

# InSight

A woman with her hair in a ponytail, wearing a green short-sleeved button-down shirt and khaki shorts, stands in a lush green forest. She is holding a black book with a red spine. To her left, a chimpanzee is sitting on the ground, reaching up with its right hand to hold the woman's hand. The background is filled with dense green foliage and trees.

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Remembering Jane Goodall  
Dishari Dasgupta

Science Fiction Quiz

In Conversation with Professor Bikram Dhara  
Subham Sarkar

# Interdisciplinary Frontiers in Modern Science

Foreword by *Prof. Kajaljyoti Borah*  
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The field of science has witnessed significant advancements in recent years driven by diverse disciplines, varied perspectives and lived realities, where insights from one domain illuminate challenges in another. This issue of InScight brings together a collection of studies that explore environmental consciousness, biological sciences, geophysics, and mathematical theory. Together they reflect the growing importance of interconnecting modern research.

It begins by reflecting on the enduring legacy of Dr. Jane Goodall, whose work serves as a reminder that science is not only about discovery but also about responsibility towards protecting biodiversity and studying human evolution through basic research. The world laments the loss of such a selfless human.

Natural hazards always remain a pressing concern. The Bengal Basin is seismically one of the most vulnerable regions due to high density of human population and presence of thick sediments. This amplifies the seismic waves generated even from small magnitude earthquakes. The most recent 21st November 2025, Mw5.4 earthquake that occurred 25 km from Dhaka took lives of 10 people in the region. The study on seismic wave amplification in the Bengal Basin will be helpful for seismic hazard assessment in the region.

Complementing seismic hazards, the present issue is an exploration of interdisciplinary medical research, where the role of sleep-related hormones is examined as a potential candidate in understanding Wilson's disease. It highlights how innovative pathways can be designed to approach complex disorders.

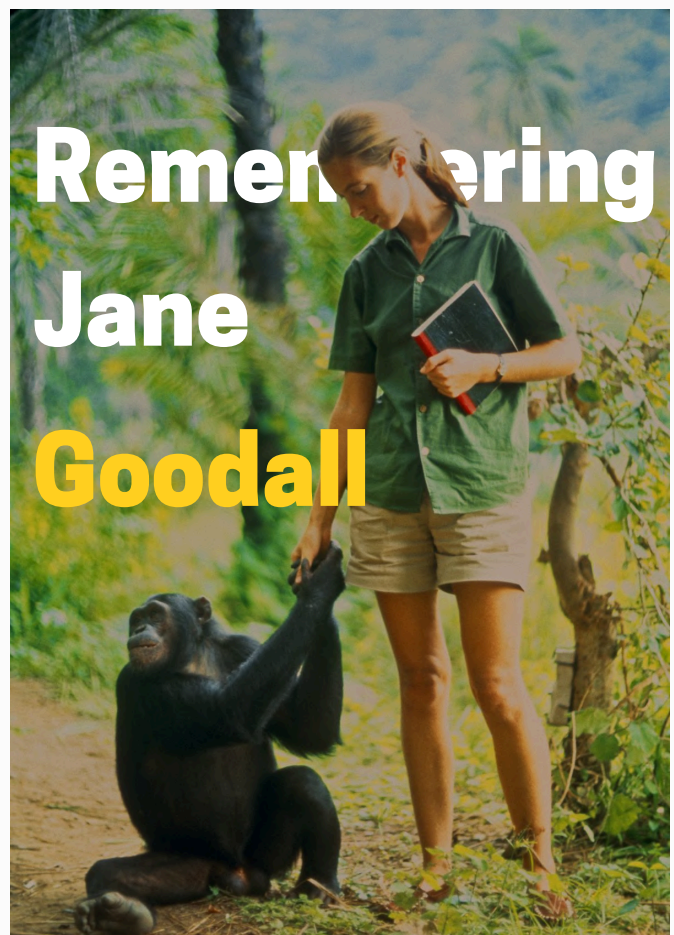
This issue is further enriched by a mathematical exploration of finite points, infinite lines, and elegant proofs which remind us that the real beauty of mathematics lies in its simplicity and logical thoughts.

In addition, Prof. Bikram Dhara has highlighted the phenomenon of brain drain, wherein talented brains migrate abroad in search of better opportunities. This has raised an alarm about how India can retain and empower its brightest minds. Also, the bridge connecting the elegant symmetries of particle physics to the profound abstractions of topology and algebra has been wonderfully presented by Dr. Sridip Pal. It not only challenges our intellect but also the very way we perceive the universe.

This edition not only showcases cutting-edge research but also catalyze reflection on policies, practices and interdisciplinary research. I sincerely appreciate the authors for their valuable contributions, as well as the reviewers and editorial team for their dedication and rigorous efforts. Hopefully, this issue stimulates further research and foster deeper understanding in the related fields.



Enjoy our [pop quiz](#) on works of science fiction.



In her article, Dishari traces how Jane Goodall, a young woman with no formal scientific training, walked into Gombe with a notebook and binoculars and ended up overturning one of humanity's most cherished assumptions — that tool-making, complex social life, and culture belonged to us alone.

# A Word from the Editors

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Editor at InSight, IISER Kolkata

Science does not confine itself to laboratories or lecture halls; it lives in forests, fault lines, and the restless minds of those who dare to ask uncomfortable questions.

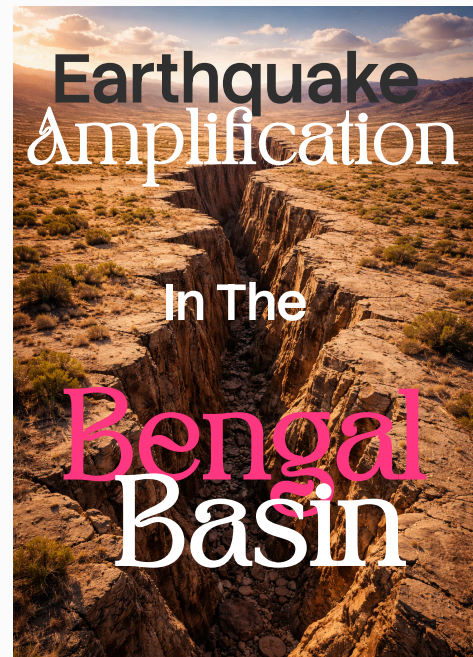
Across the world, research budgets are being slashed, grants are drying up, and scientists are being asked to do more with less. The question of who funds science, and why, has never felt more political. And yet, science persists, in forests, in fault lines, in the quiet determination of researchers who refuse to stop asking questions. It persists in magazines like this one, built not on funding or politics, but on curiosity.

In this issue, we bring to you, a tribute to Jane Goodall, who spent decades amongst the chimpanzees of Gombe and redefined what it means to observe, to empathise, and to advocate. Her legacy continues to inspire many of us.

From the restless earth beneath our feet to the abstract world of mathematics, researchers shed light on how the Bengal Basin shapes earthquake risk in one of the world's most crowded regions. A sleep hormone, long overlooked beyond its role in regulating sleep, emerges as a promising treatment candidate for Wilson disease. And we journey through finite points and infinity lines.

Perhaps the most compelling piece is our conversation with Professor Bikram Dhara, who speaks with candour about the dilemmas facing Indian research today, brain drain, systemic bias, and what he calls the "supersaturation trap." It is a conversation that lingers long after you've finished reading. We also venture to the crossroads of theoretical physics and mathematics, where the boundaries between disciplines blur and some of the deepest questions take shape.

And because curiosity should also be fun, we haven't forgotten to leave you with a smile. Flip to the end for our comics and games, a small reminder that the scientific mind deserves to play as much as it ponders. This is a diverse issue, but its pieces share a common spirit, the refusal to accept the world at face value, and the joy of exploring what lies beneath it.



New research focused on the boundary between the ancient Shillong Plateau and the soft, deep sediments of the Bengal Basin has revealed a mechanism for earthquake wave amplification that is so severe it could multiply shake intensity by two to five times in urban areas. [Read the rest in this article.](#)

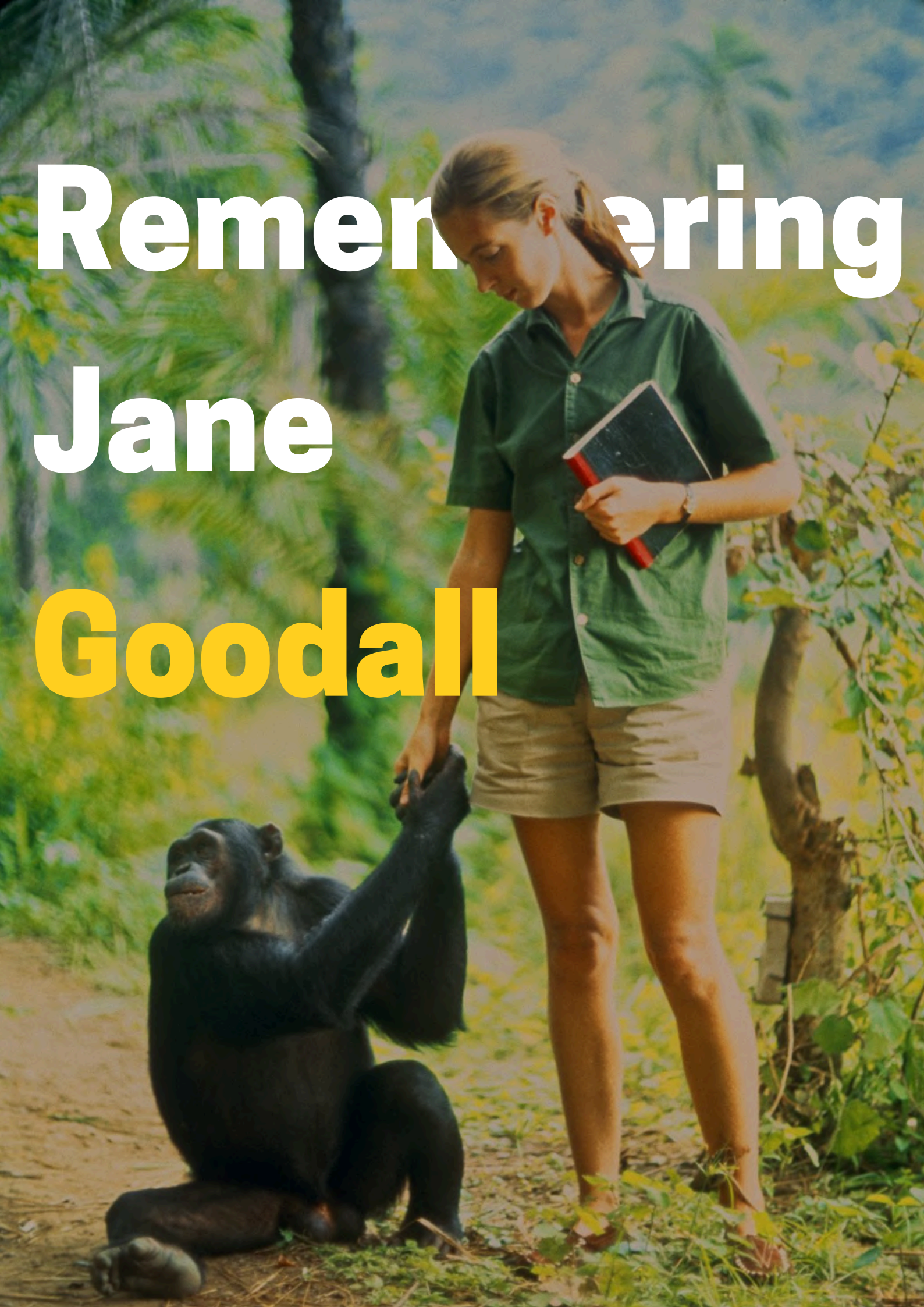
## In Conversation With Bikram Dhara



Prof. Bikram Dhara discusses the evolving mindset of Indian science students, shaped by career pressures and global aspirations. [Read the rest in this interview.](#)

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**Remembering**

**Jane**

**Goodall**

# Remembering Jane Goodall: In the Forest and Beyond

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 Jan 27, 2026

Reviewed By: Ishita Bardhan



**FIG 1:** A photo of Jane Goodall and infant chimp Flint reaching out to each other, captured by her husband Hugo van Lawick in 1964. Long after that, the image continues to influence our perception of chimpanzees. *“When I saw it, though I did not realise it would become iconic, it did make me think of Michelangelo’s painting of God reaching out to Man.”* – Goodall

Dishari traces how Jane Goodall, a young woman with no formal scientific training, walked into Gombe with a notebook and binoculars and ended up overturning one of humanity’s most cherished assumptions – that tool-making, complex social life, and culture belonged to us alone.



\*Dishari Dasgupta\*, currently a PMRF scholar at the Dog Lab, works under the joint supervision of Prof. Anindita Bhadra and Dr. Manabi Paul. Her research focuses on the urban adaptation of free-ranging langurs and their interaction dynamics with free-ranging dogs and humans.

The iconic image of a blonde-haired lady in khaki shorts stretching out her hand towards a baby chimpanzee, and the chimpanzee too stretching out its hand towards the lady in the forest, is still fresh in my mind from when I first saw it back in college.

Out of curiosity, I had tried to find out more about her and got to know her name was Jane Goodall, an iconic primatologist who changed the world’s perception about our non-human primate cousins – the chimpanzees of Gombe. That is also when I realized there is more to life science than the usual cancer-virus-DNA sequences. Cut to 2025, almost a decade after coming across this image, Jane Goodall breathed her last on 1st October at the age of 91. The internet was flooded with obituaries. After all, a legend had died.

## Early Life and Inspiration

To know who she was, it helps to begin before the forest, before the chimpanzees, when she was a little girl named Valerie Jane Morris-Goodall. She was born in London in 1934. Her first encounter with chimpanzees came in childhood through a stuffed toy named Jubilee. Her father left early, and she was raised largely by her mother in a household shaped by strong women. Although she did well in school, university was financially out of reach. In 1953, at nineteen, she enrolled at London’s Queens Secretarial College and went on to hold a series of clerical jobs. Amidst all this, she nurtured within her an ambitious dream: a dream to visit Africa. In 1955, a former school friend invited her to stay on her family’s farm in Kenya. Determined to seize the opportunity, Jane worked as a waitress to save the fare. In 1957, she finally travelled to Africa.

She took an office job in Nairobi, where she met Louis Leakey, a paleoanthropologist studying human evolution. Though he was an academic, he believed that formal training could sometimes limit a person’s capacity for observation, binding them to pre-conceived theories. Jane’s lack of a degree, which would later become one of the strongest criticisms against her, was an advantage to him. Leakey trained her in basic research methods and entrusted her with a task to study wild chimpanzees in what would later become Gombe Stream National Park.



**FIG 2** : Jane Goodall with David Graybeard. In Gombe, the first chimp to lose their fear of Jane was Greybeard. This gave Jane the opportunity to study the complex world of chimpanzee life. [National Geographic / Jane Goodall Institute]

## Work at Gombe Stream National Park

Armed with a notebook and binoculars, Jane arrived at the National Park in the 1960s in her 20s. Authorities did not permit solo women in the forest, so her mother agreed to accompany her. There were no sightings of the wild chimps for the first few months. Eventually, the chimps appeared. And once they did, everything changed.

She documented chimpanzees deliberately choosing grass stems or twigs, stripping leaves from them, and altering their length before inserting them into termite mounds. The termites clung to the probe, which the chimpanzees then withdrew and consumed. This work, published in *Nature* (1964), demonstrated that tool use occurred in the wild and that these tools were made for a specific purpose. This finding was revolutionary because it challenged the long-held definition of humans as “the toolmaker.” By showing that chimpanzees could not only use but also modify objects for a specific task, Goodall provided the first clear evidence that the capacity for purposeful tool-making was not unique to our species, fundamentally altering the understanding of this boundary between humans and other animals. Louis Leakey responded with a line that became legendary: “Now we must redefine tool, redefine man, or accept chimpanzees as humans.” The findings reframed chimpanzees as cognitive agents capable of planning, learning, and problem-solving, laying the foundation for modern primate cognition research (Goodall, 1986; McGrew, 2010). Her subsequent research in the following decades further revealed that these free-living chimps of Gombe had social hierarchies, alliances, maternal bonds, territorial fights, male infanticide, and cannibalism. The world reacted to her findings with both appreciation and criticism. She named her chimpanzees instead

of numbering them, a practice critics dismissed as anthropomorphism. Many pointed out her lack of formal scientific training and statistical rigour in the early years. Goodall responded to part of this criticism by earning a PhD from Cambridge under the mentorship of Robert Hinde, becoming one of the few people admitted to a PhD programme without an undergraduate degree.

Her visibility grew when she met her first husband, Hugo van Lawick. His photographs and films for National Geographic carried Gombe into living-room televisions across the world. One of those images, the same one that I mentioned in the beginning, came to define her in the public imagination. Leakey’s institutional backing, paired with van Lawick’s captured imagery, helped secure the grants that kept the research project running.

## Criticisms and Scientific Debate

But the spotlight created a simplified story of Jane Goodall alone in the forest, quietly erasing the native Tanzanian field assistants whose knowledge and labour sustained the research. This omission has since become a central point in broader critiques of how scientific fieldwork, particularly in colonial and post-colonial contexts, has historically overlooked the contributions of local collaborators. Their absence from authorship and intellectual credit is now recognized as part of a larger pattern of structural bias in early primatology.

In 1975, the Gombe project was shaken when four young researchers linked to Jane Goodall were kidnapped at night by rebels associated with Laurent Kabila. In her memoirs, Goodall mentions the incident briefly, framing it as one of many dangers of working in a politically unstable region and focusing on the



**FIG 3 :** The Jane Goodall Institute is a global organization founded by Dr. Jane Goodall in 1977. It works in 6 African countries and supports the rehabilitation of chimpanzees, alongside conservation projects. [Jane Goodall Institute]

relief of the researchers' eventual release. However, contemporary media accounts were far less restrained in their reporting. They detailed the beatings, the weeks of captivity, and the ransom, eventually raised by the families, while questioning why neither institutions nor senior leadership took a more visible public stand. This crisis left a haunting question for everyone, one that extends beyond Gombe: when science crosses borders and goes to the field, who is responsible for the safety of the people who make it possible?

## Conservation and Advocacy

By the 1980s and 1990s, she gradually shifted from daily field research and moved towards advocacy. She founded the Jane Goodall Institute and redirected her efforts to community-based conservation, education, and livelihoods. This transition into advocacy came to define the latter half of her life. She became a global voice on conservation ethics, fearlessly advocating for policies that protect the environment. Her commentary often extended to world leaders, whom she consistently urged to prioritize science and environmental health over short-sighted political or economic gains.

## Legacy

Jane Goodall – a celebrity scientist, a global advocate, an icon. But to understand her legacy, we must focus on her journey and not just the outcome. The journey of a woman who ventured out with a notebook and binoculars to explore the world of free-living chimpanzees. She quietly redefined what it meant to be a field-based researcher in academia. Demonstrated

that the previously known boundaries differentiating between human and ape were not rigid.

Her story also reminds us that science is a method that can be used by people, who were not formally trained in their 'formative' years, to go on to do great work in future, given the right mentorship, generous funding agency, great visual storytelling, and timing.

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# Earthquake Amplification

In The

Bengal  
Basin

# Earthquake Amplification in the Bengal Basin: Insights into Basin-Induced Seismic Hazard

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Nov 01, 2025

Reviewed By: Suddhajit Bishayee, Shibaraj Sahu, Sushrat Mishra

The Asian megacities of Kolkata and Dhaka sit atop the sediment-filled expanse of the Bengal Basin, one of world's most densely populated but far from the Great Himalayas. New research focused on the boundary between the ancient Shillong Plateau and the soft, deep sediments of the Bengal Basin has revealed a mechanism for earthquake wave amplification that is so severe it could multiply shake intensity by two to five times in urban areas.



\*Baibhab Karmakar\* is a 4th year BS-MS student at IISER Kolkata, pursuing studies in geosciences and computer science under the joint supervision of Prof. Supriyo Mitra and Dr. Arjun Datta. Beyond academics, he is passionate about photography and actively engages in sports, balancing scientific curiosity with creative and athletic pursuits.

The Asian megacities of Kolkata and Dhaka sit atop the sediment-filled expanse of the Bengal Basin, one of the world's most densely populated region but far from the Great Himalayas. For decades, seismic hazard assessments have focused heavily on major fault lines and rupture zones, but a critical, often underestimated factor is now demanding attention – the ground itself.

New research focused on the boundary between the ancient, rigid Shillong Plateau and the soft, deep sediments of the Bengal Basin has revealed a mechanism for earthquake wave amplification that is so severe it could multiply shake intensity by two to five times in urban areas. This work highlights a global imperative to move beyond simplified velocity models and account for the complex interaction between earthquake waves and the heterogeneous, soft subsurface.

## Understanding Seismic Wave Amplification in the Bengal Basin

The world of seismology is rich with complexities, especially in regions where geological structure strongly controls how seismic waves travel and evolve. This is particularly true in the Bengal Basin, where thick sedimentary layers [1] overlying transitional crust can significantly modify ground motion, making seismic hazard assessment more challenging. In such settings, soft, loose, and water-saturated sediments can amplify shaking, prolong wave trains, and in some cases enhance damage through secondary effects like liquefaction. Historical earthquakes from the broader eastern India–Himalaya–NE India region provide striking examples of how this can play out in practice: the 1934 Bihar–Nepal earthquake (Mw 8.1) is often cited for severe destruction patterns that were influenced not only by the rupture itself but also by the amplification of shaking in sediment-filled basins and plains, helping illustrate how distant earthquakes can still produce disproportionately strong impacts in soft-ground regions (bhookampan.co.in). Similarly, the 1897 Shillong earthquake (Mw 8.1) caused widespread shaking across northeastern and eastern India, with later reports and hazard documents noting that alluvial and deltaic deposits—such as those beneath Kolkata and surrounding areas—can intensify ground motion compared to hard rock (wbmd.gov.in);

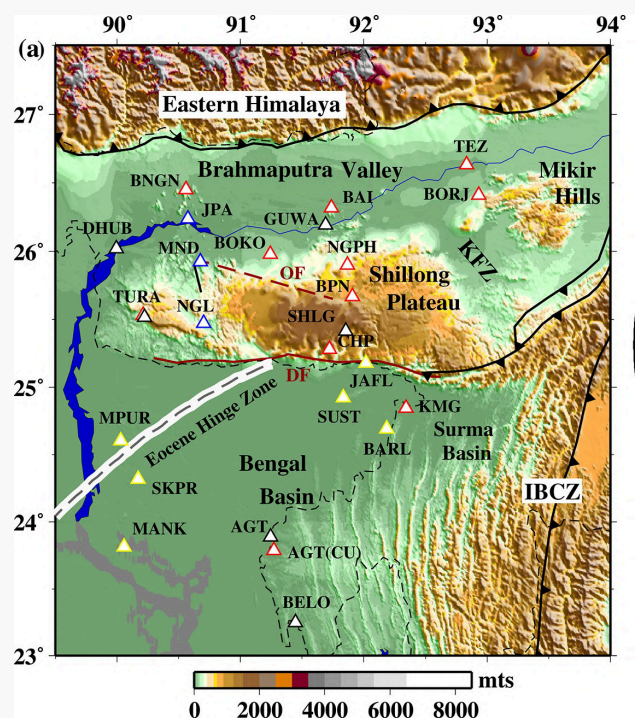


FIG 1: Topographic and seismotectonic map of our study area

cires1.colorado.edu). Further, large events like the 1950 Assam–Tibet earthquake ( $M_w$  8.6–8.7) demonstrate how unconsolidated, saturated sediments can contribute to destructive ground failures, including sand blows and lateral spreading—mechanisms that are especially relevant for thick sedimentary basins such as the Bengal delta system (sciencedirect.com). For readers eager to explore these dynamics in depth, our analysis of the Bengal Basin highlights how sedimentary architecture and local site conditions can strongly shape seismic wave behaviour—and ultimately influence seismic risk across the region.

## The Geophysical Context

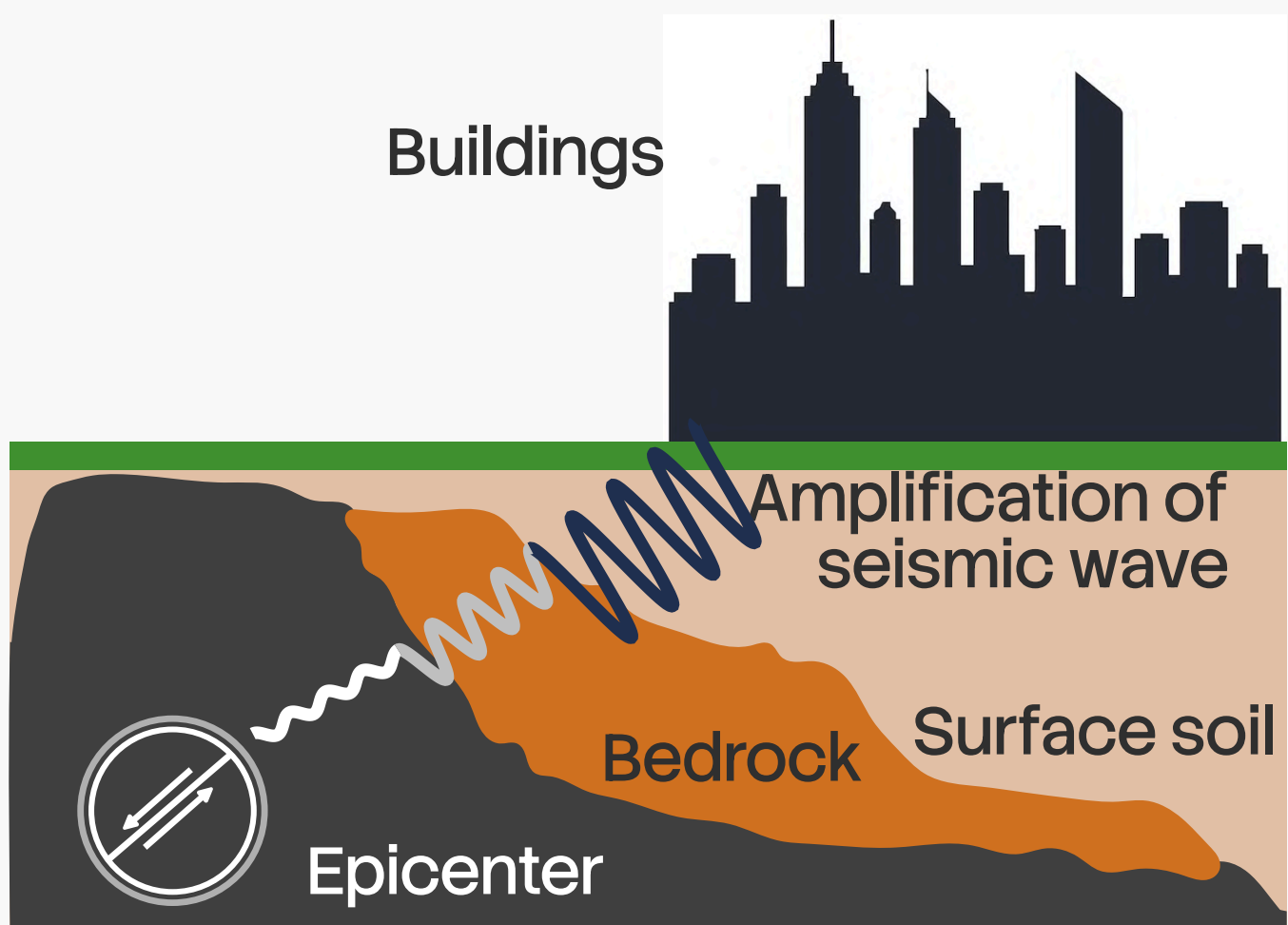
At the heart of our study lies the interaction between surface waves and geological structures. The Bengal Basin is known for its considerable sedimentary deposits, which contrast sharply with the more stable crystalline rocks of the Shillong Plateau. In between these contrasting geological structures the Dauki Fault is present, which acts as a discontinuity between them. This transition creates conditions conducive to the amplification of seismic surface waves, a critical factor that can influence the intensity of seismic shaking during earthquakes [2].

When seismic surface waves travel from the dense, rigid terrain of the Shillong Plateau into the softer, sediment-filled valleys of the Bengal Basin, several factors come into play. Primarily, the lower shear-wave

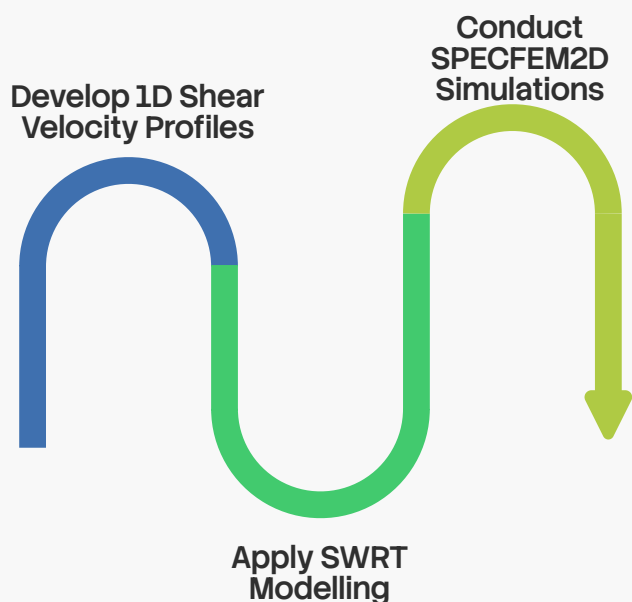
velocities intrinsic to the sediments and the impedance differences across the boundary of these terrains lead to significant surface wave amplification [2]. From an energy-conservation viewpoint, the seismic wave carries energy (energy flux) as it propagates. When it enters soft sediments, the wave speed drops sharply; to transmit nearly the same energy across this slower medium, the particle motion must increase; so the ground oscillates with larger amplitude. In addition, the impedance contrast at the bedrock–sediment boundary causes partial reflections, trapping energy inside the sediment layer and further enhancing shaking through resonance. This phenomenon is crucial for understanding the potential seismic hazards faced by nearby urban centres, which often occupy these sedimentary basins.

## A Tectonic Fault Line: Hard Rock Meets Soft Sediment

The danger zone lies along a stark geological transition. To the north, the Shillong Plateau is composed of crystalline bedrock, a dense, high-velocity crustal block [5] that serves as a relatively stable foundation. In stark contrast, the adjacent Bengal Basin is a colossal bowl of earth, filled with thick layers of Cenozoic and Quaternary sediments; silt, sand, and clay; deposited by the mighty Ganga and Brahmaputra River systems over millions of years[1].



**FIG 2 :** Conceptual diagram illustrating seismic wave amplification as waves propagate from bedrock into soft surface soils, producing stronger ground shaking at the surface and higher impact on buildings.



**FIG 3 :** Workflow for surface-wave amplification analysis showing the main steps: development of 1D shear-wave velocity ( $V_s$ ) profiles, SWRT-based modeling, and numerical validation using SPECFEM2D simulations

The key scientific problem, and the source of the amplified shaking, is the impedance contrast at the boundary where these two terrains meet. Seismic waves travel through hard, crystalline rock (like the Shillong Plateau) quickly. When these waves encounter the much softer, lower-density sediments of the Bengal Basin, they behave like a fast car hitting a patch of deep mud: they slow down drastically.

This sharp change in velocity, specifically the lower shear-wave velocities ( $V_s$ ) in the basin sediments, causes the seismic energy to be concentrated and amplified. In addition, several other mechanisms can further enhance seismic wave amplification in sedimentary basins, including (i) resonance effects when the incoming wave frequency matches the natural frequency of the sediment column, (ii) basin geometry and edge effects, where waves are reflected and focused within the basin, leading to localized “hot spots” of stronger shaking, and (iii) wave trapping and multiple reflections between the sediment-bedrock interface and the free surface, which can prolong shaking duration and increase surface motion. This effect is particularly pronounced for surface waves, which travel along the Earth’s surface and carry a majority of the destructive energy, especially at lower frequencies.

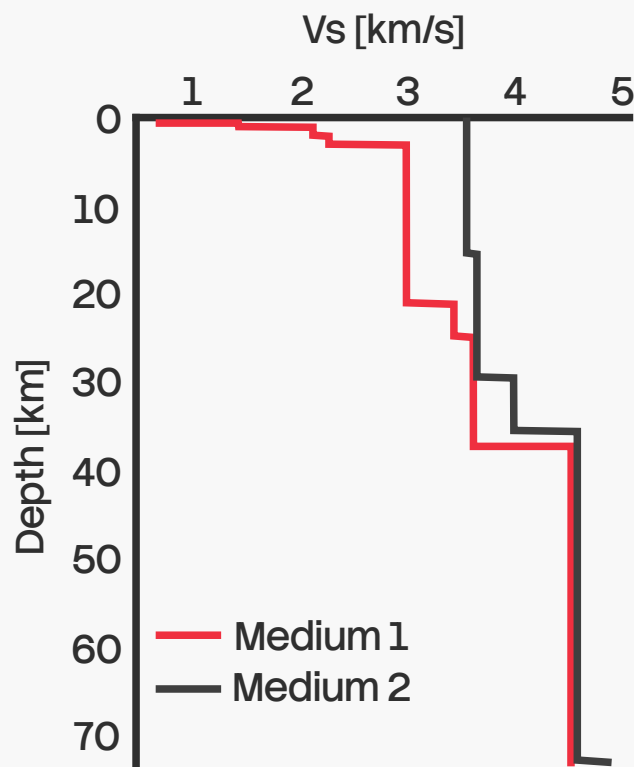
### Methodology: Shear Velocity Profiles and Modeling Techniques

To analyse the challenges posed by seismic amplification in this region, we employed a comprehensive approach using one-dimensional shear velocity profiles derived from various sites within the Bengal Basin and its adjacent crystalline terrains. Our study employed two main modeling approaches: semi-analytical simulations of surface wave propagation using SWRT (Surface Wave Reflection and Transmission) [4], and full waveform modeling with SPECFEM2D [5]. The outcomes from both methods were then compared with real seismic observation dataset to validate the results.

The first computational method used was SWRT. This technique is semi-analytical, meaning it uses simplified mathematical equations to model how surface waves propagate across a sharp, vertical boundary—the kind that separates the Shillong Plateau from the Bengal Basin.

A crucial capability of SWRT is its ability to explicitly incorporate mode conversion, i.e., the process in which seismic wave energy is redistributed into different wave modes when it encounters a strong contrast in subsurface properties. As a surface wave (such as a fundamental Rayleigh or Love wave) reaches a boundary, it cannot continue in the same form entirely; instead, part of its energy is transferred into other modes, often generating higher-mode surface waves that propagate differently through the layered basin sediments. This mechanism of energy conversion helps trap seismic energy and redistribute it within the basin, contributing to the overall amplification.

The SWRT results were then validated using SPECFEM2D, a more computationally intensive full waveform simulation tool. SPECFEM2D solves the complete elastic wave equation, providing a highly accurate, dynamic picture of how the entire seismic wavefield interacts with the two-dimensional geological structure. By showing where the energy goes, SPECFEM2D essentially acts as a high-fidelity ‘virtual seismograph’ to confirm the predictions of the more simplified SWRT model.



**FIG 4 :** S-wave Velocity Profiles. This figure shows the S-wave (shear-wave) velocity variation with depth for two distinct regions: Medium 1 representing the Shillong area, and Medium 2 representing the Agartala area.

## The Terrifying Forecast: Two to Five Times Higher Amplitudes

The predictions from both independent modeling techniques were starkly consistent: Both SWRT and SPECFEM2D predict 2-5 times higher amplitudes in the Bengal Basin sediments than in the adjacent crystalline terrain.

This significant amplification occurs across a crucial frequency band: 0.01-0.15 Hz. This low-frequency range is particularly dangerous because it corresponds to the natural resonant frequencies of tall structures like high-rise buildings and bridges [6]. The amplified shaking at these frequencies can drive buildings into destructive resonance, magnifying structural damage far beyond what would be expected based solely on the earthquake's magnitude.

## Confirmation from the Earth

Crucially, these computational predictions were not just theoretical. We compared their calculations to observations from a regional earthquake recorded at actual seismic stations located on both the plateau and the basin. The analysis revealed that the observed amplification, particularly in the transverse component of the ground motion, showed good agreement with the model predictions. This observed match confirms that the combined effects of the low shear-wave velocity [7] and mode conversion at the lateral discontinuity are evident and must be integrated into future hazard models.

## Future Directions and Importance of the Study

Our study is just the beginning. We are committed to expanding our research by analysing a more extensive dataset, focusing on both the vertical and radial components of seismic waves. By further refining our understanding of wave propagation in this dynamic environment, we hope to develop more robust models for predicting seismic hazards in megacities situated on complex sedimentary basins.

The implications of our findings are immense; not only for the affected regions but also for the global community. As urban populations continue to grow and megacities emerge in geologically diverse areas, understanding the effects of lateral heterogeneities and sedimentary basins becomes paramount. Building resilience in these urban structures requires meticulous seismic hazard assessments informed by accurate geophysical models.

## Conclusion

For science enthusiasts, the exploration of the Bengal Basin serves as a fascinating case study of how geological structures can mediate seismic risks in urban contexts. By understanding wave amplification, we help improve seismic hazard assessment and reduce earthquake risk for communities living in vulnerable sedimentary regions. As our research progresses, we invite continued engagement and curiosity from both academic and public spheres as we strive to enhance our understanding of seismic dynamics in sedimentary basins around the globe.

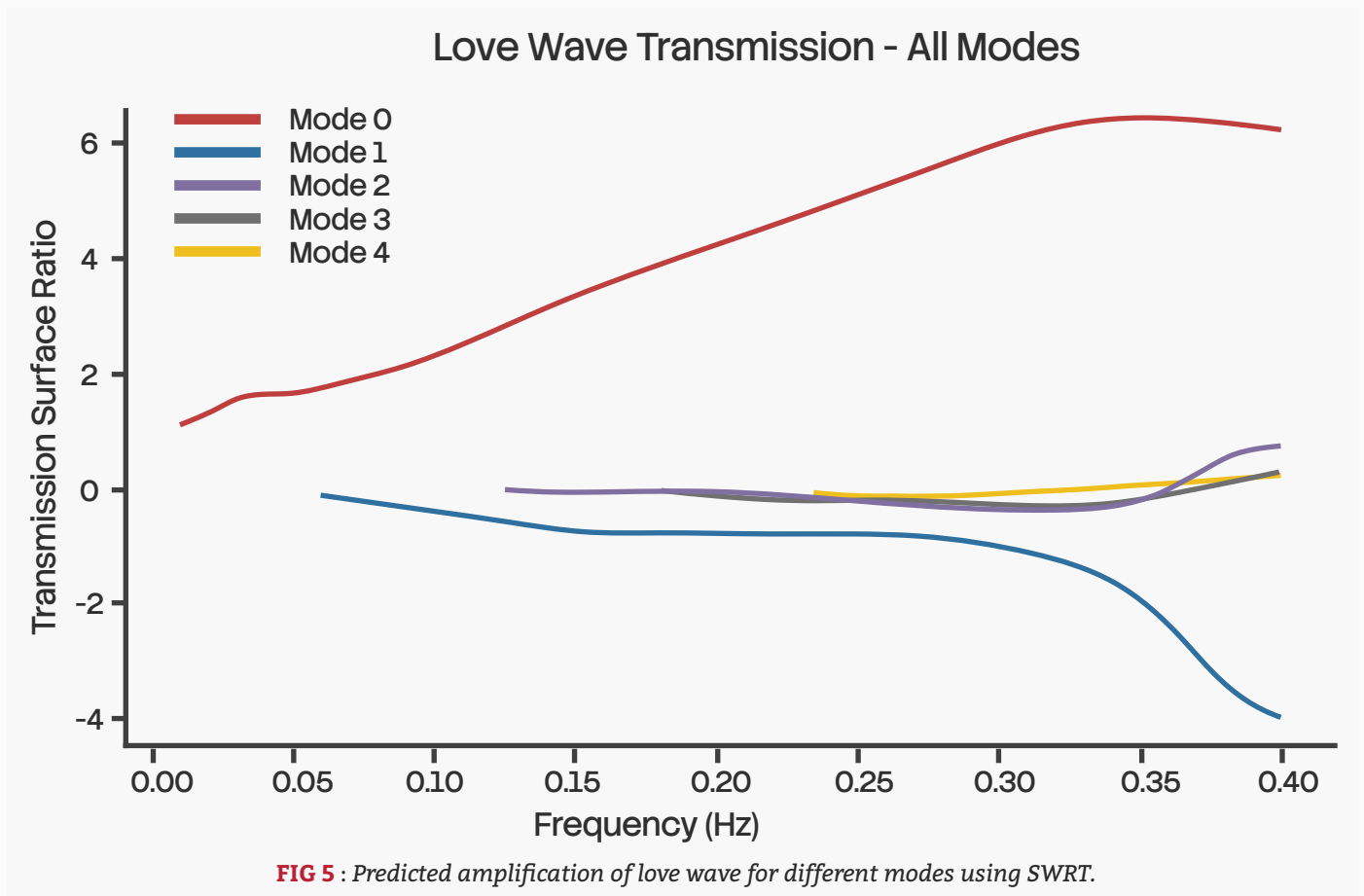
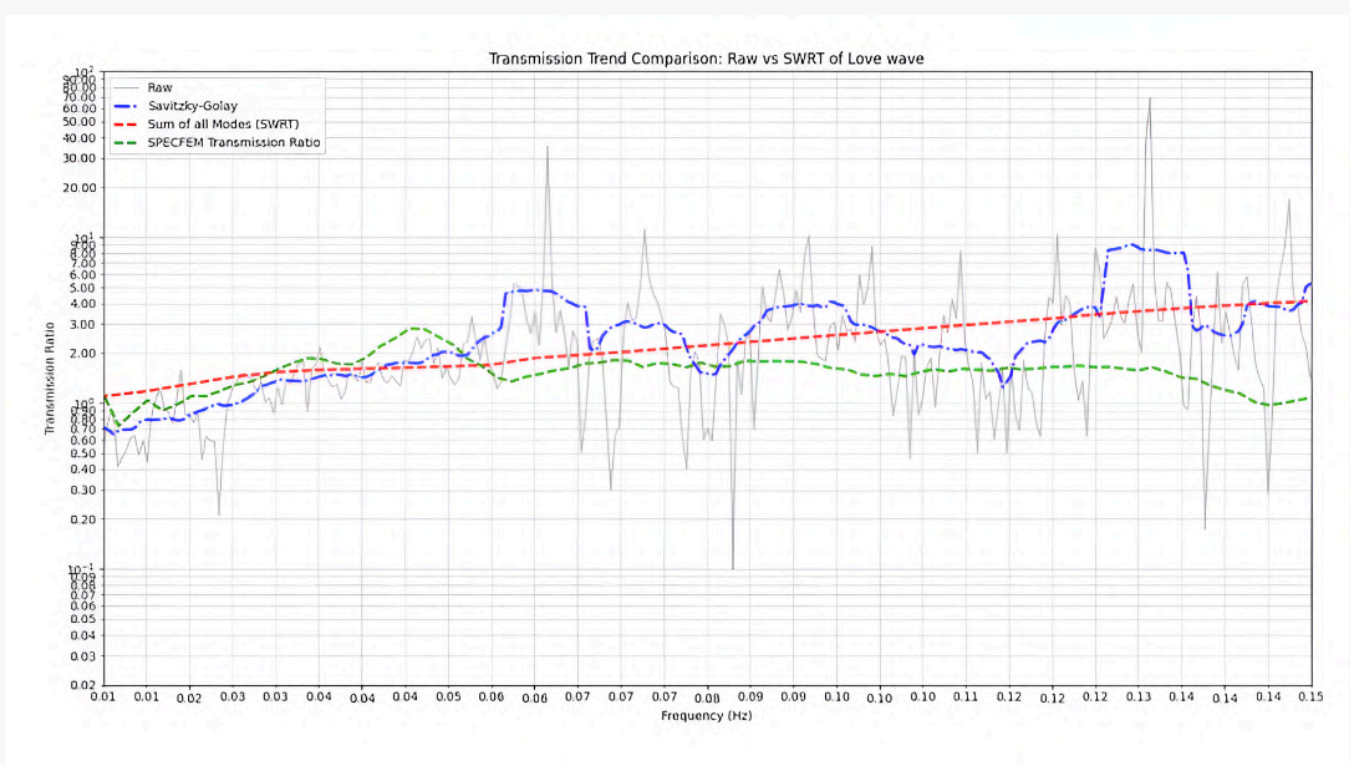


FIG 5 : Predicted amplification of love wave for different modes using SWRT.



**FIG 6 :** Frequency-dependent transmission ratio of Rayleigh waves comparing the raw observed trend with SWRT-based predictions. Smoothed curves (moving average/LOWESS) highlight the overall amplification pattern, while the sum of all SWRT modes is compared against the SPECFEM transmission ratio to evaluate the model's agreement with numerical observations.

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# How A Sleep Hormone



Became A  
Drug Candidate  
For  
Wilson Disease

# How a Sleep Hormone Became a Drug Candidate for Wilson Disease

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Dec 22, 2025

Reviewed By: Debanuj Chatterjee

**Wilson disease occurs due to toxic copper accumulation** and oxidative stress, yet current therapies only chelate excess copper but do not reduce oxidative stress. This study repurposes melatonin as a dual-action molecule that both chelates copper and modulates redox imbalance.



\*Raviranjana Pandey\* is a final-year PhD student in the Department of Biological Sciences at IISER Kolkata. His curiosity about biological processes began during his undergraduate years, when learning how each biological process works at a molecular level gave him a deep sense of satisfaction, excitement, and happiness.

I have always enjoyed solving problems and finding simpler ways to approach complex tasks, both in everyday life and in research. After completing my Master's degree, I sought research opportunities focused on the therapeutic aspects of diseases, in particular metabolic and neurodegenerative disorders. To pursue that research path, I joined the laboratory of Prof. Arnab Gupta in the year 2021. There in the initial days, while I was learning the fundamentals of copper metabolism an idea sparked in my head: could we develop better therapeutic molecules for Wilson disease, a disorder of copper metabolism? Thus, transforming this biological problem into a potential therapeutic solution became the primary driving force behind my PhD research.

## Understanding the problem – copper: vital for life, dangerous in excess

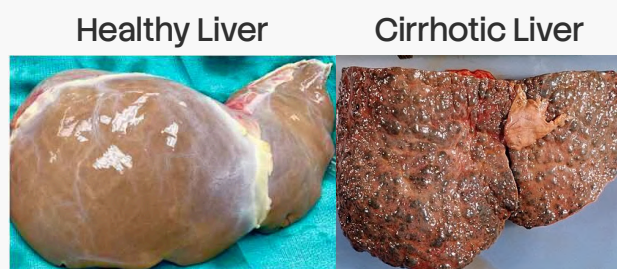
The use of copper is a common aspect of day-to-day life; it transports electricity through wires, provides

utensils for domestic use, and has been used for tools and weaponry since ancient times. In living organisms, copper is also vital, as it forms essential cofactors for enzymes that drive various physiological processes including ATP production. It also supports immune defence by allowing the antimicrobial activity of specific immune cells and helps protect cells from oxidative damage through antioxidant enzymes[1].

This useful nature of copper, however, has a dangerous duality. Its capacity to change between two oxidation states  $Cu^+$  and  $Cu^{2+}$ , while giving it biological utility, also has the potential to be toxic. Copper can produce extremely reactive free radicals during these redox transitions which can damage biomolecules such as proteins, lipids, and DNA that are essential for survival[2].

Cells use specialized proteins, mainly Copper transporter 1 (CTR1), ATP7B, and ATP7A, to maintain an optimum copper level in the body, in order to prevent copper toxicity. While ATP7B and ATP7A export excess copper outside of the cells, CTR1 imports copper within cells. Whenever there is a disturbance in copper homeostasis, it leads to different copper metabolism disorders such as Wilson Disease[3]. Wilson disease is a rare genetic disorder (affecting about 1 in 30,000 people worldwide) caused by mutations in ATP7B, the liver's main copper-exporting protein. When ATP7b fails to perform its exporting function, copper builds up in the liver and later in the brain, leading to symptoms such as liver damage (Fig 1), movement disorders, psychiatric changes, and eye discoloration known as Kayser–Fleischer rings (Fig 2)[4].

Current treatments for Wilson Disease mainly focus on removal of copper from the body. Chelating agents, such as Trientine and D-penicillamine, can lower the copper burden and slow the progression of Wilson disease but they do not directly address oxidative stress which is the major cause in Wilson disease. Use of chelating agents also worsen neurological conditions and cause systemic toxicity in some patients. This therapeutic gap raised a crucial question: rather than just using a copper chelator,



**FIG 1:** Healthy individual liver Vs Cirrhotic liver in Wilson Disease

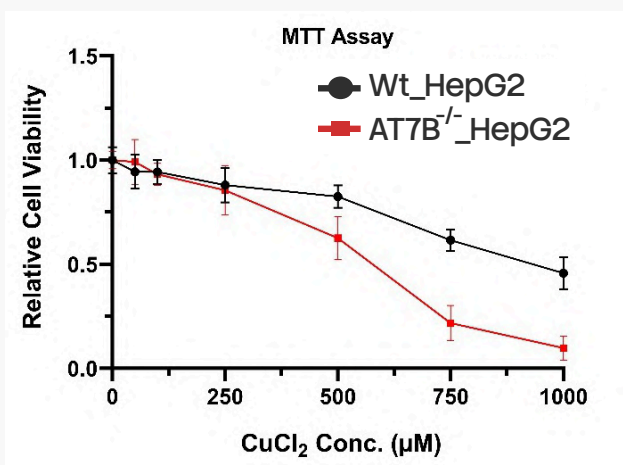


**FIG 2 :** Eye discoloration in Wilson Disease Patient. [Source: Wilson Disease Association]

can we develop a molecule that can both regulate copper and prevent the oxidative damage it causes?

That question became the seed of my PhD journey.

When I began my doctoral research, I did not anticipate that a familiar, over-the-counter molecule, **melatonin**, would emerge as an unexpected candidate for my study. Melatonin is best known for regulating sleep and circadian rhythms. Meanwhile, the scientific literature pointed at melatonin’s antioxidant capabilities and its ability to bind with metal ions. Recent clinical observations revealed something far more interesting: disruptions of normal sleep patterns often accompany the course of Wilson disease[5]. Therefore, a natural question to ask was: **could this endogenous, safe molecule, melatonin, have a larger role in our body other than regulation of sleep?** Can it be repurposed for the management of Wilson Disease? What started as a physiological curiosity quickly morphed into a deeper biochemical question: could melatonin interact directly with copper, other than in its role as a hormone? Could it stabilize redox imbalance and mitigate oxidative stress, the central drivers of tissue damage in Wilson disease? This hypothesis, a mere intellectual itch at the stage,



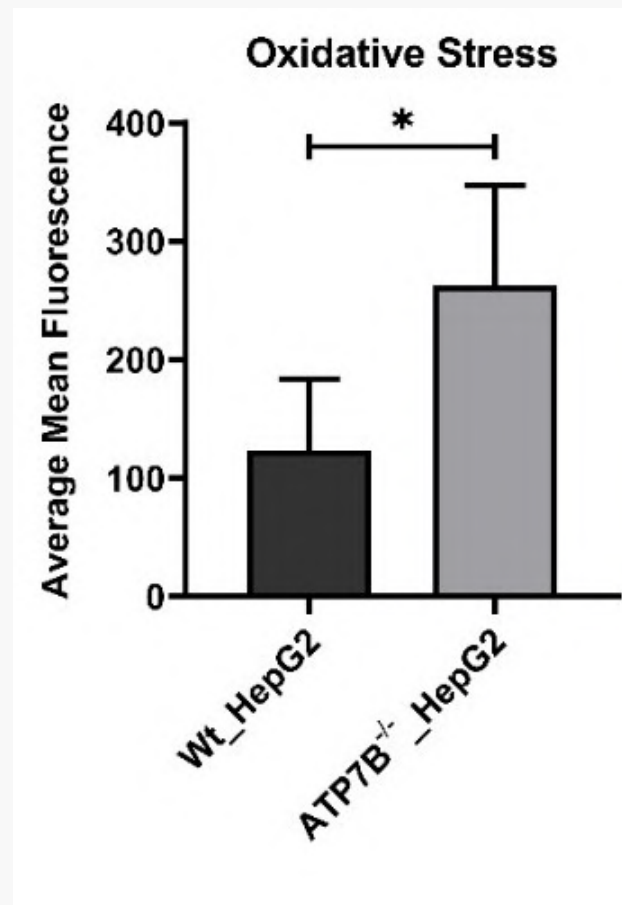
**FIG 3 :** Cell Viability assay showing cells lacking ATP7B are more sensitive to copper

crystallized as the very foundation of my PhD work. This was followed by a scientific odyssey, ranging from cell biology, redox chemistry, biophysical techniques, and nanotechnologies, arriving at organism-level models. Herein, the article traces how a small idea was tested, refined, and then transformed into a coherent scientific argument; a manifestation of how, during a PhD, following a question rather than a predefined outcome shapes the arc.

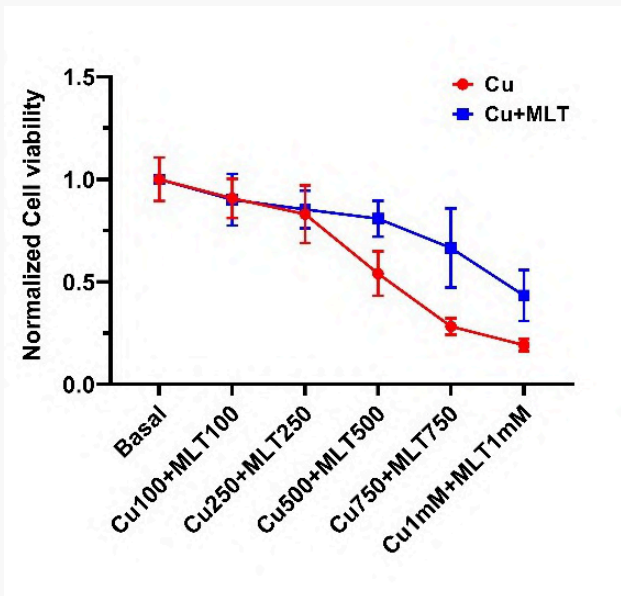
## The first clue: a cell line that tells a story

To study copper toxicity, we created a simple disease model by using CRISPR to delete ATP7B in a human liver cell line (HepG2). Because the liver is the main organ affected in Wilson disease and ATP7B is its key copper exporter, removing this gene causes copper to accumulate in HepG2 cells—closely mimicking the Wilson disease phenotype in ATP7B<sup>-/-</sup>\_HepG2. Using this model, we compared the copper toxicity of the normal liver cell line (WT\_HepG2) with cells lacking ATP7B (ATP7B<sup>-/-</sup>\_HepG2). When both were exposed to copper, cell survival dropped in each case, but the ATP7B-deficient cells were far more sensitive. Without the ability to export copper, these cells accumulated higher copper levels and suffered more severe damage (Fig 3).

We compare the oxidative stress level of ATP7B<sup>-/-</sup>\_HepG2 with WT\_HepG2 cells, we found increased level of oxidative stress, which is the primary reason for the sharp decrease in cell viability ATP7B<sup>-/-</sup>\_HepG2,



**FIG 4 :** Due to excess copper accumulation, there is more oxidative stress in ATP7B<sup>-/-</sup> HepG2 cells.



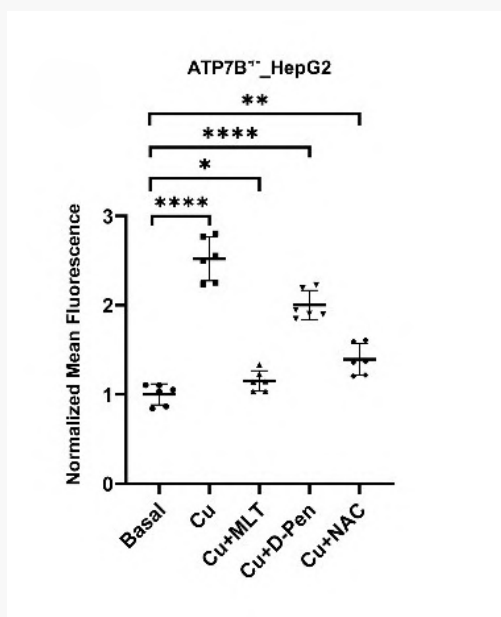
**FIG 5 :** Cell Viability has improved after melatonin treatment.

following the contemporary cellular model for Wilson Disease (Fig 4).

### A surprising therapeutic candidate

Based on both our observations and earlier studies, oxidative stress emerged as a major candidate that could drive of tissue damage in Wilson disease[6].

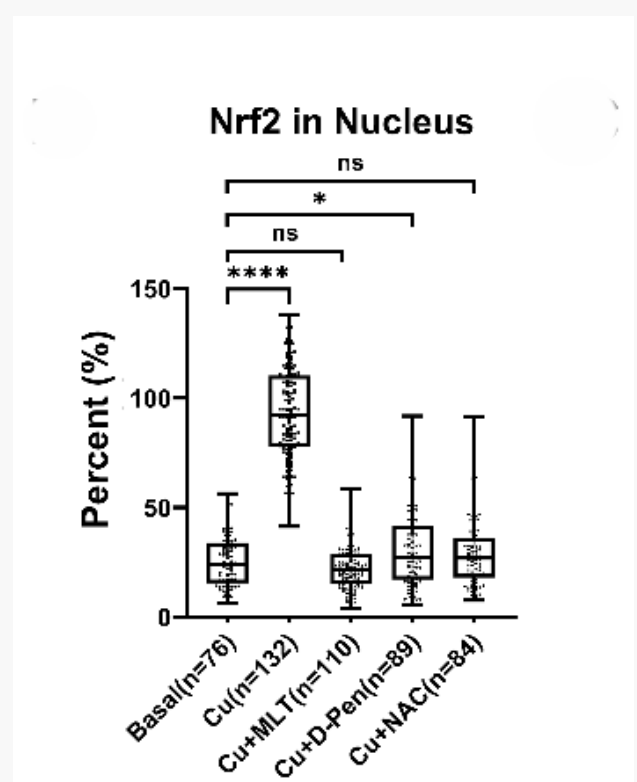
This led us to rethink conventional treatment strategies. Instead of focusing only on copper removal, we asked whether additional antioxidants property might offer a more logical and complementary therapeutic approach or not. From the literature survey, one molecule stood out i.e., melatonin. Best known for regulating sleep, melatonin is also an endogenous, safe, and FDA-



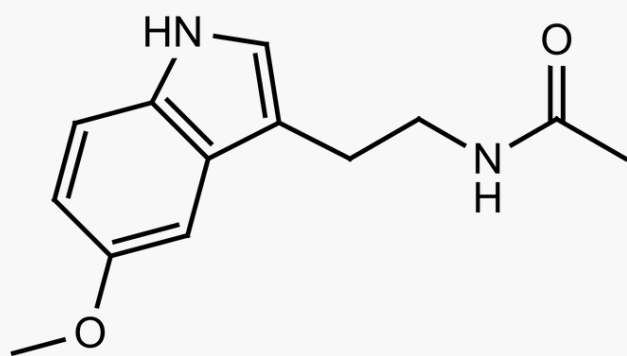
**FIG 6 :** Melatonin markedly attenuates copper-induced oxidative stress, demonstrating superior protective efficacy compared to D-pen and NAC.

approved antioxidant. We postulated that this well-known molecule might be repurposed to combat the copper-induced toxicity of Wilson disease[7]. When we checked melatonin’s potential to combat copper toxicity, it dramatically improved cell viability (Fig 5). Melatonin also decreases oxidative stress (Fig 6) caused by copper when tested in our cellular models. Surprisingly, it outperformed both the well-known antioxidant N-acetylcysteine (NAC) and the common Wilson disease medication D-penicillamine(D-Pen). Melatonin not only lowered oxidative stress but also more effectively modulated key cellular defense pathways, including the Nrf2–HO-1 axis as depicted from Nrf2 nuclear translocation. In copper treated cells, Nrf2 nuclear localization was high but melatonin treatment has reduced it to basal level. (Fig 7).

However, melatonin’s protective effects seemed too strong to be explained by antioxidant activity alone. This prompted a closer look at its chemical structure, which contains nitrogen and oxygen atoms capable of binding metal ions (Fig 8). Inspired by this chemical intuition, we looked into the possibility of melatonin interacting directly with copper. In fact, we found that melatonin binds copper in an energetically favourable way with quantifiable affinity, demonstrating an unexpected chelating ability (Fig 9) with kd value of  $3.36 \times 10^3 \text{ M}^{-1}$  (Fig 10). This discovery changed the course of our investigation. Beyond its function as an antioxidant, melatonin evolved into a dual-action molecule that could directly control excess copper and reduce oxidative stress. This conceptual change encouraged us to test the theory at the level of entire organisms, which advanced our work beyond cell-based experiments and brought us closer to therapeutic relevance.



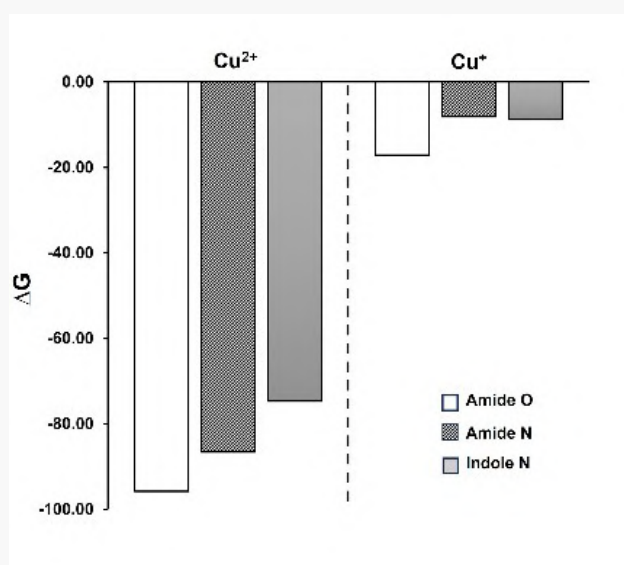
**FIG 7 :** Melatonin exhibits the strongest suppression of Nrf2 nuclear localization, outperforming D-Pen and NAC.



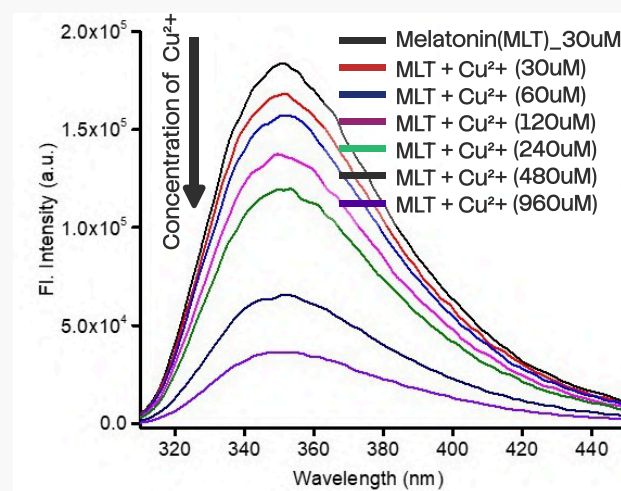
**FIG 8** : Structure of melatonin.

## Extending the idea beyond cells: validation in organisms

To ensure that our results were not merely obtained on cellular model, we chose organism models that included Zebrafish and *C. elegans* to test melatonin efficacy against copper toxicity. These organisms can be used for the assessment of copper toxicity. In zebrafish embryos, excessive levels of copper caused a significant increase in oxidative stress as observed in increase of fluorescence intensity of CellRoX orange. Increase in CellRoX intensity is directly proportional to increase in oxidative stress. (Fig 12). We also observed decrease in copper induced cell death as measured by flow cytometry using Annexin V-PI dye. (Fig 11). Remarkably, both effects were almost completely reversed by melatonin pretreatment, restoring cellular health in the early phases of development. We discovered a similar protective effect using *C. elegans* mutants, which lack an essential copper transporter. Copper built up to hazardous levels in these worms, but melatonin treatment dramatically decreased copper burden (Fig 13) and oxidative stress (Fig 14), which closely matched our cellular findings. These models together proved that melatonin's anti-copper action is not confined to isolated cells. Rather, melatonin's protective potential is retained at even larger scales of life, from cells to



**FIG 9** : Gibbs free energy for binding sites of melatonin with copper

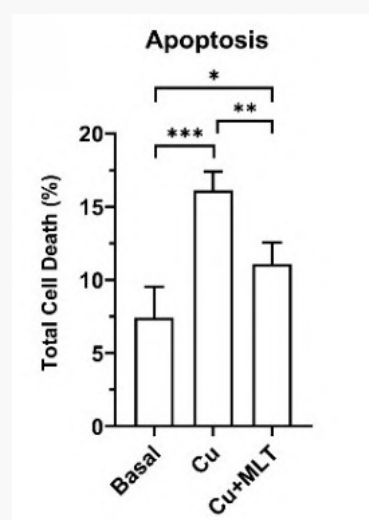


**FIG 10** : Melatonin interacts with  $\text{Cu}^{2+}$  with an association constant ( $K_a$ ) of  $3.36 \times 10^3 \text{M}^{-1}$ .

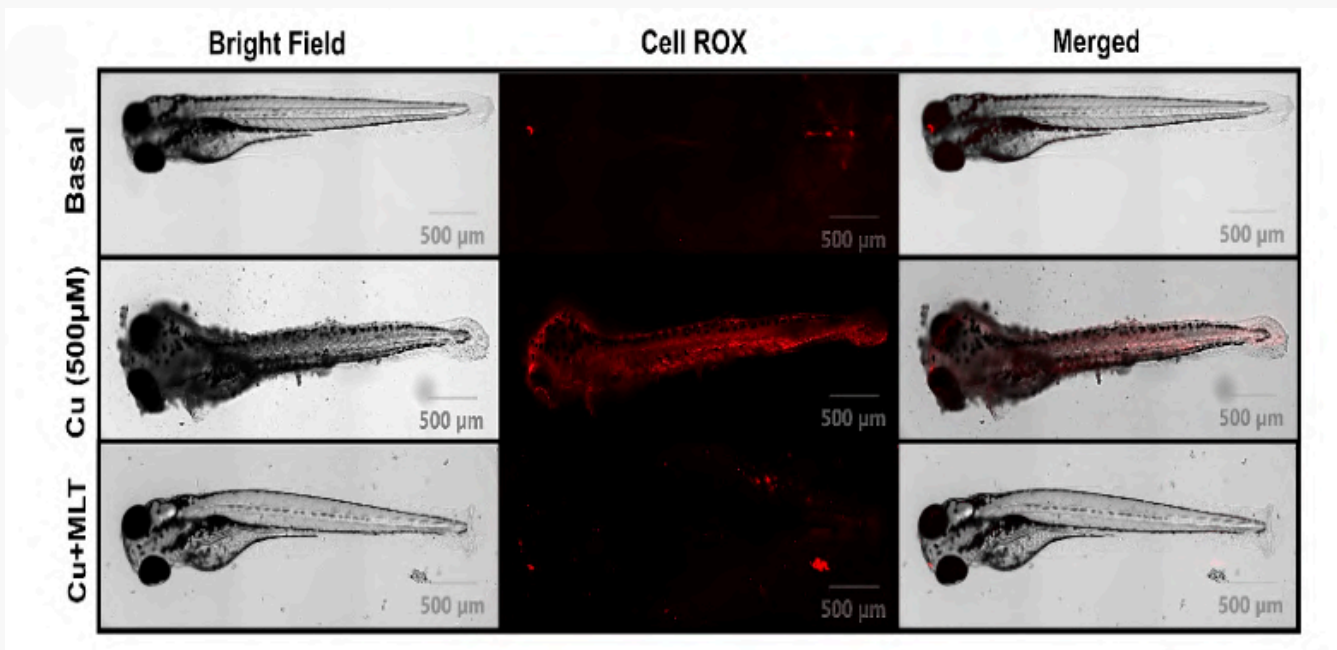
organisms, and this further strengthens melatonin's potential therapeutic utility in Wilson disease.

## Nanocapsule engineering: bridging chemistry and biology for better therapy

Although melatonin is remarkably safe, it has a major limitation as a drug: a short half-life in the bloodstream. To overcome this, we collaborated with chemists to design redox-responsive melatonin loaded polymeric nanocapsules (MNC) capable of carrying and protecting melatonin. Encapsulating melatonin transformed how it behaves in the body. The nanocapsules increased its stability. (Fig 15), enabling the drug to reach its target in a much more effective way. More importantly, these nanocapsules were engineered to be responsive to the cellular environment, when oxidative stress is high. When nanocapsules experienced high levels of intracellular glutathione—a signature of oxidative stress—they released melatonin exactly where and when needed (Fig 17). This targeted release dramatically enhanced



**FIG 11** : Annexin V/PI flow cytometry of embryo-derived single-cell suspensions shows Cu increases total cell death, which is reduced by melatonin.



**FIG 12** : Representative Spinning-disk confocal show increased CellROX fluorescence with Cu (500 µM), which is reduced by melatonin co-treatment.

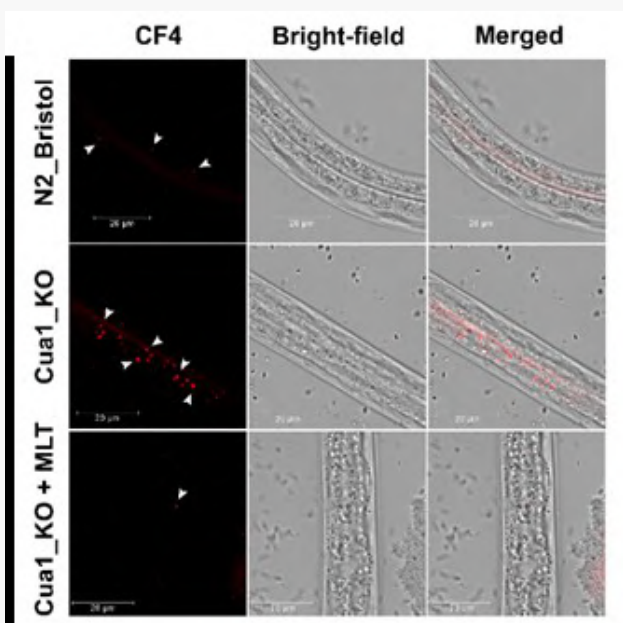
melatonin’s effectiveness, up to almost a three-fold increase in scavenging reactive oxygen species (Fig 16). In doing so, nanotechnology transformed melatonin from a simple dietary supplement into a smart, responsive therapeutic bridge between chemistry and biology that can be used to improve the treatment potential of Wilson disease.

### Revisiting the big question

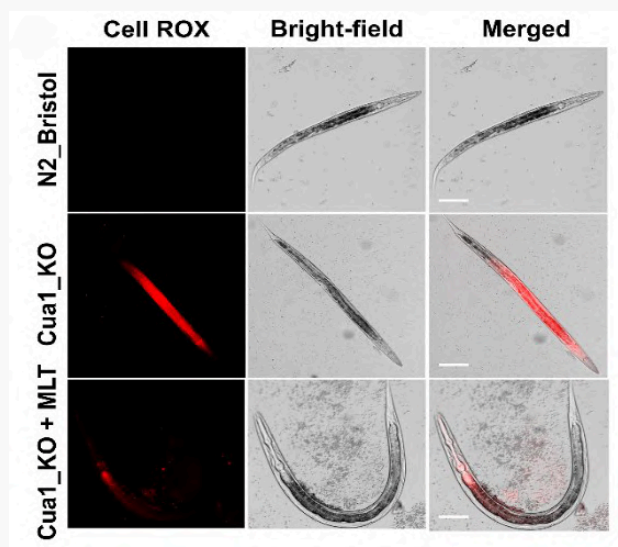
Over the course of my PhD, this is a story of how melatonin evolved. An originally very simple question, “could melatonin help manage Wilson disease?” - led to a more nuanced answer: melatonin emerged as a dual-function molecule that could selectively bind labile

copper and simultaneously suppress copper-driven oxidative stress. Its therapeutic potential increased when delivered through redox-responsive nanocapsules.

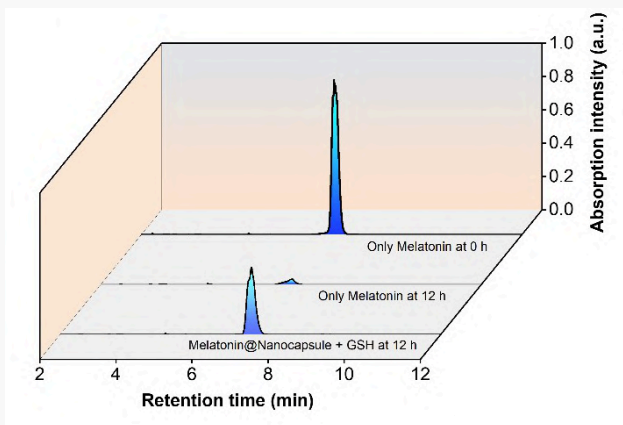
So, melatonin—an indoleamine with a recognized role in regulating the sleep-wake cycle — underwent a radical transformation to a next-generation candidate capable of treating both metal overload and the subsequent redox imbalance. Moving ahead in time, the current discovery now paves the way for the design of next-generation molecules that can treat Wilson disease and other related conditions of metal and redox imbalances. By regulating both metal homeostasis and redox equilibrium simultaneously in future medications, they can potentially treat various complex diseases in a holistic way that current single-target therapies cannot. One such is melatonin, and the nanocapsules are just one way of delivering it. The broader idea—



**FIG 13** : Melatonin helps *C. elegans* to alleviate free copper.



**FIG 14** : Melatonin treatment rescues *cua-1* from oxidative stress.

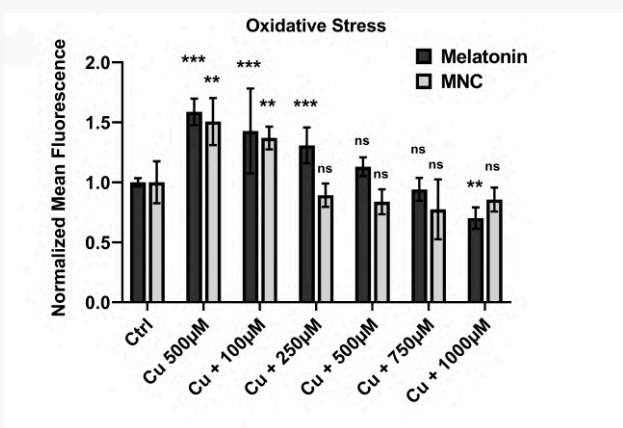


**FIG 15 :** MNC show improved serum stability, ensuring sustained melatonin availability.

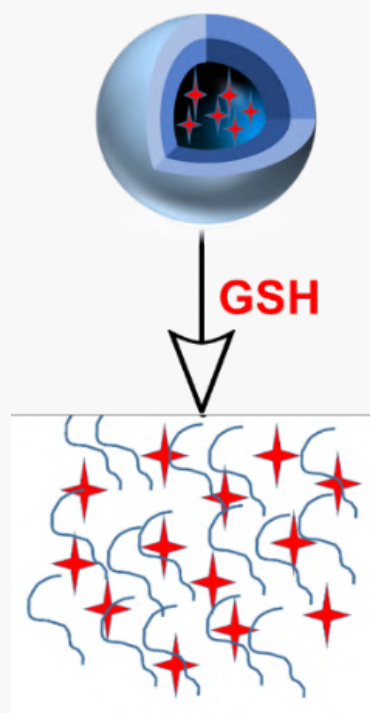
integrating chemistry, biology, and nanotechnology to restore balance in diseased cells—can be applied across many pathologies. This, is the journey of that idea and the scientific story behind my PhD.

### Want to know more?

This article is based on our original research published as: Repurposing Melatonin’s Therapeutic Potential in Wilson Disease: Addressing Copper Overload and Redox Imbalance (Pandey et al., Redox Biology, 2025, DOI: <https://doi.org/10.1016/j.redox.2025.103971>).



**FIG 16 :** MNC is more efficient than free melatonin in reducing oxidative stress.



**FIG 17 :** MNCs exhibit redox-triggered release in response to GSH.

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**Finite** Points,

**Infinity** Lines

**And A**

**Couple Of**

**Nice** Proofs

# Finite Points, “Infinity Lines” and a Couple of Nice Proofs

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Sometimes, the most fun problems to work on are the ones easiest to visualise. We will go through 2 proofs of a deceptively simple statement conjectured by James Joseph Sylvester in 1893: one of them is a surprisingly short one by Kelly (1986) and the other is a more conceptually dense one by Melchior (1941).



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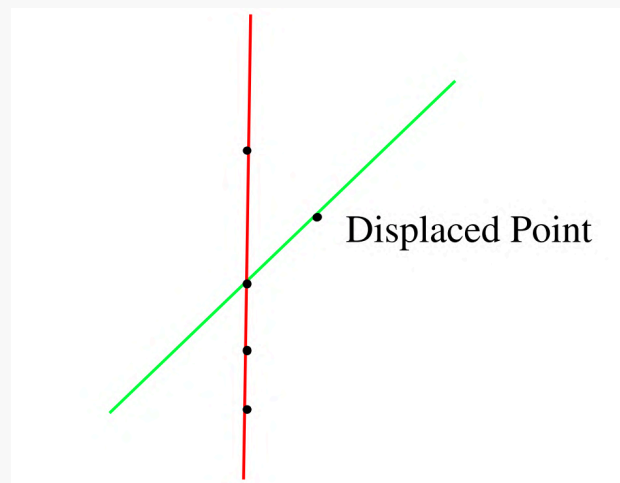
## Introduction

Sometimes, the most fun problems to work on are the ones easiest to visualize. Especially in geometry, problems like this are everywhere. The simplest ideas can generate non-trivial problems, with beautiful solutions. Thinking about random point arrangements (the basis of incidence geometry; that is, the geometry that deals with sets of points and lines through points), one stumbles upon a problem that is easy enough to come up with: the following problem, presented by James Joseph Sylvester in 1893.

**Problem:** Prove that it is not possible to arrange any finite number of real points so that a straight line through every two of them shall pass through a third, unless they all lie in the same straight line.

Or rephrased, in every arrangement of a finite number of real points on the Euclidean plane (which is just the familiar flat, infinite, two-dimensional surface of standard high-school geometry), there is a straight line passing through only two of these points, unless all points are collinear.

To get an initial hold of this problem, imagine some points, all in the same line. We know there is some unique line passing through all of them. Now, we displace one of these points slightly.



We can see that some line has been generated that passes through only two of the points: the displaced point, and the adjacent point to it. The idea of the problem is to show such a line, passing through **exactly two points**, exists in all possible arrangements of finite points.

On first instinct, proof by contradiction seems to be the way to go. And it was, for Kelly, although this proof was pretty pervasive, and went undiscovered for decades, it is a really short and simple one.

We shall go through two proofs of the problem statement. One given by Eberhard Melchior, in 1941, after Paul Erdős popularised the problem; and the other much later, in 1986, by Leroy Milton Kelly. The former proof is a much more general one, made using concepts of graph theory, and projective plane geometry (I will try my best to explain this, to the extent at which I am able to grasp it myself), and the latter is a much simpler and more elegant one, although not being nearly as useful in application to other spheres or problems as Melchior’s.

We list 2 standard definitions for our proofs:

**Definition 1:** Let  $P = \{n_1, n_2, n_3, \dots\}$ ,  $n \geq 3$  be a set of not all collinear points in the euclidean plane. A line that contains two or more points of  $P$  is called a connecting line and is **ordinary**, if it contains exactly two points.

**Definition 2:** If a line passes through  $n$  points on the plane  $P$ , it is called  **$n$ -rich**.

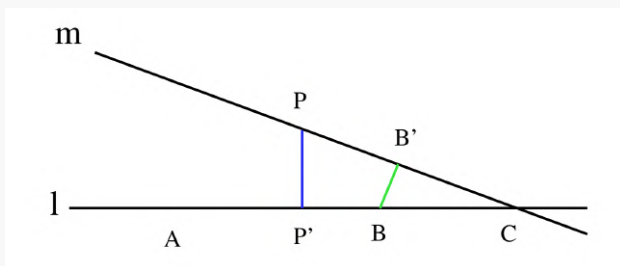
We restate **Problem 1** as the following theorem, then proceed to prove it.

**Theorem 1.1: (Sylvester–Gallai Theorem)** Every such set  $P$  determines at least one ordinary line.

Let us first look at Kelly’s proof, a truly beautiful and simple one, with elementary geometrical construction, proving the theorem by contradiction.

### Kelly’s Proof

*Proof.* Let  $l$  be a line in the plane, such that it passes through  $n$  points in the plane, and there exists some point  $P$  in the plane, whose perpendicular distance to  $l$  is the minimal perpendicular distance between any point–line pair in the plane. Note that since we have an arrangement of a finite number of points (in the set  $P$ ) in our plane, the set of lines determined by the points in  $P$  is also finite.



Now we draw a perpendicular  $PP'$  onto  $l$ . There must exist at least one point on either side of  $P$ , on  $l$ . We have two cases:

1.  $l$  is ordinary.
2.  $l$  is not ordinary, it is  $n$ -rich for some  $n > 2$ .

We assume Case 2 to be true. Then, there must be more than one point on the left or right of  $P'$ . Let us say there are two points  $B$  and  $C$  to the right of  $P'$ , such that  $B$  is the first point on the right of  $P'$ , and  $C$  is some other point.

Now, we draw a line  $m$ , through  $PC$ . We draw a perpendicular from  $B$  onto  $m$ . Observe that this perpendicular  $BB'$ , will have a shorter length than  $PP'$ . Then we have found a point–pair, namely  $B$  and  $m$ , such that the perpendicular distance is even lesser than  $PP'$ .

But, this contradicts our choice of  $l$  and  $P$  as the closest point–line pair.

Hence, Case-1 must be true, and  $l$  is proved to be ordinary.

On first read, this proof felt extremely satisfying to me, like it was out of Erdős’ “Book”. But in a way, this proof is “a bit too clever”. There isn’t much of anything we can extend this to.

For the purpose of extension, and to find some results we can apply to other areas of Mathematics, we turn now, to Melchior’s proof.

### Melchior’s Proof

In this proof, the concepts of the **Projective Plane** and **Graph Theory** have been used. We will go through the specific results/concepts we need.

### Projective Plane

**Definition 3:** A projective plane  $\pi$  is a triple  $(\mathbb{P}, \mathbb{L}, \mathbb{I})$  such that  $\mathbb{P}$  is a set of points,  $\mathbb{L}$  is a set of lines and  $\mathbb{I}$  is an incidence relation generated by the following binding axioms:

1.  $\exists$  a unique line in the set  $\mathbb{L}$  joining any 2 distinct points from the set  $\mathbb{P}$ .
2.  $\exists$  a unique point of intersection of any 2 distinct lines from the set  $\mathbb{L}$ .
3.  $\exists \geq 3$  non-collinear points in the set  $\mathbb{P}$ .
4.  $\exists \geq 3$  points on each line in the set  $\mathbb{L}$ .

The modification made to our “normal” notions of geometry here, is that **all** lines intersect. More precisely, all parallel lines now intersect at **one, distinct point** which is placed “at infinity” and on the **line at infinity**.

**Definition 4:** A affine plane is a triple  $(\mathbb{P}, \mathbb{L}, \mathbb{I})$  such that  $\mathbb{P}$  is a set of points,  $\mathbb{L}$  is a set of lines and  $\mathbb{I}$  is an incidence relation generated by the following binding axioms:

1. Every pair of points in the set  $\mathbb{P}$  lies on a unique line in the set  $\mathbb{L}$
2. Given any line  $l \in \mathbb{L}$  and any point  $P \in \mathbb{P}$  which doesn’t lie on  $l$ ,  $\exists$  a unique line  $m \in \mathbb{L}$  such that  $P$  lies on  $m$  and  $l \cap m = \emptyset$  (no point lies on both  $l$  and  $m$ ).
3.  $\exists 3$  non-collinear points in the set  $\mathbb{P}$ .

The affine plane represents pretty much what our “normal” notion of geometry is. The euclidean plane, which we are most used to, is an example of an affine plane.

**Definition 5:** A pencil of parallel lines is the set of all lines which are parallel, in the affine plane.

**Theorem:** Let  $\pi = (\mathbb{P}, \mathbb{L}, \mathbb{I})$  be a projective plane. Removing any line  $l_\infty$  of  $\pi$  as well as all points on it, forms a new triple  $\pi^{l_\infty}$ , such that  $\pi^{l_\infty}$  is an affine plane.

*Proof.* We verify the 3 points in Definition 4.

1. Let  $P, Q$  be two distinct points, not on  $l_\infty$ . Then, there is a unique line  $m$  through them in  $\mathbb{L}$ , by the definition of a projective plane. Hence,  $m$  is a line in  $\mathbb{L} - \{l_\infty\}$  passing through  $P$  and  $Q$ .
2. Let  $m \in \mathbb{L} - \{l_\infty\}$  and  $P \in \mathbb{P}$  be a point not on  $m$ . Then, in the projective plane  $\pi$ , there is a unique line passing through  $P$  and  $I = m \cap l_\infty$ . Then, clearly  $n \neq m$  and  $n$  only intersects  $m$  at  $I$  in  $\pi$ , so that in the new plane,  $n$  and  $m$  are parallel. The uniqueness of  $n$  follows from the fact that the line passing through  $P$  and  $I$  in  $\pi$  is unique.
3. Follows directly from the definition of a projective plane.

**Theorem 3.1: (Theorem of Duality)** If  $\mathbb{T}$  is a valid theorem in the projective plane, and  $\mathbb{T}'$  is a new statement obtained from  $\mathbb{T}$ , by making the following changes:

1. "point"  $\leftrightarrow$  "line"
2. "collinear"  $\leftrightarrow$  "concurrent"
3. "join"  $\leftrightarrow$  "intersection"

Then,  $\mathbb{T}'$  holds for the projective plane.

The proof for Theorem 3.1 is omitted here, but it is quite easy to see why it works with an example, as given below.

We consider the Theorem of Pappus as an example.

**Theorem 3.2: (Pappus' Theorem)** Let  $l, l'$  be two lines in the plane. Let

1.  $A, B, C$  be points of  $l$ .
2.  $A', B', C'$  be points of  $l'$ .
3. all these points be distinct from  $l \cap l'$ ,

Then,  $L = AB' \cap A'B, M = AC' \cap A'C, N = BC' \cap B'C$  are collinear.

**(Dual Version of the Theorem)** Let  $P, P'$  be two points in the plane. Let

1.  $a, b, c$  be lines concurrent at  $P$ .
2.  $a', b', c'$  be lines concurrent at  $P'$ .
3. all these lines be distinct from that joining  $P, P'$ .

Then,  $l$  joining  $(a \cap b')$  and  $(b \cap a')$ ,  $n$  joining  $(a \cap c')$  and  $(c \cap a')$ ,  $m$  joining  $(c \cap b')$  and  $(b \cap c')$  are concurrent at some point  $Q$ .

Below are the standard, and dual versions of the theorem in a diagrammatic form.

**Some concepts of Graph Theory**

**Definition 6:** A **graph** is defined as an object consisting of 2 sets:  $V_G$ , a set of vertices and  $V_E$ , a set of edges, which are 2 point sets.

For example, a graph  $G$  can be written as  $\{\{P, Q, R, S, T\}, \{\{P, Q\}, \{R, S\}, \{Q, T\}\}\}$ .

**Definition 7:** The **degree** of a vertex is equal to the number of edges connecting at that vertex.

**Definition 8:** The **Euler Characteristic**  $\chi$  is defined for graphs, by the formula  $\chi = V - E + F$ , where  $V$  is the number of vertices,  $E$  is the number of edges and  $F$  is the number of connected regions (including unbounded regions).

We take it as a fact that for projective planes,  $\chi = 1$ . The rigorous proof for this is quite convoluted, but we can accept the intuition that for planar graphs, it is easy to prove that  $\chi = 2$  and in the projective plane, the line at infinity acts like an "extra edge".

Proofs of this fact use algebraic topology and are out of the scope of this article.

**Proceeding with the proof**

Now we can finally attempt to understand Melchior's proof, with the knowledge of preceding subsections.

*Proof.* Let  $P$  be a finite set of points in a projective plane  $\pi = (P, L, I)$ . Let us consider a **dual collection** of  $n$  lines:

$$P^* = \{p^* : p \in P\}.$$

We know from that (for the projective plane)

$$V - E + F = 1.$$

Now, by duality, we can write

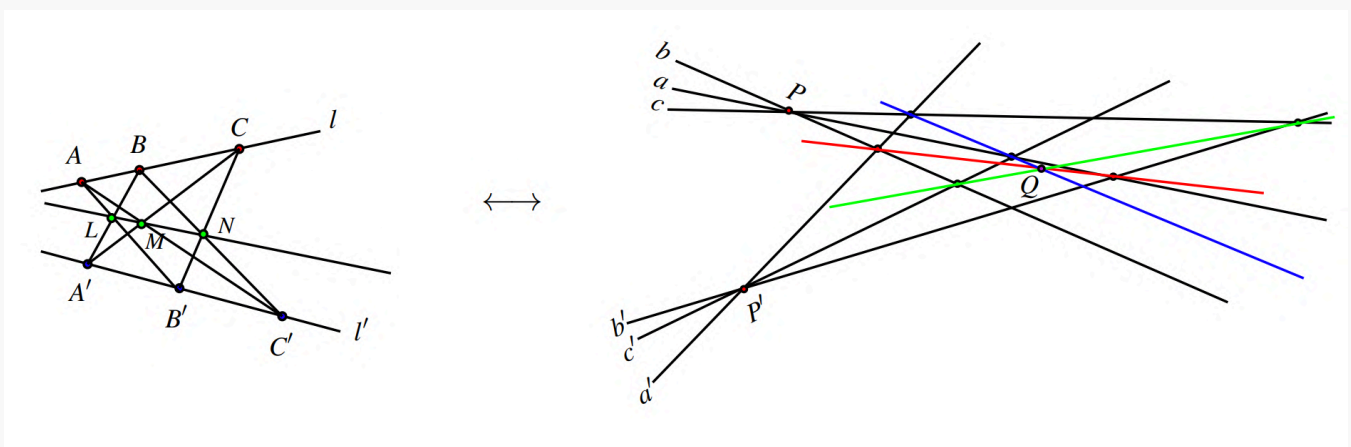
$$V = \sum_{k=2}^n N_k,$$

where  $N_k$  is the number of lines passing through only  $k$  vertices. (By duality, this sums up all vertices of degree 2, then of degree 3, and so on till degree  $n$ , which spans all vertices.)

Also, the degree of a vertex  $l^*$ ,  $d(l^*)$  is twice the number of lines passing through it, since a line through a point consists two edges for that point. This degree (by duality) can be written as  $2|P \cap l|$ , which is equal to twice the number of points of  $P$  on any line in the arrangement.

Summing over all lines  $l$ :

$$2E = \sum_l d(l^*) = 2 \sum_l |P \cap l| = 2 \sum_{k=2}^n k N_k.$$



Let  $M_s$  be the number of faces with  $s$  edges. Since every face is bounded by at least 3 edges, and each edge is incident to 2 faces, we can write

$$2E = \sum_{s=3}^n sM_s.$$

Combining equations 1,2,3 and 4, we can find our required result.

$$3V = 3 + 3E - 3F$$

$$\text{or, } 3 \sum_{k=2}^n N_k = 3 + (\sum_{k=2}^n kN_k + \sum_{s=3}^n sM_s) - 3 \sum_{s=3}^n M_s$$

$$\text{or, } 0 = 3 + \sum_{k=2}^n (k - 3)N_k + \sum_{s=3}^n (s - 3)M_s$$

$$\text{or, } 0 = 3 - N_2 + \sum_{k=4}^n (k - 3)N_k + \sum_{s=4}^n (s - 3)M_s$$

$$\text{or, } N_2 = 3 + \sum_{k=4}^n (k - 3)N_k + \sum_{s=4}^n (s - 3)M_s$$

which implies the Sylvester-Gallai Theorem.

Surprisingly enough, this proof not only shows that one ordinary line shall exist, but rather that **three must exist**, for any finite arrangement.

This proof gives us a "better" result, although it is way more convoluted than what Kelly came up with. It is quite stunning how elusive the prior proof was. It took decades after Melchior's publication, for someone to revisit the problem, after Paul Erdos brought it back up, so this elegant and beautiful proof could be presented to the world.

The most satisfying mathematics is not always the most applicable, or "the best". Beauty, in many cases, arises from simplicity.

# In Conversation With **Bikram** Dhara



# Dilemma, Brain Drain, Biasness, and Supersaturation Trap in Indian Research – In Conversation with Professor Bikram Dhara.

interview by

Subham Sarkar Department of Biotechnology, St. Xavier's College

17 December 26, 2025

**Prof. Bikram Dhara discusses the evolving mindset of Indian science students, shaped by career pressures and global aspirations. He critiques exam-centric systems, declining interest in basic science, and weak mentorship, while advocating interdisciplinary learning, ethical research, and resilience, framing scientific pursuit as a lifelong commitment rooted in curiosity and social responsibility.**



\*Professor Dhara\* is a clinical and environmental microbiologist with specializations in studying host-pathogen interactions, nanobiotechnology, and transdisciplinary research. He is a distinguished faculty of Department of Microbiology, Saveetha Medical College and Hospital, Chennai, India.

**SS: Hello Professor Dhara. As someone deeply embedded in the academic ecosystem, how do you perceive the current mindset of high school students in India regarding the pursuit of science?**

BD: It is fascinating because, while the enthusiasm for science is high, the why behind it has been deeply bifurcated. In my observation, Indian high school students generally fall into two distinct sociological brackets. On one hand, you have the multi-generational learners. These students come from families where science is a tradition; their parents or grandparents were scientists, doctors, teachers, engineers, or have studied science in their high school or university. They understand the nuances of research, the prestige of

academia, and the long-term rewards. Motivating this group toward a research career is relatively seamless because the path is already illuminated. On the other hand, we have a growing surge of first-generation science aspirants. These are brilliant students who achieve stellar results, which, as we know, are becoming increasingly common today, but they view science through a more pragmatic lens. Their attraction to the stream is often driven by a one-dimensional search for security. They see science not necessarily as a quest for discovery, but as the most reliable stream for a steady, respectable job in an uncertain economy.

**SS: That distinction in motivation is striking. However, regardless of their background, there seems to be a common goal for many, which is leaving India for higher studies and research. How pervasive is the abroad narrative today?**

BD: It has become the dominant narrative. My estimate is that more than 50 percent of students in both groups share a singular, deeply held impression, that meaningful scientific breakthroughs are only possible abroad. There is a pervasive belief that to do real science or to have a significant global impact, one must settle abroad for higher studies and professional life. Interestingly, this is not just a passing thought, rather it has become a fundamental predisposition that has intensified significantly since post 2010s.

**SS: Why has this tendency accelerated so much post-2010? Is it purely academic, or is there any deeper social influence at play?**

BD: It is deeply social, particularly within the middle class. We are seeing a powerful peer-observation effect. Younger students look at their seniors of their neighbourhoods, schools, relatives, or acquaintances, who have moved to Europe, the US, or other developed nations. They see the polished lifestyle, the advanced laboratories, and the global recognition. To a teenager in India, that success story becomes the ultimate benchmark. This creates a self-perpetuating cycle. Each success story abroad serves as a silent recruitment poster for the next generation to leave India. This is one of the engines driving the modern brain drain. It is not just that they are running away from something here, they are being magnetically attracted toward a lifestyle and a research culture that they believe India cannot yet replicate.

**SS: Regarding the brain drain, you mentioned that juniors are influenced by the lifestyle of seniors abroad. How do we create a narrative in Indian science that can compete with the allure of the West?**



**FIG 1 :** Prof. Bikram Dhara being felicitated at Scottish Church College, Kolkata, India.

BD: We cannot compete on lifestyle alone, as the economic gap is real. However, we can compete on the impact and belonging. We must publicize the instances of those who successfully navigated the Indian system to solve local problems, be it in bioresources, agriculture, or indigenous medicine. When a high schooler sees a senior building a successful deep-tech startup or a world-class lab in India, the 'abroad or nothing' mindset begins to crack. I encourage brain circulation, where going abroad is for exposure, but returning is for the mission.

**SS: Professor, given the complexities of student motivations we discussed, how do you personally intervene when a student is standing at the crossroads after high school, feeling trapped or confused?**

BD: My primary role at that stage is to act as a stabilizer. High school graduates in the science stream often feel confused or dilemmatic. I start by deconstructing that pressure. I explain to them the realities of the academic rigors ahead and, more importantly, how to manage the psychological toll. I never believe in rushed decisions. I tell them to take their time and think. I provide them with the mental space to consider their future not as a race to a job, but as a long-term alignment of their identity with their work. My goal is to transform their confusion into a calculated exploration of their own potential.

**SS: In present day Indian context, Biology has almost become synonymous with NEET. How do you address this singular focus among students?**

BD: You are right. It has become a craze. When a student chooses biology, the social machinery immediately pushes them toward the medical entrance exams. This unilateral focus creates a bottleneck where immense talent is often wasted if they are somehow unable to secure a seat. I actively motivate my students to look beyond the NEET horizon. I introduce them to specialized institutes and diverse professions in biotechnology, genetics, bioinformatics, and other research sectors, that are just as prestigious and impactful. Interestingly, the students who refuse to focus unilaterally on NEET often excel. By broadening their scope, they find paths that actually resonate with their aptitude rather than just following the herd.

**SS: You mentioned that student interests are shifting. Are there specific trends you have noticed in terms of gender or the topic of science they want to pursue?**

BD: There are distinct patterns. For instance, among female students, there remains a strong inclination toward nursing, a field that offers a unique blend of scientific application and social service, even when they choose not to pursue specialisation in traditional medicine. More broadly, there is a worrying trend toward applied or translational research. Everyone wants to work on the end product, such as the cure, the gadget, the immediate solution. While this is important, it has caused a decline in interest in basic or classical scientific research. We must remember that without basic science, there is nothing to apply. The balance between the two is currently dwindling. I find myself increasingly advocating for the beauty of fundamental research, the kind that seeks to understand the why and how of the universe before rushing to the how can we commercialize this.

**SS: Beyond passion and aptitude, there is the undeniable factor of economics. How do you factor a student's background into your guidance?**

BD: This is perhaps the most grounded part of my mentorship. I always check the financial scaffolding supporting a student. I believe, higher studies and a career in research are marathons, not sprints. They require years of hard work, dedication, and determination before they become financially lucrative. If a student has a dream but lacks the financial means, I do not tell them to quit. I help them find the right scholarships, funded fellowships, and integrated programs that provide stipends. Identifying interest and potential is only half the battle, and ensuring that a brilliant mind is not stifled by an empty pocket is the other half. I aim to provide direction and hope, but always rooted in the reality of their circumstances.

**SS: Professor, you have spoken about the individual dilemmas students face. However, research is rarely a solitary pursuit. How are you addressing the need for a more integrated, community-driven approach to science in India?**

BD: You have hit on a very important point. In the traditional academic setup, students often work in silos. To break these walls, I founded the Society of Multidisciplinary Biology and Translational Research. This is not just a student club, it is a comprehensive, multi-generational network. We have brought together undergraduate and postgraduate students, seasoned researchers, alumni from prestigious institutions, industry veterans and professionals, and active scientists. The goal is to create an educative network, where an aspirant can see the entire trajectory of a scientific idea, from a theoretical spark in a textbook to a tangible product in the industry, linking basic science to translational research.

**SS: That sounds like a massive undertaking. What is the core philosophy you instil in the members of this society?**

BD: We focus on the strategy of research. Most students know what to study, but very few know how to build

a research career. We expose them to the foundational architecture of scientific inquiry. We emphasise a dual-lens approach, encompassing theoretical depth and practical application. We help them to master the beauty and logic of science, and understand the industrial and entrepreneurial potential of that knowledge. By bringing in biotech companies and industry professionals, we provide entrepreneurship exposure. We want our students to realize that they always do not just have to apply for jobs; they can also be the architects of new scientific ventures. We mould them to appreciate that science is both an art form and a practical tool for societal advancement.

**SS: Have you noticed a tangible difference in students who are part of this multidisciplinary environment compared to those in traditional academic paths?**

BD: The difference is conceivable and, quite frankly, profound. Most students are taught to pass exams, whereas we guide our students to solve problems. Because we encourage a full spectrum approach, allowing them to explore any topic that ignites their curiosity, their research aptitude develops much faster. They possess a certain research mindfulness. They are not intimidated by complex data or industrial requirements because they have already been in the room with the experts. This exposure gives them a competitive edge, in disguise of a scientific maturity, that sets them apart in both domestic and international arenas.

**SS: Professor, you have built a remarkable ecosystem through your Society. However, when you gather so many high-achieving minds in one place, do you find that the rat race of the outside world eventually finds its way inside?**

BD: It is an inevitable shadow. Even within our Society, the human tendency toward comparison is persistent. I see students beginning to parameterize their accomplishments, turning their research, their



**FIG 2 :** Prof. Bikram Dhara is a trained herpetologist.



**FIG 3 :** Prof. Bikram Dhara in conversation with his mentor, Dr. Arup Kumar Mitra, at Bhagalpur University, India.

networking, and even their learning into a series of competitive metrics. They start asking, “Who has more citations?” or “Who has the better internship?” This is the very mindset I fight against. I constantly remind them that while academic scores are the keys that open doors, the thrill of discovery and the strength of one’s professional network are what keep you in the room. If you turn research into a rat race before you have even finished your degree, you kill the soul of your scientific inquiry. The thrill must remain the primary driver; otherwise, you are just a high-functioning machine, not a scientist.

**SS: Who bears the responsibility for keeping this competitive fire from becoming destructive? Is it purely on the students to stay grounded?**

BD: Not at all. The onus lies equally upon the students and their guides. A mentor’s job is not just to teach a lab technique or introduce the students to a topic; it is to provide continuous mentorship and constant emotional support. In research, failure is more common than success. If a guide only rewards good results, they inadvertently fuel a toxic competitive environment. A true mentor must celebrate the process, the failed experiment that taught a lesson, and the collaborative spirit. Without that steadying hand, a student is likely to lose their way in the pursuit of superficial parameters.

**SS: You’ve mentioned the importance of the guide. How would you describe the current state of mentorship within the broader Indian government college system?**

BD: I will speak plainly, and I say this without overestimation, unfortunately, roughly 90 percent of government college professors are least bothered about the future of their students. There is a pervasive culture of academic stagnation. Many educators have become comfortable within the confines of a rigid curriculum and administrative routine. They rarely think outside the box, and consequently, they fail to encourage their students to do the same. They view their roles as purveyors of information rather than architects of careers.

**SS: That is a stark and concerning figure. Is there any room for optimism within that system?**



**FIG 4 :** Prof. Bikram Dhara at Forest Research Institute, Dehradun, India.

BD: Exceptions are always there. There are brilliant, tireless professors in government institutions who go above and beyond, often with very little recognition. But they are the outliers. The system, as it stands, does not prioritize the unconventional thinker. This is why our Society is so crucial, it fills the void left by institutional apathy. We provide the mentorship that the mainstream system often ignores. We are not just trying to produce graduates; we are trying to rescue the small percentage of brilliant minds who are stuck in a crowded indifferent system and give them the wings to think beyond the horizon.

**SS: You have been vocal about the 90% institutional apathy in government colleges. If you were given the authority to overhaul the Guide - Student relationship, what would be the changes you would advocate?**

BD: I would advocate implementation of mandatory mentorship training. Being a brilliant researcher does not spontaneously make one a good guru. Professors must be trained in psychological support, ethics, and career counselling. Also, I would like to introduce comprehensive feedback mechanisms where students can safely and anonymously report bias without fear of career suicide.

**SS: Professor, you have spoken about the external rat race for jobs, but what about the internal competition within the research community? Do you think that passion for discovery is still the primary driver for today's doctoral candidates and research aspirants?**

BD: Honestly, only a very limited percentage of students are truly mad for research. These rare individuals are driven by a need to explore the unknown, possessing a dedication that exists independently of materialistic expectations. The majority, however, are drawn by the glamour of research. They are often students who possess significant financial and social safety nets, allowing them to pursue a Ph.D. as a prestigious ornament. I call this the supersaturation trap. If some were to strip away the social prestige and the high-profile lifestyle often

associated with international science (as it is portrayed), this group would vanish. Because their motivation is superficial, their research often lacks the grit required for true translation into practical terms. We are seeing a burgeoning number of unnecessary research papers that add volume but no value to the global scientific pool.

**SS: You've previously mentioned the dwindling interest in basic science. Does this glamour play a role in which fields of study students choose?**

BD: Absolutely. There is a massive imbalance fuelled by over-glorification. Take cancer research, for example. Students flock to it in massive numbers because it is perceived as high-stakes. Of course, cancer research is necessary, but a student interested in soil microbiology is often judged upon by his or her peers, because this is how the idea of research themes have been framed. Meanwhile, vital basic and fundamental research comparatively remains neglected. Even when there is ample funding available for fundamental studies, we see a scarcity of interested minds. Everyone wants to work on the cure, but no one wants to do the foundational work that makes the cure possible. This is because basic science is no longer considered glamorous; it is slow, methodical, and often invisible to the public eye. Without a return to fundamental science, our translational successes will eventually run dry.

**SS: Professor, you mentioned a supersaturation trap where unnecessary research is clogging the system. If we were to design a filter for this, how do we distinguish between research that is truly transformative and meaningful, and research that is glorified?**

BD: The filter must be the intentionality of the inquiry. Currently, we measure success by impact factors and citation counts, metrics that can be easily manipulated by smart students and biased professors. To break the trap, I believe, we must shift toward process - based evaluation. Instead of first asking, "Where did you publish?" we should ask, "What fundamental gap does this fill?" or "How does this challenge the existing dogma?" If a project is merely a slight variation of existing applied work, which has been designed only to capitalize on a glamorous trend, it should be scrutinized more heavily. We need to reward the courage to tackle basic science over the convenience of following a trend.

**SS: You have been very honest about the Rat Race. If a student still feels compelled to enter that high-pressure environment, what is your advice to them?**

BD: I tell them this: if the rat race excites you, if that adrenaline drives you, then by all means, enter it. But do so with your eyes wide open. Do not regret your choices later. If you choose the path of high-stakes, high-pressure competition, you must be mentally prepared for the fallout. The greatest tragedy in research is not failing an experiment; it is losing your individuality and your confidence mid-race. If you find that the pressure is eroding the person you are, then you must have the courage to stop and rethink. If you lose your spirit, you are no longer suitable for the profound experiences and the beauty of the unknown and unexplored that a life in research has to offer. Research is for the resilient. It is for



those who can remain themselves even when the results are nowhere to be found.

**SS: Beyond the choice of subjects, you hinted at a deeper systemic issue regarding the relationship between Professors and their students. How does "biasness" manifest in the Indian research ecosystem?**

BD: Biasness in the laboratory can be, at times, eye-offending. It is an open secret that many professors maintain a circle of favourite students. These favourites are chosen not just for their potential, but for how they serve the professor both personally and professionally. From my personal experiences I can say that this creates a dangerous ripple effect. Students who benefit from this favouritism often feel invincible. This entitlement leads them to commit academic malpractice with total confidence because they know they are protected. These students become adamant and unteachable. Eventually, this bias can become a burden even to the Professor who fostered it, as the favourite might begin to demand more than they contribute. The truly hardworking students who are not in the inner circle become the victims, their morale crushed by a system that rewards loyalty over logic.

**SS: Does this change how students view their mentors? We often hear about the Guru-Shishya tradition in Indian education. Is that still alive?**

BD: That tradition is fading fast. Today's students are incredibly clever. They are smart in a transactional sense. They no longer view their principal investigators as gurus. Instead, they observe their professors with a cold, analytical eye. In top-tier institutions, students approach their professors based on convenience and utility. They study the professor's attitudes, their weaknesses, and their biases, and they approach accordingly. It is a strategic partnership rather than a quest for knowledge. When science is reduced to a game of navigating a professor's ego for personal gain, the quality of research suffers an irreparable blow. I believe, we are gradually losing the sanctity of the lab to a culture of tactical manipulation.

**SS: Professor, to conclude this profound discussion, what is your final message to the students who are currently standing at the threshold of a research career?**

BD: My message is simple but demanding. You must realize that a Ph.D. is a way of life, not a mere academic pursuit. If you view it only as a degree to be earned or a certificate to be framed, you will miss the essence of the journey. You must be dedicated, socially responsible, and genuinely educated. When these three traits converge, they do not just build a career; they create a promising future for the country. But this future is only sustainable if you approach good science with balance. Passion is the engine, but you must prioritize your physical health, your mental well-being, and your quality time. A researcher who has no life outside the laboratory, no extracurricular joy, or no connection to the world, will eventually find their creativity drying up.

**SS: Thank you, Professor, for sharing with us your views and valuable insights.**

BD: Thank you.

To conclude, the interview reveals that the crisis in Indian science is not a lack of talent, but a crisis of orientation and integrity. Professor Dhara's final message remains a powerful call to arms for the young researcher. He defines the Ph.D. as a way of life, one that demands a delicate equilibrium between intellectual passion and personal well-being. By fostering societies like the Society of Multidisciplinary Biology and Translational Research, he demonstrates that the alternative to the rat race is a collaborative, multidisciplinary community that values the Guru - Shishya spirit in a modern, industrial context. Ultimately, the interview suggests that for India to reverse its brain drain and reclaim its scientific heritage, it must build an ecosystem where merit is shielded from bias and where the pursuit of truth is considered the one of highest form of social responsibility.



**FIG 5 :** Prof. Bikram Dhara addressing at a conference at Khulna University, Bangladesh.



**WHAT LIES**  
beneath  
the **LEAF**

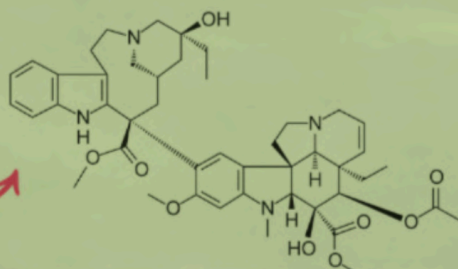


Comic on

**Asima Chatterjee**



Chatterjee began studying alkaloids,



complex natural compounds responsible for powerful biological effects.



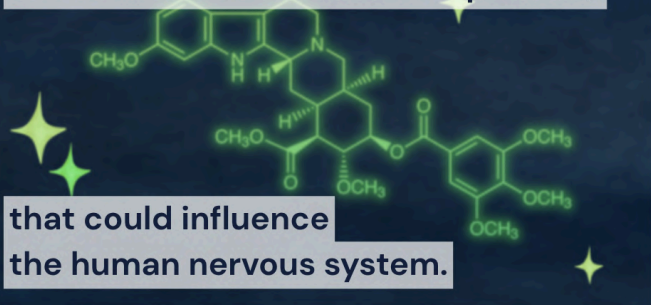
Recognition did not come easily. Resources were limited. Support was uneven.

Her work demanded extracting, isolating, and identifying molecules hidden in plant chemistry.



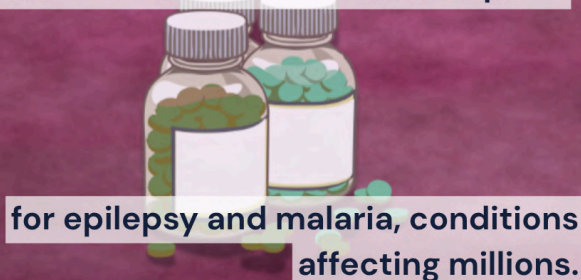
Progress was slow. Failure was frequent. But patterns began to emerge.

She identified bioactive compounds,



that could influence the human nervous system.

Her research contributed to therapies,



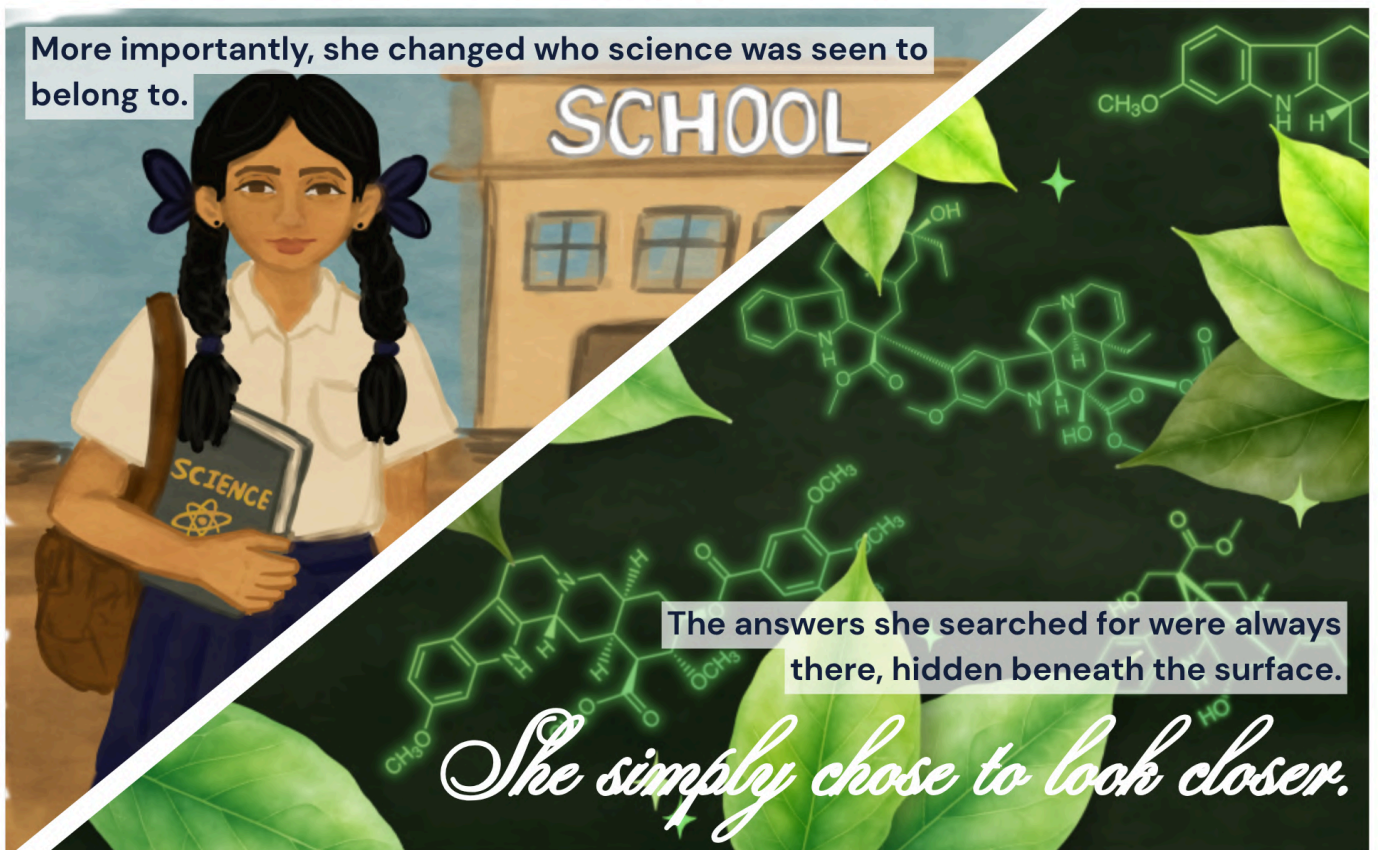
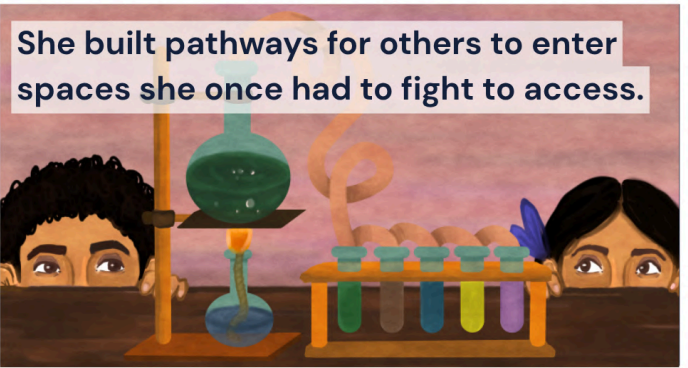
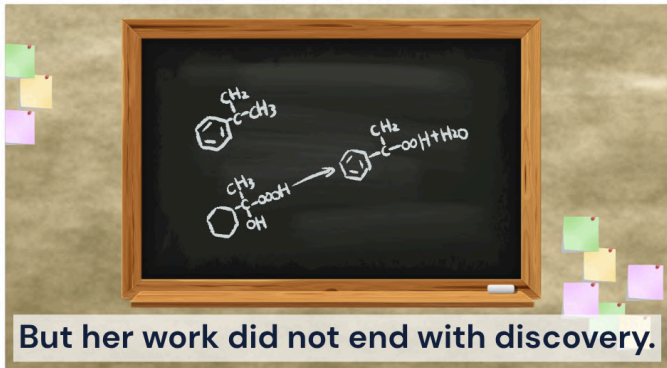
for epilepsy and malaria, conditions affecting millions.

She became the first Indian woman to earn a



Doctorate  
of  
Science.

(in Organic Chemistry!)






Hi! I'm **Nandita Sriram**, a 3rd-year BS-MS student majoring in Biology with a strong interest in the intersection of science and art. I enjoy using illustration and visual storytelling to explore scientific ideas through creative and imaginative perspectives. My work is inspired by biology, science fiction, retro media aesthetics, and experimental ways of communicating through art.



# Insight Digest – Curated Science News

## Fresh highlights from the frontiers of science

**Swarnendu Saha** From Dust to Dynamics: Understanding  $PM_{2.5}$  Variability in Arid Climates Using Wavelet Coherence

 Also available online, at [scicomm.iiserkol.ac.in](http://scicomm.iiserkol.ac.in)

# From Dust to Dynamics: Understanding PM<sub>2.5</sub> Variability in Arid Climates Using Wavelet Coherence

Kafy, A.A., Ibrahim, W.M., Baky, A.A. et al. Trends and oscillation characteristics of hourly PM<sub>2.5</sub> levels in arid environments using wavelet coherence and lagged correlation. *Sci Rep* 16, 6827 (2026)

Contributed by Swarnendu Saha (20MS IISER Kolkata)

This paper presents a comprehensive analysis of the temporal variability and meteorological controls of PM<sub>2.5</sub> concentrations in Kuwait City, an archetypal arid urban environment. Using high-resolution hourly data from 2017–2024, the authors combine advanced statistical and signal-processing techniques—including wavelet coherence, lagged correlation, and non-parametric trend analysis—to capture both multiscale oscillations and long-term trends in air pollution.

The study successfully demonstrates pronounced diurnal and seasonal variability in PM<sub>2.5</sub> levels, with peak concentrations occurring during summer evenings (notably around 7 PM in July) and comparatively lower levels during winter mornings. These patterns are convincingly linked to boundary-layer dynamics, dust resuspension, and anthropogenic activity. At longer timescales, the application of Mann–Kendall and Theil–Sen estimators reveals a general declining trend in PM<sub>2.5</sub>, although statistical significance is limited to specific months (notably September), suggesting that improvements in air quality may still lie within natural variability bounds.

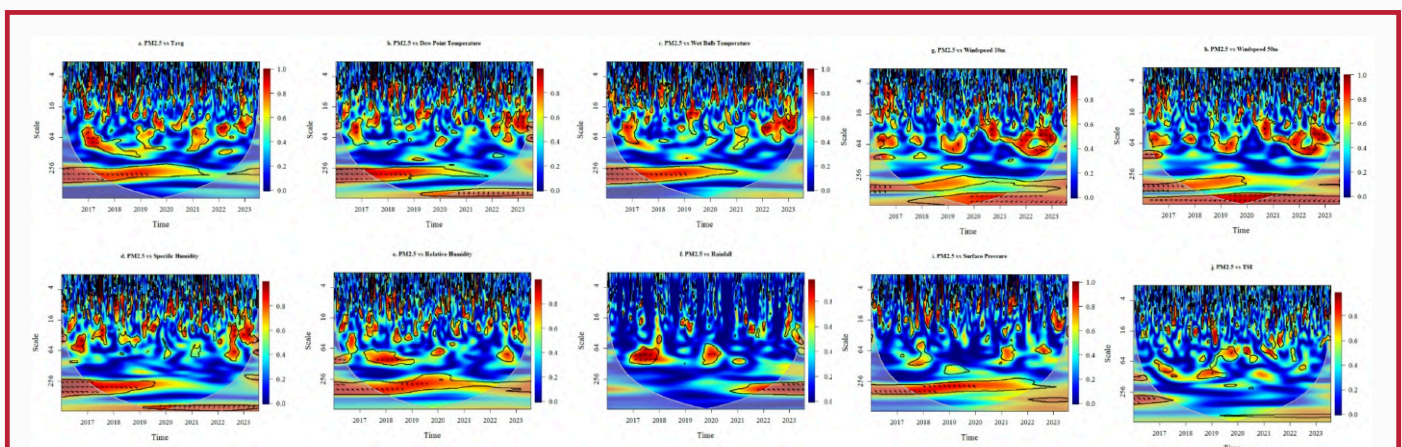
A key strength of the paper lies in its use of cross wavelet transform (XWT), which effectively captures scale-dependent relationships between PM<sub>2.5</sub> and meteorological variables. The results highlight strong in-phase coherence with temperature, humidity, and related thermodynamic variables at seasonal scales (100–300 days), reinforcing the role of climatic forcing in aerosol dynamics. Additionally, lagged correlation analysis provides valuable insight into

delayed atmospheric responses, with peak influences ranging from 10 to 30 hours depending on the variable. This temporal lag is particularly relevant for forecasting and suggests that PM<sub>2.5</sub> dynamics are governed by cumulative and nonlinear processes rather than instantaneous interactions.

The multivariate regression framework further supports these findings, identifying wind speed, rainfall humidity, and solar irradiance as significant predictors. However, some relationships (e.g., rainfall showing both positive and negative associations depending on scale) highlight the inherent complexity of aerosol–climate interactions in desert environments.

Despite its methodological rigor, the study has notable limitations. The absence of vertical atmospheric structure (e.g., boundary-layer height) and satellite-derived aerosol data (AOD) constrains the interpretation of transport and mixing processes. Moreover, the lack of source apportionment prevents differentiation between natural dust and anthropogenic emissions, which is critical in arid regions. Addressing these gaps could substantially enhance the robustness of the conclusions.

Overall, the paper makes a strong contribution by integrating high-resolution data with multiscale analytical tools, offering nuanced insights into PM<sub>2.5</sub> dynamics in arid climates. Its findings are particularly relevant for air quality forecasting, renewable energy planning, and climate adaptation strategies, although future work incorporating vertical dynamics and source-specific analysis would further strengthen its applicability.



Cross-wavelet coherence between PM<sub>2.5</sub> and meteorological variables wind over 2017–2024, showing time–frequency relationships with color indicating coherence strength and arrows denoting phase/lead–lag interactions; significant regions are contoured and the cone of influence marks edge-effect zones; dominant coherence at seasonal scales ( 64–256 days) highlights strong climatic control on PM<sub>2.5</sub> variability.



This issue's quiz is based on popular works of science fiction.

## Science Games

**SciFi Quiz** Quiz questions drawn from popular works of science fiction.

**Themed Crossword** The theme for this issue is Science of Medieval India.

**Linked List** Link each term with the next, and complete the science word chain!

# Pop Quiz – For The Science Fiction Enjoys

Abhirup Mukherjee [DPS, IISER Kolkata]

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**Q1.** In H.G. Wells' *The Time Machine*, the Time Traveller discovers that humanity has diverged into two species. Which group lives underground and maintains the machinery?

- I. The Eloi
- II. The Morlocks
- III. The Selenites
- IV. The Fremen

**Q2.** In *The Invisible Man*, Griffin becomes invisible by changing his body's "refractive index" to match what?

- I. Water
- II. Glass
- III. Air
- IV. Mirrors

**Q3.** In the 1999 film *The Matrix*, how do freed minds leave the simulation and return to the real world?

- I. Via phone booths
- II. Via cell phones
- III. Via subways
- IV. Via modems

**Q4.** In the movie *Interstellar*, the protagonists visit a planet near a supermassive black hole where time passes much slower than on Earth. What real physics concept is this based on?

- I. Dark Matter expansion
- II. Gravitational Time Dilation
- III. The Hawking Radiation effect
- IV. Quantum Entanglement

**Q5.** Isaac Asimov's "Three Laws of Robotics" are designed to protect humans. According to the First Law, a robot may not injure a human or, through \_\_\_\_\_, allow a human to come to harm.

- I. Malfunction
- II. Disobedience
- III. Calculation
- IV. Inaction

**Q6.** In the *Star Wars* universe, Han Solo famously claims the *Millennium Falcon* made the "Kessel Run" in less than 12 parsecs. In real-world physics, what does a parsec measure?

- I. Time
- II. Speed
- III. Distance
- IV. Fuel efficiency

**Q7.** Jules Verne's *Twenty Thousand Leagues Under the Seas* featured the *Nautilus*, a highly advanced submarine. What was its primary power source, considered "futuristic" in 1870?

- I. Steam
- II. Electricity
- III. Coal
- IV. Nuclear Fusion

**Q8.** In Mary Shelley's *Frankenstein*, Victor uses a specific scientific "spark" to animate his creature. What 18th-century scientific theory inspired this?

- I. Alchemy
- II. Galvanism
- III. Phrenology
- IV. Atomic Theory

**Q9.** In Andy Weir's *The Martian*, what specific chemical compound does Mark Watney burn to extract hydrogen and create water?

- I. Hydrazine

- II. Methane
- III. Ammonia
- IV. Perchlorate

**Q10.** In Jurassic Park, the scientists “de-extinct” dinosaurs by extracting DNA from mosquitoes. Where was this DNA preserved for millions of years?

- I. In frozen permafrost
- II. Inside fossilized bones
- III. Inside hardened amber
- IV. In deep-sea thermal vents

*Answers can be found at the end of the issue. For an interactive version of the quiz, check out our [website](#)*

# Linked List – General Science Edition

Swarnendu Saha [20MS, IISER Kolkata]

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[ ] [ ]

Linked List is a general science-based word game. The rules are straightforward:

1. The goal is to guess eleven words that have been drawn from science.
2. The first word (the seed) will be provided to you, and hints and number of letters will be provided for the remaining words.
3. You are also informed that the first letter of any word is the last letter of the previous word. So the first letter of the second word will be the last letter of the seed word, the first letter of the third word is the last letter of the second word, and so on.
4. This property goes all the way, so that the last letter of the last (eleventh) word is also the first letter of the seed word.

Find all the words!

Today's seed: **ATOM**

1. A group of two or more atoms held together by chemical bonds, representing the smallest unit of a pure substance that retains its unique chemical properties (8)

**M**

2. Stable, negatively charged subatomic particle (8)

3. Vast, interstellar cloud of dust, hydrogen, helium, and other ionized gases located between stars (6)

4. A small, airless, rocky or metallic body that orbits the Sun, ranging in size from roughly 1 meter to hundreds of kilometers across (8)

5. Stable molecule that carries the genetic instructions for the development, functioning, growth, and reproduction of all known organisms (3)

6. Natural light display near poles (6)

7. Diverse, largely aquatic group of photosynthetic, chlorophyll-containing organisms that range from single-celled microbes to large multicellular seaweeds (5)

8. Biological catalyst (6)

9. The instant of understanding (6)

**A**

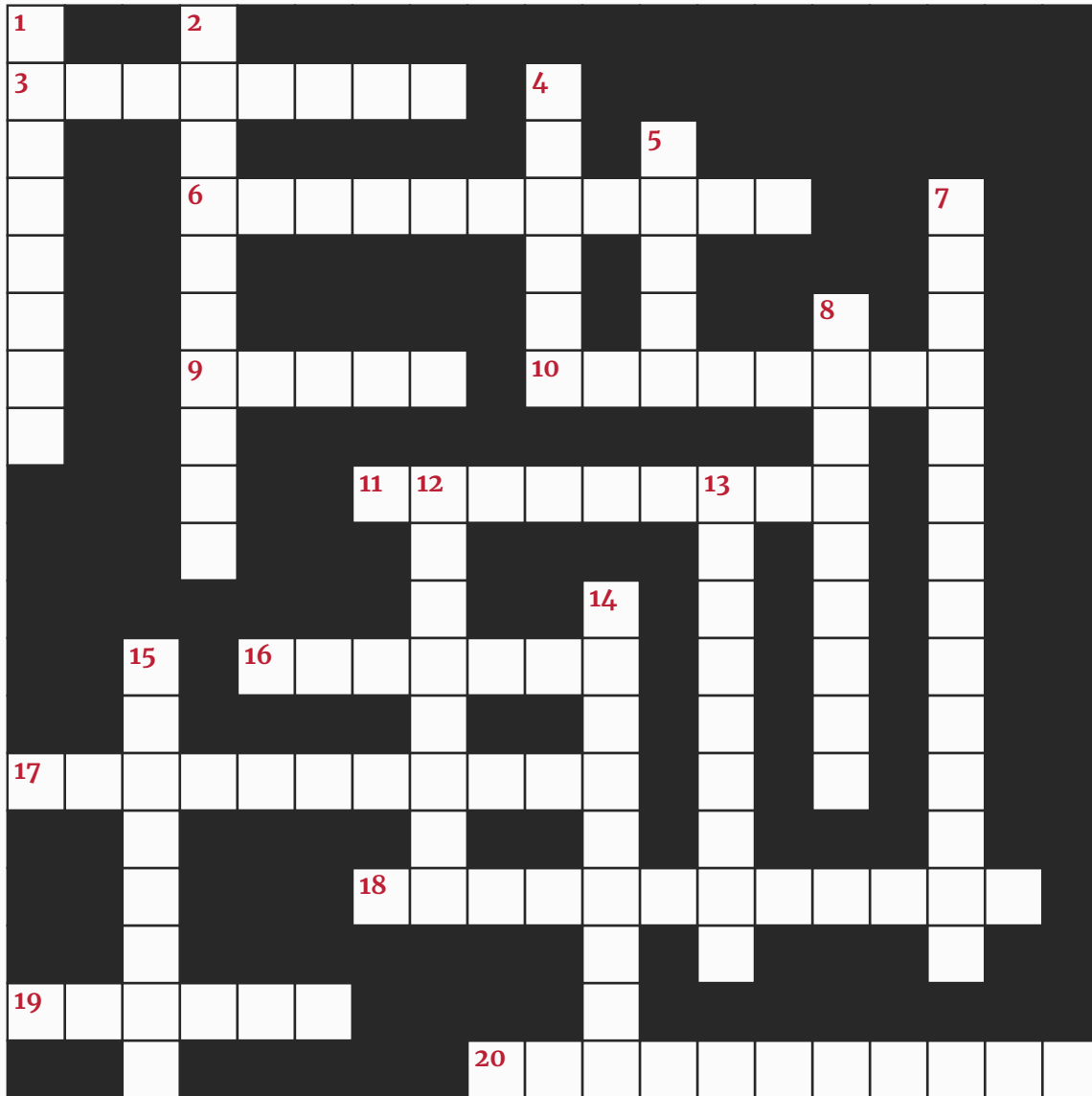
Solution can be found at the end of the issue. For an interactive version of this game, check out our [website](#).

# Themed Crossword – Science of Medieval India

Swarnendu Saha [20MS, IISER Kolkata]

This issue’s crossword is based on trivia about the science of medieval India.

[[[



## Across

- 3. Persian polymath who wrote about India (8)
- 6. Famous astronomical text by Aryabhata (11)
- 9. System of medicine brought via Arabs (5)
- 10. Medical system rooted in ancient India (8)
- 11. Device used to observe celestial objects (9)
- 16. Kerala school mathematician (7)
- 17. The concept of zero as both a placeholder and a functional number was developed by (11)
- 18. Observational astronomy site (12)
- 19. Mathematical infinite series discovered in Kerala (6)
- 20. Instrument to measure time using water (11)

## Down

- 1. Famous observatory builder king (8)
- 2. Science of metals and minerals (10)
- 4. Branch of Ayurveda dealing with surgery (6)
- 5. Ancient Indian numeral system later transmitted to Arabs (6) (5)
- 7. Islamic scholar who translated Sanskrit works (14)
- 8. Study of planetary motion (9)
- 12. Ancient Indian doctor (8)
- 13. Study of stars and celestial bodies (9)
- 14. Medieval Indian text on alchemy (9)
- 15. Medieval mathematician who wrote Lilavati (8)

Solution can be found at the end of the issue. For an interactive version of the crossword, check out our [website](#).











# Academic Listings: Internships, PhDs, Post-docs

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Position titles are hyperlinked

## INTERNSHIPS


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- DoS/ISRO Internship & Student Project Trainee Schemes  Deadline: —
- Visiting Student Research Program at KAUST  Deadline: —
- Long Term Visiting Students Program  Deadline: —
- Undergraduate Student Internships Max Planck Institute for Gravitational Waves  Deadline: —
- Undergraduate Student Internships Max Planck Institute for Gravitational Waves  Deadline: —
- Undergraduate Student Internships Max Planck Institute for Gravitational Waves  Deadline: —
- Undergraduate Student Internships Max Planck Institute for Gravitational Waves  Deadline: —
- University of Tokyo UTRIP  Deadline: —
- 2026 Summer Student Programme IISER Pune  Deadline: —
- Summer School on Gravitational-Wave Astronomy  Deadline: 15 May 2026


## PHD POSITIONS

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- Max Planck Institute for Informatics - PhD Applications  Deadline: —
- Exoplanet Characterisation Predictions via Gravitational Microlensing: Competition Funded PhD Project  Deadline: —
- University of Chicago Graduate School Programme  Deadline: —
- University of Texas at Austin Graduate School Programme  Deadline: —
- University of Utah Graduate School Programme  Deadline: —
- Louisiana State University PhD Programme  Deadline: —
- PhD Position - EPFL  Deadline: —
- Doctoral (PhD) and postdoctoral position (m/f/d) in Computational Biology | Biomathematics | Biosystems Engineering  Deadline: —
- Doctoral (PhD) and postdoctoral position (m/f/d) in Computational Biology | Biomathematics | Biosystems Engineering  Deadline: —

Doctoral (PhD) position (m/f/d) in Glia Biology | Neurobiology at the Dioscuri Centre for Chromatin Biology and Epigenomics at the Nencki Institute for Experimental biology (Poland)  **Deadline:** —


PHD in geospatial analytics  **Deadline:** —


PhD candidate working on advanced ML and LHcb physics, between Heidelberg and Paris  **Deadline:** —

## POSTDOCTORAL AND OTHER POSITIONS

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HRDG- Nehru Science Postdoctoral research Fellowship  **Deadline:** —

Postdoc position (m/f/d) | Development and Application of an Ultra-Bright Coherent Soft X-Ray Beamline  **Deadline:** —

Doctoral (PhD) and postdoctoral position (m/f/d) in Computational Biology | Biomathematics | Biosystems Engineering  **Deadline:** —

Postdoc/Research Scientist in the Reproductive Ageing Research Group (m/f/d)  **Deadline:** —

Reasearch fellow in geophysics  **Deadline:** —

Geospatial AI scientist  **Deadline:** —

Assistant or Associate Professors in Active Tectonics and Earthquake Hazards Nanyang Technological University, Singapore  **Deadline:** May 18, 2026

2027-2028 Fulbright-Nehru Doctoral Research Fellowships  **Deadline:** —

# Join the Conversation

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## Contribute

Contributions are welcome from students and faculty members across all academic institutions, on a rolling basis. Submission portals for all types of content can be found on our website. More detailed guidelines are also available there, so please refer to the linked page if you're interested in contributing. For any queries, feel free to contact us at [scicomm@iiserkol.ac.in](mailto:scicomm@iiserkol.ac.in).

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### Quizzes and Games

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### Short Summaries

To showcase cutting-edge research, we publish short summaries (350–400 words) of recently published scientific papers. The summary should broadly outline the research questions and highlight the key findings.. Submit your research stories [here](#).

### Interview Recommendations

If you would like us to interview a particular scientific personality, or if you have an interview you'd like us to consider for publication, please reach out to us at [scicomm@iiserkol.ac.in](mailto:scicomm@iiserkol.ac.in).

More importantly, we would love to hear any feedback that you might have about this endeavour, so please send us your comments at [scicomm@iiserkol.ac.in](mailto:scicomm@iiserkol.ac.in).

## Join our team

We are currently looking to expand our team. If you are interested in what we do and are confident that you will be able to devote time to this, please reach out to us at [scicomm@iiserkol.ac.in](mailto:scicomm@iiserkol.ac.in). We will be happy to discuss possible roles for you depending on your skills.

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# The Last Page

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## Crossword

### Across

3. ALBERUNI
6. ARYABHATIYA
9. UNANI
10. AYURVEDA
11. ASTROLABE
16. MADHAVA
17. BRAHMAGUPTA
18. JANTARMANTAR
19. SERIES
20. GHATIYANTRA

### Down

1. JAYSINGH
2. METALLURGY
4. SHALYA
5. HINDU
7. HUNAYNIBNISHAQ
8. CELESTIAL
12. SUSHRUTA
13. ASTRONOMY
14. RASARATNA
15. BHASKARA

## Quiz

1. The Morlocks
2. Air
3. Via phone booths
4. Gravitational Time Dilation
5. Inaction
6. Distance
7. Electricity
8. Galvanism
9. Hydrazine
10. Inside hardened amber

## Linked List

1. MOLECULE
2. ELECTRON
3. NEBULA
4. ASTEROID
5. DNA
6. AURORA
7. ALGAE
8. ENZYME
9. EUREKA

You made it to the end! While we cook up the next issue, here's a random photo dump.



### **Giving It Back**

National Science Day celebration at IISER Kolkata, on February 27.

*Credit: IISER Kolkata*



### **Science, Technology and Education**

IISER Kolkata's outreach activity at the 11th Indian National Exhibition 2025 at Kolkata.

*Credit: IISER Kolkata*



### **Forward Defense**

Prof. Ayan Banerjee, Prof. Bheemalingam Chittari and Suman Halder playing cricket in the last DPS picnic.

*Credit: DPS, IISER Kolkata*