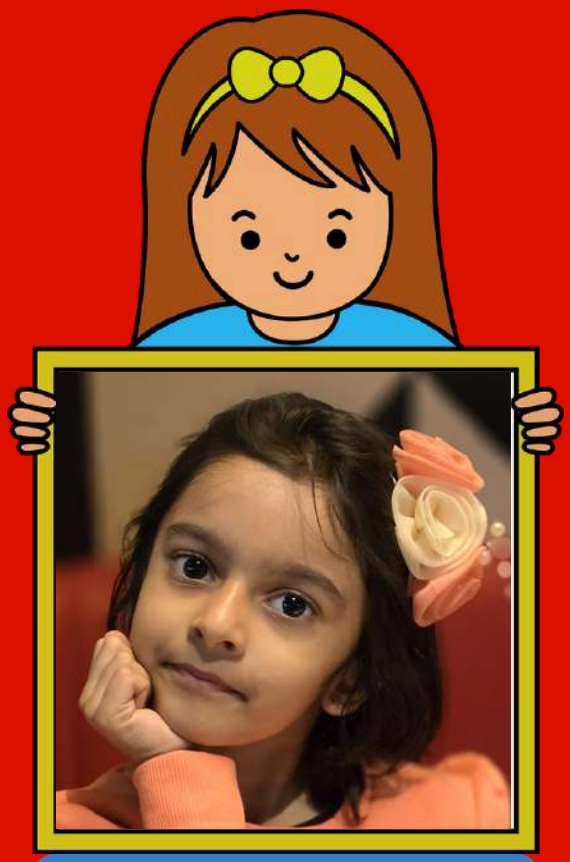
SCHOOL: **Bharati Vidya Mandir, Kendrapara, Odisha, India**

FOCUS:

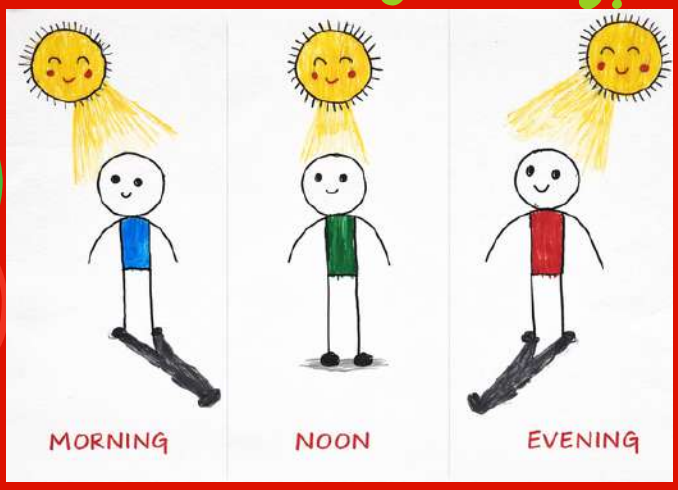
Why do ants look bigger inside the glass?

The glass is called a magnifying glass. It has a special curved shape and is made of a lens. When light from the ant passes through this curved lens, the light bends (this is called refraction). Normally, light travels straight to our eyes, so we see the ant at its real size. But the magnifying glass spreads the light rays before they reach our eyes. Because of this, our brain thinks the ant is coming from a bigger area, so it looks larger and closer.

back to school



CURIOUS KID'S



NAME: **Shivanshi Mahapatra**

Grade: **1**

SCHOOL: **The Kalyani School, Pune, India**

FOCUS:

Why does my shadow keep changing during the day?

Your shadow keeps changing because of how sunlight travels and how the Sun appears to move in the sky. The Sun gives out light that travels in straight lines, and when your body blocks this light, it creates a dark shape called a shadow. As the Earth spins, the Sun seems to move from one side of the sky to the other. In the morning, the Sun is low, so the light comes at an angle and makes your shadow long. At noon, the Sun is almost directly above you, so the light falls straight down and your shadow becomes very short. In the evening, the Sun goes low again on the opposite side, so your shadow becomes long again but in the opposite direction. In simple words, the angle of sunlight changes throughout the day, and that is why your shadow keeps changing.

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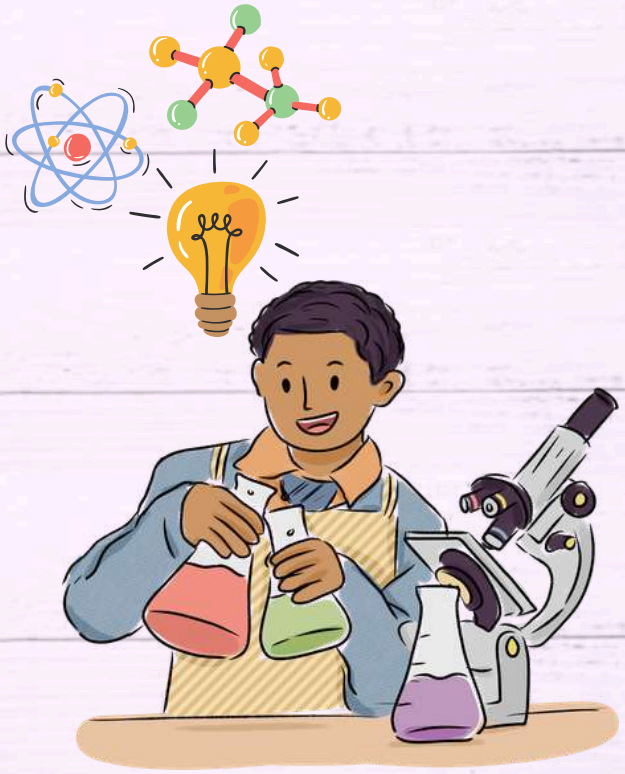

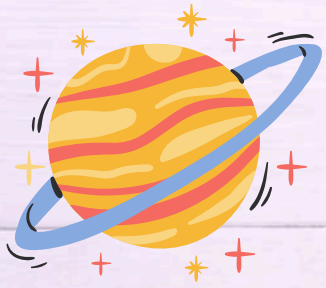

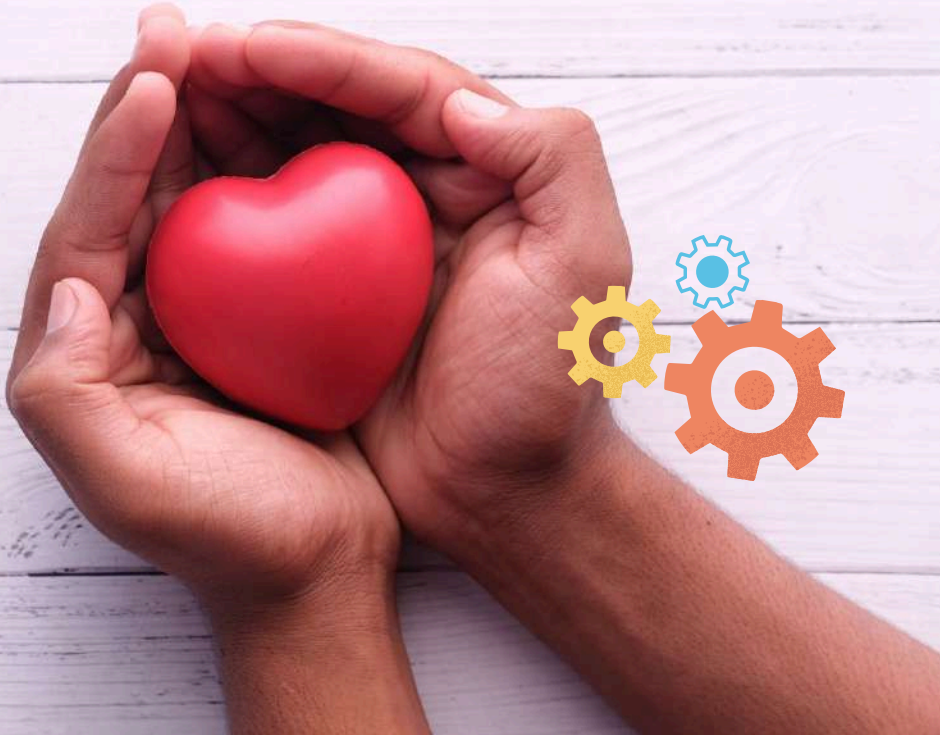

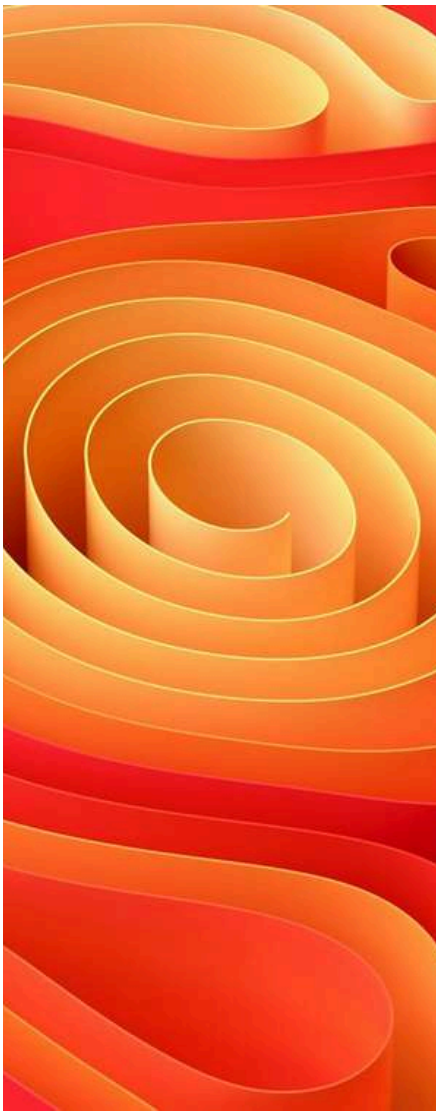

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