Connect

WITH THE INDIAN INSTITUTE OF SCIENCE

Volume 13 Issue 4 Dec 2025

Stranger Things
Untold campus tales

How Glass Forms
Cracking the mystery

Safety First
Handling risky pathogens

भारतीय विज्ञान संस्थान
ISSN 2454-6232

IN THIS ISSUE

EDITORIAL

Take a look around. Your phone screen, the spectacles on your face, or the bulb lighting up the room – all of them are made of glass. It is so common that we barely notice it, but it is one of nature's most puzzling materials. Though it appears solid, at the atomic level, its structure is as disordered as a liquid. In our cover story, we delve into this enduring mystery and into various theories about how glass forms.

We love a good mystery, and this issue is full of them. We explore how predatory bacteria hunt – sometimes in packs, sometimes with toxic needles – and how these strategies might help us develop better antimicrobial therapies. We also speak to campus residents who share anecdotes of encounters stranger than fiction.

In other campus stories, a student reflects on the challenges of socialising in the digital age and some efforts to address these. Staff at the biosafety facility share how they prioritise safety while working with high-risk pathogens.

Science isn't removed from the human experience. We look at how art and creativity are helping scientists see their work in new ways, and how curious citizens are helping researchers collect critical data for conservation.

This issue also features two in-depth conversations: One with materials physicist Yuri Kivshar, a pioneer in metamaterials, and the other with former staff member Renugopal Murugesan, who wore many hats during his four-decade journey at IISc. We also spent a day with Geetha Ramaswamy, who keeps IISc's guest houses running smoothly.

Finally, try your hand at our quick crossword and chuckle at our students' comic on the last page.

Happy reading!

Team Connect

Abinaya Kalyanasundaram (Coordinator), Ashmita Gupta, Bitasta Das, Kavi Bharathi R, Ranjini Raghunath, Rohini Subrahmanyam, Sandeep Menon

Contributing Writers

Creetika Dahal, Divyanshu Bhatt, Kavitha Harish, Shruti Sharma, Yashashree Prabhune

Contact

Email: connect.ooc@iisc.ac.in

Phone: 91-80-2293 2066

Address: Office of Communications,
Indian Institute of Science,
Bangalore 560 012

Website: http://connect.iisc.ac.in

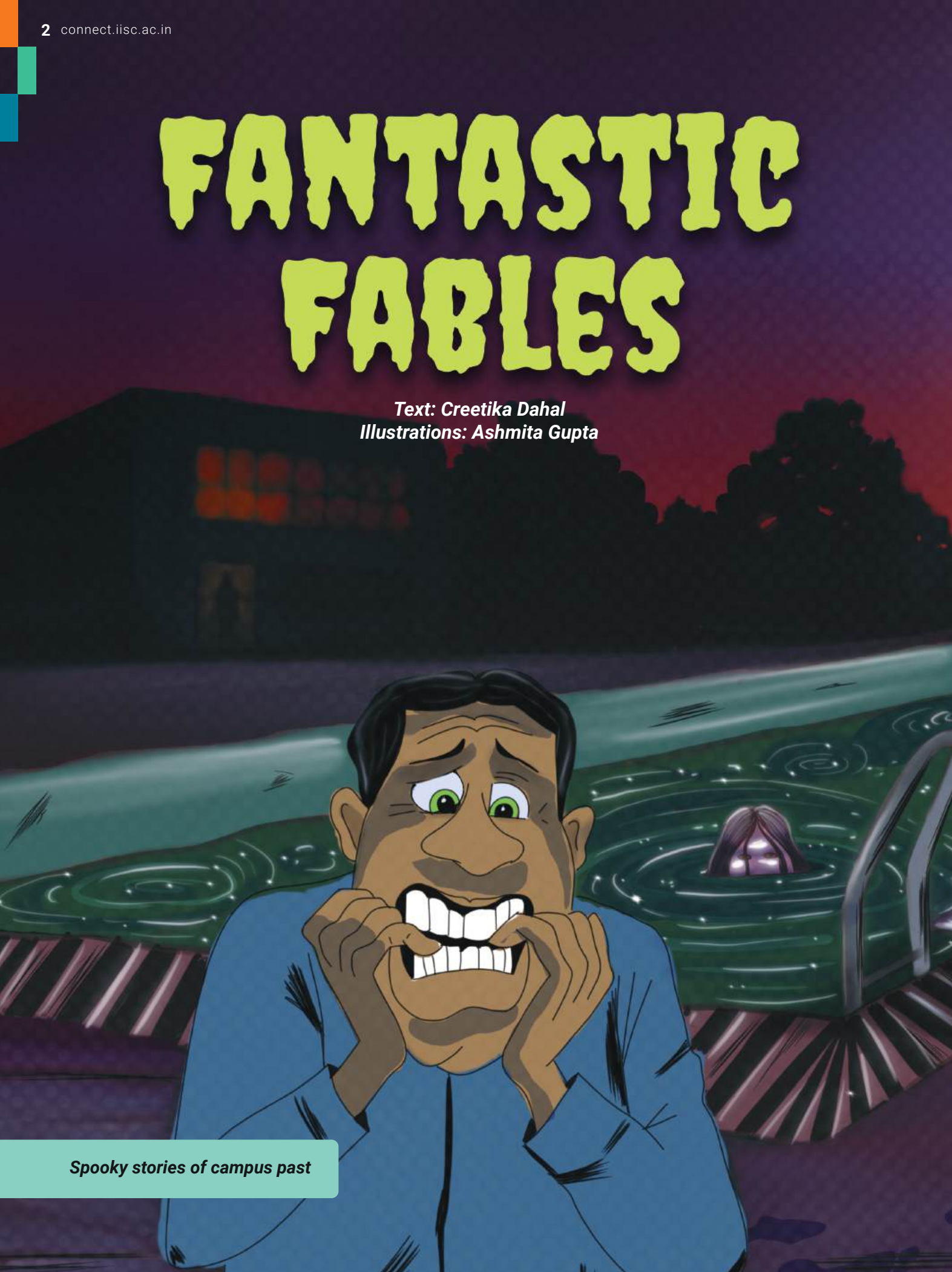
Design: Magnetyz

Cover illustration: Sumana Sainath

Printer: Sri Sudhindra Offset Process

FANTASTIC FABLES

Text: Creetika Dahal
Illustrations: Ashmita Gupta



Spooky stories of campus past

IISc is equal parts a university and an epic, covering several epochs in its century of existence. Stacks of dusty files overflow with correspondence and documents, digital folders burst with names and passwords, and fossilised records lie silently in the farthest corners of the library. Yet, there is more.

Beyond this recorded history, under the fabric of everyday life on campus, is an anthology of twisted tales whispered amongst the IISc community. Most of the time, these otherworldly experiences are shunned as far-fetched, mistranslated truths, unworthy of time and spare thoughts. After all, what could possibly be scarier than looming finals, deadlines, soaring Bengaluru cab prices, and the truly mortifying confessions on anonymous Instagram pages?

But the curious thing about stories is that they always find a way to be told. They wait patiently on the tip of the tongue or in the recesses of the mind. At times, they are a whisper on empty roads and departmental buildings, ready to infect the curious. A blur of movement in the corner of the eye or the impossible sound in an empty room, IISc tells its stories to those who will listen.

Let us, then, listen.

Just keep swimming?

The campus swimming pool is a fantastic facility, kept clean by amazing staff – visibly, at least. Devansh*, a security guard on campus, was unfortunately one of the few who experienced the grime under the surface.

Over a decade ago, Devansh was on the night shift at the entrance of the swimming pool. He had grown so accustomed to silence as his lone companion that he was puzzled when he heard footsteps. It rose above the rustling of shrubbery and the creaking of his old plastic chair. He turned around … and suddenly the echo of footsteps stopped. The paved road greeted him innocently, still and empty. He shrugged it off as a figment of imagination from his sleep-addled mind, maybe a nosey nocturnal animal scampering across the undergrowth.

When the footsteps came around again, his rationale started to erode. The third time was one too many, and Devansh did not stick around to investigate. He ran, lungs aching, until he was standing in front of the nearby guest house, where a very confused co-worker sat him down and listened to his experience. After the incident, Devansh refused to work around the swimming pool area.

Viraj*, another member of the IISc staff, was not so lucky. He was tasked with serving tea to the 150 permanent staff on duty during the graveyard shift. Late into his work one night, Viraj was tasked with bringing tea to the security guard on swimming pool duty. When he reached the facility, all that Viraj saw was an empty plastic chair gleaming under the street light. As he stepped into the pool complex, the pungent chlorine enveloped him alongside the darkness. The water in the pool bobbed silently.

Suddenly, something dived off the building and into the pool. He didn't have to turn back to see the giant splash as the water rose '20 metres' into the air upon impact. And yet, not a drop touched him. Heart thundering, he took off running, making his way to the guest house. To his surprise, he found a watchman there, shaking like a leaf as he explained that an otherworldly presence at the swimming pool had scared him away.

Legend has it that if you walk along Gulmohar Marg at night and stand quietly in the dark stretch between two streetlamps, you may hear someone calling out your name

An out-of-the-way, sparsely visited location may feel like low-hanging fruit for an urban legend begging to catch on. What about departments, with their packed laboratories and overworked students who might as well bring in a mattress as part of course material?

The years bygone

A ways away from the swimming pool stands a building filled with people who stare at brains – the Centre for Neuroscience (CNS). Legend has it that on your way there, if you walk along Gulmohar Marg at night and stand quietly in the dark stretch between two streetlamps, you may hear someone calling out your name. Does it not sound like your friend who bid you goodnight hours ago? Maybe she finally deduced that you were the culprit who burned the packet of Maggi in her kettle and is coming to give you a piece of her mind? Or maybe it's a trickster spirit?

The CNS building, before it was occupied by scientists, used to be the home of the Archives and Publications Cell (APC), currently the Office of Communications (OoC). Tejashwi*, who has been working on campus for several years, recounts some stories of her time at the old APC building.

Something seemed off about the place, Tejaswhi claims. Multiple people reported eerie sightings and strange feelings of being watched. It had become routine small-talk for both believers and sceptics.' "*Hello, how did your meeting go? Do you think it will rain tonight? Did you catch sight of the thing that knocks on the second-floor window?*"

Once, Tejashwi had stayed back beyond working hours to get through some paperwork. As 5 pm hit, her colleagues popped into her office to take their leave. "Goodbye, see you tomorrow!"

Click.

The door to the room locked automatically upon closing, meaning it could be opened either by twisting the handle from the inside or with a key from the outside. Tejashwi got to work.

Around 6.30 pm, as the sunlight fought valiantly to keep the impending darkness at bay, Tejashwi felt a sudden chill over her skin. She looked up from her desk and tried to shake off the feeling. Just as she was about to get back to work, the door cracked open.

Tejashwi sat frozen as the hinge gaped, a millimetre a second, silent and slow, like an intruder tiptoeing through a house. It swung open fully to reveal… nothing. The dark corridor looked back at her, as if she had not distinctly heard the lock click into place hours ago. As if the door could have physically been opened

with anything but a key. As if anybody but her and the watchman even *had* copies of that key.

Needless to say, she became more open to letting paperwork spill over to the next working day.

But there is more. Soon after Tejashwi had started working in the office, the building also had space for visiting scholars to stay overnight. Two students, John* and Drew*, were at IISc for summer internships. They were incidentally assigned single rooms right down the hall from each other. During the day, Tejashwi, the watchman, and a few cleaning staff would be around, while the students only returned to the building at night after working in labs elsewhere.

One night, John woke up to a loud thumping on his door. Half asleep, he expected Drew to be on the other side. But when he opened the door, an empty corridor greeted him, with a goosebump-inducing cold draft and white fluorescent lighting that could put hospitals to shame. John didn't even need to blink past the glare in his eyes to see the dark outline of Drew's securely shut door.

The place was simply haunted, the uniformed man supplied helpfully

Conversation at breakfast the next day was … interesting. John tiptoed around the fact that he had spent the night trying to convince himself that the thumping had been a stress-induced hallucination. Until, of course, Drew confessed to an incorporeal thumping on his door too. He even confronted the watchman to see if he'd been the victim of a prank, and the former assured him otherwise. The place was simply haunted, the uniformed man supplied helpfully.

The students could now either risk telling the administration that they were hearing things go bump in the night, or suck it up and hope for the best. They dragged their beds into one room and had a sleepover for the rest of their internship.

Eventually, APC moved to a different building, and was rebranded as the Office of Communications. It is now nestled behind a whimsical garden, next to the Faculty Club that hosts lunch for faculty members. It also sits right across the road from a graveyard.

Beyond the veil

While Tejashwi currently no longer works with the Office of Communications, she did continue working for a while after the department moved. There was an eatery behind the currently located Faculty Club, which she frequented with her friends and co-workers.

The period also coincided with her family members constantly suffering from ailments. Her mother fell sick suddenly and the illness stayed stubbornly for over a year. Several colleagues were also facing similar problems – mysterious illnesses and mood swings ran rampant in the office, and spirits (the human emotion kind) were at an all-time low.

One day, Tejashwi and her friend, Aditi*, discussed these issues at the canteen. Aditi's husband had fallen ill recently, and she was concerned about its abrupt onset. "I suppose all this is to be expected," Aditi said, with a sigh. "We are literally very close to a graveyard," and she showed her the compound that was visible from there.

Tejashwi was flummoxed. She looked out at the land which had been her view for countless meals, realising that it was, at the time, *still a functional graveyard*. Eventually, the people recovered. But they were hesitant to share their experiences outside their close circles, fearing ridicule and exclusion. After all, how could you work at a research institution and spread such ignorant tripe?

The sister temples

So far, these legends have been rooted in malignance. For a different flavour, one has to travel closer to the periphery of the campus. If you happen to pass by a particular tree around the Department of Mathematics, stop and observe. Legend has it that a woman was once found hanging on a branch. Be on the lookout for sudden breezes or bird calls (and remember to check up on your loved ones if they're struggling). Past that, where the A and B hostel blocks stand today, is a story that stems from what's considered a traditionally benevolent force.

The expanse of land donated to build IISc included two ancient temples that were worshipped by locals in the area. One was dedicated to Circle Maramma, who is widely revered as a kind deity. The other, smaller one, was dedicated to her mythical sister, Goddess Sollapuriammaa. Back in the day, people believed that the two sisters often walked around or met in this area because they considered it their own space.

As the campus was built up over the years, departments, water tanks, and hostels arose. The boundary around campus, however, remained fuzzy and porous for a surprisingly long time. When they finally enclosed it within physical walls, Circle Maramma's temple fell outside while Sollapuriamma's temple stayed within the premises.

As the student population flourished, the demand for a new hostel complex became unavoidable. The administration decided to build two hostel and mess complexes, and signed off on orders to construct the A and B blocks. While they made the arguably excellent decision to operate the best mess on campus (A mess), they also decided that it would probably be alright if they demolished Sollapuriamma's temple – at this point, barely a small mound protecting an idol – in the process.

It was not, in fact, alright.

For a few months, construction on the hostel blocks was delayed, and the contractual construction workers kept dropping in and out of the project.

One of the staff members was aware of the presence of Sollapuriamma's temple at the construction site. A staunch believer in the Goddess, he interpreted the situation as her refusing to move from the site she had lived in for so long. This story spread, eventually reaching the Director's office along with a plea to construct the blocks around the temple.

Whether it was divine will or simply an administrative decision, the A and B blocks were eventually redesigned to skirt around this temple. Construction then ensued smoothly, and now the buildings stand tall and proud, albeit with horrible ventilation. To this day, Sollapuriamma's temple sits inside the hostel premises. Worshippers occasionally visit her to pay homage and offer flowers in respect.

An unwilling exercise

Our final story lies outside the campus, over at the Gymkhana. Across the creaky yellow overhead bridge is a sprawling sports area that's currently under construction to create a full-fledged student centre. What secrets does it hide?

He had barely walked 10 metres when a distinct whirring cut through the air

Before the Gymkhana renovation, it was occasionally used as a movie set. Viraj*, the aforementioned longtime IISc employee, was once assigned post-shoot cleanup duty. The cast and crew had taken away the bustle along with their camera and equipment, and quiet had descended.

Eventually, he finished the lonely task, having put away the last of the displaced chairs and double-checking the lights and fans, and prepared to lock up on his way out.

The silence was broken only by his boots crunching in the mud as Viraj trudged back towards the gate. He had barely walked 10 metres when a distinct whirring cut through the air. Confused, he turned around to the gleam of moonlight on the metal lock, the secured doors, and the solemn building. Business as usual.

When Viraj craned his neck and looked through the side window, he could see the blades of a ceiling fan rotating at full speed, as though he hadn't just triple-checked the switches. Ignoring the unease in his gut, he walked back to the door and slipped the key into the lock.

He was still trying to figure out how he could have overlooked a fan switch when he entered and realised that the room was aglow. The furthest corner of the hall was lit up, and he could feel the heat radiating all the way to where he stood. It wasn't spreading, just an angry, localised hot glow, gleaming impossibly in the otherwise dark room.

By the time Viraj's brain caught up with his body, he was already running away from the Gymkhana. Adrenaline pumping, he stumbled across the road to normalcy. The next day, he recounted his experience to his co-workers, and was teased for leaving the door unlocked all night.

Of course, it doesn't end there. Several people have had odd experiences inside the old complex. It wasn't uncommon for security guards to go to sleep on the ground floor, and inexplicably wake up on the first. Sometimes they would rise and blankets or pillows would be thrust across the room. As independently reported events bore uncanny similarities to each other, the Gymkhana cemented itself as a key location in this spiderweb of IISc urban legends.

The narrators of these stories expressed themselves with various levels of dread, humour, skepticism, reluctance, and acceptance. They are complex people with nuanced views on the supernatural, mental health, and community, and how these factors affected their own experiences. Each of them lie on different points along a broad spectrum of beliefs. Some shared that they still struggle with rationalising these experiences and staying true to their scientific training, while others showed a profound acceptance of the supernatural as a mundane, if slightly unusual, phenomenon. Either way, they carry these stories with them throughout their lives at IISc and beyond.

*(*Names have been changed to protect the privacy of the individuals.)*

Creetika Dahal is a second year BSc (Research) student at IISc, and a science writing intern at the Office of Communications

(Edited by Sandeep Menon)

Becoming Glass

- Rohini Subrahmanyam

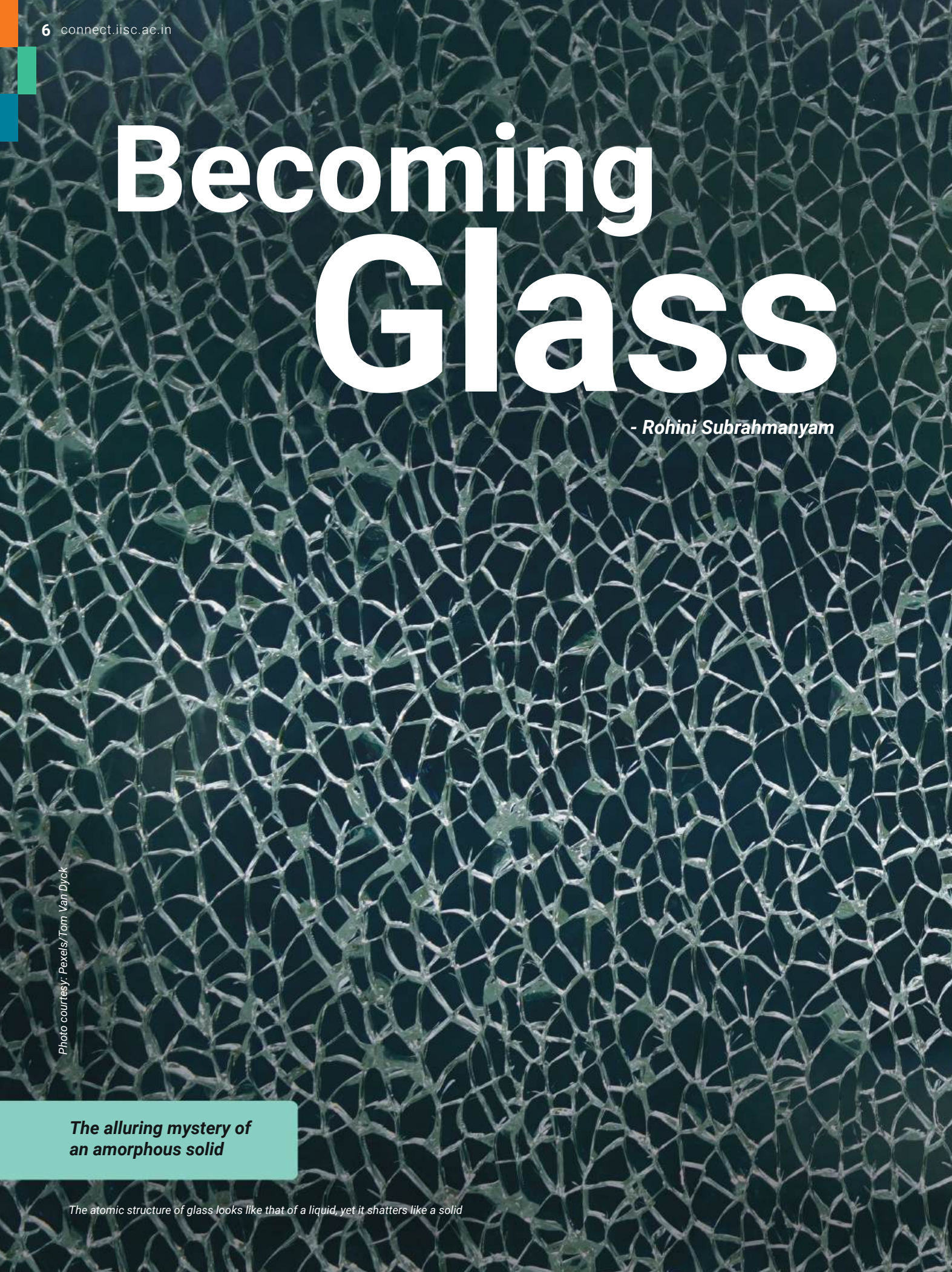


Photo courtesy: Pexels/Tom Van Dyck

The alluring mystery of an amorphous solid

The atomic structure of glass looks like that of a liquid, yet it shatters like a solid

Glass is everywhere. You scroll over it on your phone, you drink from it, it's in the spectacles perched on your nose and in the windows of your house. But how does it form?

To picture that, imagine molten glass. As a liquid, it can flow; its atoms are free to move however they please. Then, imagine cooling it down. As it gets colder, the once unrestricted atoms are forced towards stillness; the speed with which they jiggle about starts to decrease. But as they slow down, they do not line up into neat, ordered rows, like in an ice crystal. They remain disordered. After a point, their arrangement still haphazard, the atoms seemingly grind to a halt. They might still slightly wobble in place, but you don't see them move around again. It is as if, as they started slowing down, they got stuck – midstep in a dance for all of time as we know it.

Its molecules suspended in motion, the liquid eventually turns into an amorphous, rigid mass called glass. Everything looks perfectly still, yet if you peer closely, there is nothing perfect about it.

How is it that glass seems still enough to appear solid, but its atomic arrangement remains as random as a liquid's? That is the crux of the glass problem, and despite decades of research, there are still no clear answers. A theory of the liquid-glass transition must convincingly explain the sluggishness of its atoms and the sloppiness of its structure, but none so far have managed to do so.

How is it that glass seems still enough to appear solid, but its atomic arrangement remains as random as a liquid's?

"It's probably one of those things that will never get resolved," says Sriram Ramaswamy, Honorary Professor at the Department of Physics, IISc. "That's my suspicion, but some, perhaps many, will disagree with me."

This is not due to a lack of ideas; physicists have long theorised about how a liquid cools into glass. Some believe that it only depends on the atoms' movement and is thus a purely dynamic phenomenon – as the atoms cool, they slow down to the extent that the liquid looks solid, but deep down, its structure remains stubbornly that of a liquid. Others insist that there is a hidden structural change slowing down the atoms, making it a thermodynamic phase transition – like a complex version of water turning into ice. Physicists have found evidence that supports both sides of this debate. Many even think reconciling the two sides might give us the full picture. But so far, that has been easier said than done.

"The deepest and most interesting unsolved problem in solid-state theory is probably the theory of the nature of glass and the glass transition," wrote theoretical physicist and Nobel laureate Philip Anderson in Science in 1995. "This could be the next breakthrough in the coming decade."

30 years later, how far have scientists come?

Facilitating flow

In the early 1900s, scientists realised that if you rapidly cool some liquids, like silica, to a temperature below their freezing point, they become "supercooled" and eventually turn into glass. As the liquid transitions, it becomes incredibly viscous – its atoms slow down by about 1,000,000,000,000,000 times.

As it transitions, the relaxation time of its atoms also changes dramatically. Picture perturbing water in which atoms are all quickly moving about and rearranging. The time that it takes for the atoms to forget the perturbation and return, or "relax"

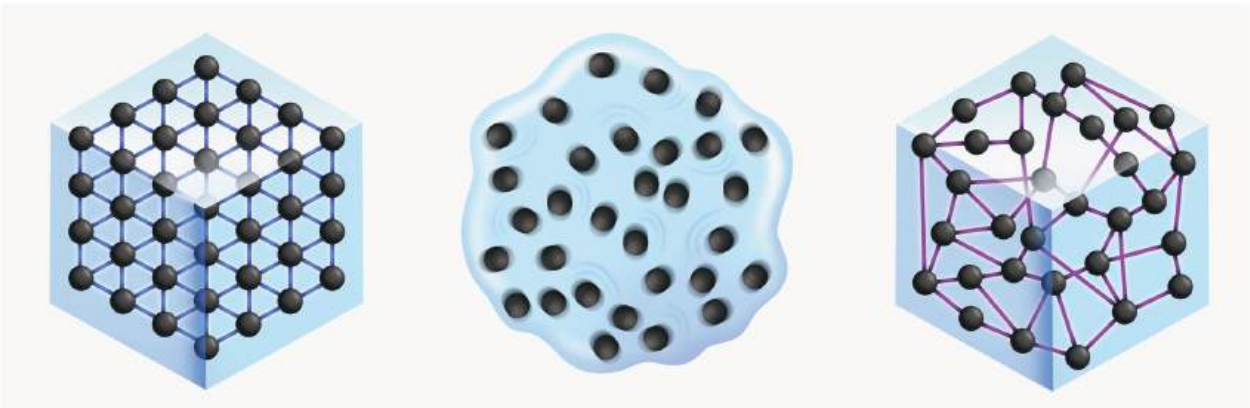


Illustration: Sumana Sainath

A **crystalline solid**, with its strictly structured atoms, is hard and rigid

A **liquid**, with its randomly moving atoms, can flow easily

Even though **glass** feels rigid like a solid, its atoms look as random as in a liquid

back into their original state, is the relaxation time; for water, this is about a billionth of a second. But at the glass transition temperature – around 550°C for window glass – these times stretch to hundreds of seconds, becoming so large that the atoms appear to stop rearranging altogether once glass forms.

But if you closely observe its molecular structure, the glass still "looks" exactly like the liquid it once was. All the atoms are still randomly arranged. Yet we know that glass feels nothing like a liquid – it can be both strikingly hard and frustratingly fragile.

Many aspects about the liquid-to-glass transition are unique and different from how water freezes. We learn in school that when water turns to ice, it releases energy in the form of latent heat. But no such heat escapes when liquid silica supercools to glass. No matter how fast or slow you cool down water, it will always turn to ice at 0°C at a fixed pressure. But the temperature at which a liquid turns to glass depends on how fast you cool it – usually, the faster it is cooled, the higher the temperature. Ice's properties vary sharply from water's, but as molten glass solidifies, its properties change smoothly instead. Even the increase in viscosity, albeit steep, is not a sharp transition.

Another peculiarity that has puzzled scientists is how glass is not at an equilibrium state. Water and ice are both at equilibrium – at any given temperature and pressure, they are in their most stable state and nothing inside them will jostle them out of it. But with glass, it seems like it just got stuck somewhere on the way to its most stable state. Like its molecules want to arrange themselves neatly in the form of a crystal, but they are moving just too slowly to get there. "In this view, it's wandering desperately forever, not settling down to the state it actually wants to be in," says Sriram.

Another peculiarity that has puzzled scientists is how glass is not at an equilibrium state

All these findings led some scientists to believe that the kinetics – or how the atoms slow down – is key in driving a liquid towards glass. In the 1980s, German physicist Wolfgang Goetze put forward the Mode-Coupling Theory (MCT) from this dynamics perspective.

This mathematical theory predicted that the atoms of the liquid get increasingly crowded the closer you get to glass, to the extent that they become almost trapped by their neighbours. At this point, they cannot move any further, they can only wobble about in a cage formed by their own surrounding atoms. Close to the critical temperature around which glass forms, the atoms get stuck in their cages, unable to break free or "relax" back into their original state.

But that was not entirely accurate. Experiments eventually found that even beyond that temperature, glass atoms could still relax; the system had not stopped rearranging as some had hoped. The theory explained the early stages of glass formation as the atoms start slowing down, but what happens at the transition was still somewhat opaque.

Scientists have also used colloids – microscopic particles suspended in liquids – to study glass formation. Densely packing together many colloidal particles is similar to supercooling a liquid, and because the particles are big enough in size, they are easier to visualise than assemblies of glass atoms. Using such systems, scientists have discovered "dynamic heterogeneities" in supercooled liquids – not everything is perfectly still, particles in some regions can reorganise and relax to a smaller extent as compared to other regions. As some particles relax, they help their neighbours move.

"For example, in a very, very dense crowd, not everybody gets to relax at the same time," explains Rajesh Ganapathy, Professor at the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR). "You will see 10 people next to you relaxing, then you will get some room to move, then somebody next to you will move, right? Somebody facilitated your motion."

This led to the more recent dynamic facilitation (DF) theory, which predicted that cooperative movement in different regions could help glass atoms eventually relax, even if all the atoms seem like they are stuck in their cages. In fact, many DF theorists believe that there is no "glass transition" as such; it's just that the likelihood of these cooperative regions appearing goes down the colder it gets. DF was able to explain some features of glass even in a "deeply supercooled" regime – when the liquid appears as still as glass.

But physicists on the thermodynamics side were not completely convinced, because DF does not say much about

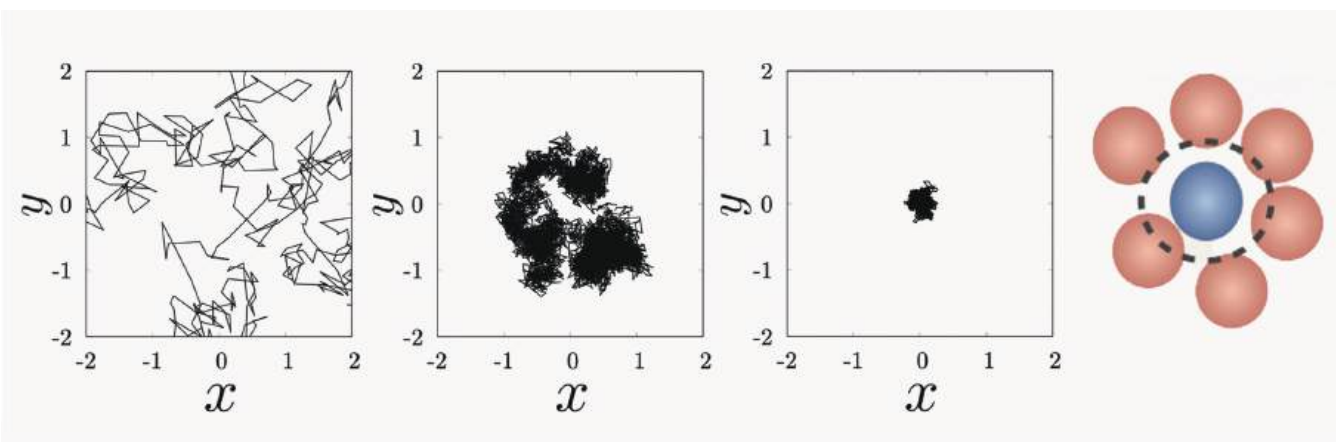


Image courtesy: Rituparno Mandal, RRI

As the temperature drops (left to right), the trajectory of a tagged particle gets progressively more restricted as it gets caged by its neighbours

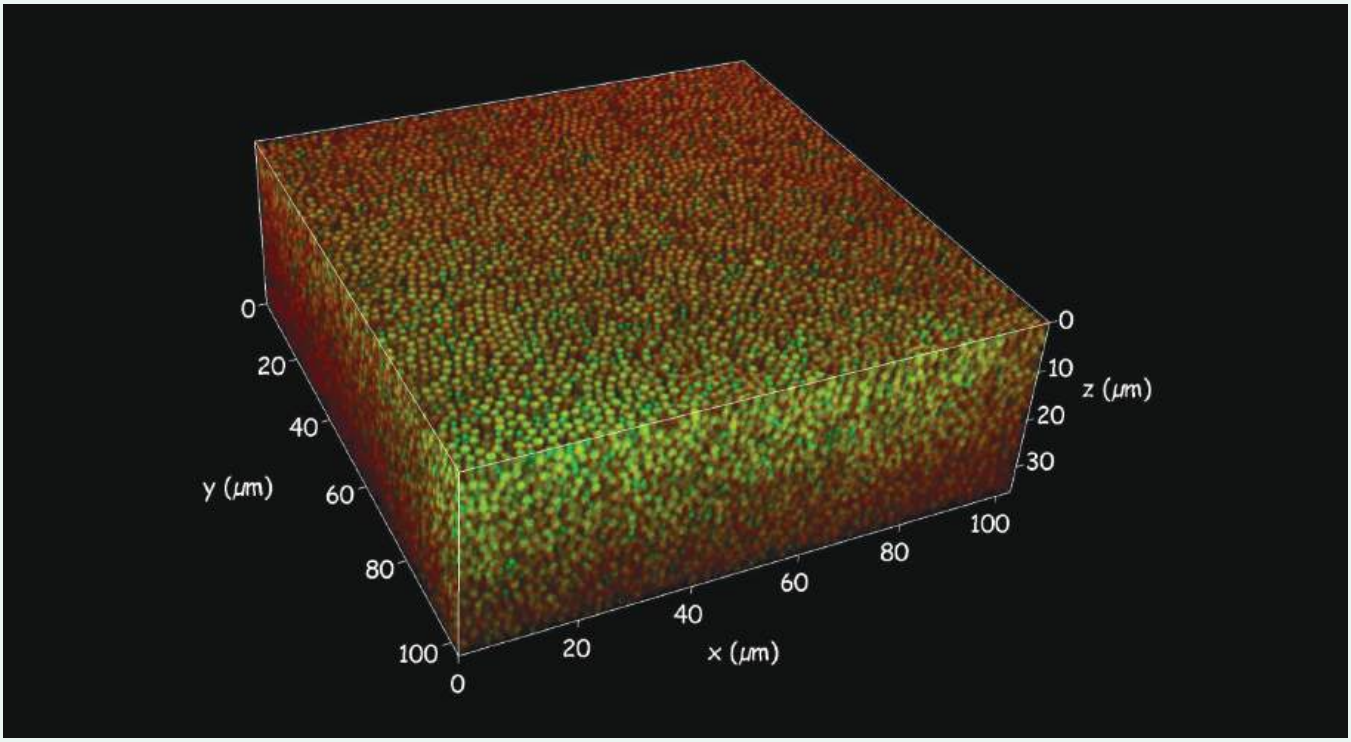


Image courtesy: Kamlesh Mishra/JNCASR

In this confocal microscopy image of colloidal glass, particles of two different sizes (orange and green) prevent crystallisation, and the system is disordered at high densities

how or why cooperative regions would pop up in the first place.

Yet another conundrum is that viscosity increases in a steep yet smooth way only in what are called "strong" glasses, like silica or window glass. In some organic liquids, like o-terphenyl, the viscosity shoots up much more dramatically – almost sharply increasing as they transition to glass. Such "fragile" glasses prompted thermodynamic theorists to believe that something deeper must drive this drastic change. Could it not be that instead of particles simply slowing down, there is some inscrutable, yet increasing sense of order that instead reduces their movement? That the disorder in the system ultimately plunges to zero, tipping the deeply supercooled liquid state over to a stable, solid, glassy one?

"The fact that [an order] is hidden is what makes it [glass transition] so much more beautiful," says Rajesh. "Because you have to really go search for it."

Glassy metal

Despite not understanding glass well, humans have bent it to their will for millennia, with some of its oldest uses found in vessels and jewels in ancient Egypt. Today, glass is as ubiquitous as it is unique – found in the fibre optic cables that sustain the internet, in our megapixel camera lenses, and in many more devices.

Humans continue to push its boundaries as a material. In 1960, Belgian physicist Pol Duwez discovered that rapidly cooling certain metal alloys turns them into metallic glass – amorphous metals that are much more durable and energy-efficient. As they corrode less, metallic glasses can be used in biomedical devices, and some amorphous steel alloys have record-breaking resistance to deformation. However, they are tricky and expensive to make, as one needs to cool down the molten metals at a very rapid rate or prepare the alloys with extreme precision. Nevertheless, NASA has been exploring their use in lubricant-free gearboxes in space robots.

An emerging order

To understand the thermodynamic quest for order, let us go back to the familiar case of water cooling into ice – a true thermodynamic phase transition. As water freezes, its particles slide into a strictly ordered structure. "Therefore, you can define some order parameter – essentially a quantification of the degree of order in the system," explains Rituparno Mandal, Assistant Professor at the Raman Research Institute, Bengaluru.

An order parameter helps build a thermodynamic theory to explain how water turns to ice, but during glass formation, there is no clear change in order or any significant structural change. Nevertheless, many believe that there may be some imperceptible changes that have somehow escaped their scrutiny. "The structural indicator, if it is even there, is very hard to find," Rituparno says.

Rajesh is also interested in finding this elusive order in supercooling liquids, but he doesn't want to get attached to either the thermodynamic or the dynamic side. "As an experimentalist, I am not supposed to be biased about what to expect," he says. "My job is to go do the experiment and say, 'this is what I found.' Then we assess which theory captures the results best."

In a 2023 PNAS paper, Rajesh and his team peered at a dense mixture of colloidal particles under a confocal microscope and realised that there is an "intermediate-range" order in the system. It is not a long-range order, with all the atoms arranged periodically like in a crystal. But it goes beyond short-range order, which is looking only at links between immediately neighbouring particles. They found that as the particles get more densely packed – like what happens when a liquid is supercooled – this intermediate structural order increases and even influences the dynamics of the particles.

Other groups have also found that there is a growing "amorphous" order in supercooling, glass-forming liquids. "In a liquid, everything moves. You can go to any part of the liquid, and all the particles will behave in roughly the same manner. In a supercooled liquid, that is not the case," Rajesh says.

The myth of medieval windows

Image courtesy: Wikimedia Commons/Julian P Guffogg

Many believed that medieval stained glass windows were slowly melting

The melting of stained glass windows in centuries-old cathedrals is a myth that has appeared even in textbooks. Since the bottom of those glass windows is thicker than the top, it looks as if the glass has been gradually flowing all these years, suggesting that it may have been masquerading as a sluggish supercooled liquid all along.

However, in 1998, Edgar Dutra Zanotto, Professor of Materials Science and Engineering at Federal University of São Carlos, Brazil, published a calculation shattering this myth. Factoring in the viscosities of ancient and modern window glasses, Edgar showed that it is theoretically impossible for cathedral glass windows to have melted since medieval times. Glass atoms are too slow to flow in such a short time – even ancient Egyptian glasses from 3,500 years ago still look the same. In the best case, it would take 10^{33} years. As no one can wait that long, we cannot assume that window glass is simply a slow-moving liquid.

The reason why the glass's bottom edges are thicker is that the glassblowers of that era were unable to make completely flat panes, scientists think. They simply put the thicker edge at the bottom for stability. "For window glass to flow, it's going to roughly take the age of the universe," says Rajesh.

"There are regions that suddenly relax, there are regions that don't relax for a long time. Does that have something to do with the structure? What we find, what simulations find, what experiments find, time and again, is yes."

Another clue that supports the thermodynamic perspective is a prediction by American physicist Walter Kauzmann in 1948. He realised that if he could cool a glass-forming liquid extremely slowly beyond its freezing point, then he could "supercool" it for longer and delay its hardening into glass. He also found that the liquid's configurational entropy – all the different configurations its atoms can assume – drops gradually as the liquid is cooled. Theoretically, if one keeps extrapolating this decrease, this entropy – a rough measure of the liquid's "disorder" – ultimately vanishes. It drops to zero at a temperature called T_K or the Kauzmann temperature, which is usually below the actual glass transition temperature.

In 1958, American scientists Julian Gibbs and Edmund DiMarzio proposed that at T_K, the supercooled liquid must transition to an "ideal glass" – a state with the densest possible random arrangement of molecules. In theory, ideal glass is about as stable as a crystal.

But in reality, no one has managed to even go close to that temperature. The glass atoms slow down to such a massive extent before reaching T_K that it is eventually impossible to measure any useful structural changes with experiments or simulations. Most experiments that make measurements operate in the moderate-to-deeply supercooled regimes – not where the ideal glass transition could supposedly occur. In these early stages, the structure barely changes, prompting dynamic theorists to dismiss any small variations as largely unimportant and focus only on the atoms' motion (or lack thereof).

But thermodynamic theorists remain undeterred, insisting that scientists just haven't cooled the liquid enough. If they do ever hit T_K, there will be a payoff – a dramatic change in order will make the viscosity skyrocket and turn the liquid into ideal glass.

Dripping over decades

Image courtesy: Wikimedia Commons/John Mainstone, University of Queensland

Since 1930, pitch has dripped nine times within this setup

Some amorphous solids flow faster than window glass, oozing out a single drop in about a decade. Pitch, or bitumen – also called asphalt – is an extremely viscous component of crude oil which looks solid at room temperature. But if you wait for a decade, you can see it flow. "[Pitch] is an intermediate between water and the window glass … between 1 second and 10^{33} years," says Rituparno.

In 1927, University of Queensland physics professor Thomas Parnell heated some pitch and let it cool in a sealed funnel for three years. In 1930, he cut the funnel and let the pitch drip. It took about eight years for the first drop to fall. Since then, eight more drops have fallen, with the ninth one having plopped down in 2014. This pitch drop experiment is featured in the Guinness World Records for the world's longest-running lab experiment and won both Thomas and fellow scientist John Mainstone the 2005 Physics Ig Nobel Prize, a parody of the Nobel Prize.

As scientists access newer degrees of supercooling both experimentally and in simulations, they are starting to see more drastic changes in structure, Rajesh says. "But when it comes to the ideal glass transition, we are nowhere near there," he adds.

Some scientists think that the system simply falls out of equilibrium – gets frozen, seemingly forever, before it could ever become ideal glass. But given enough time – perhaps at the end of the universe – could it happen? "Given that nobody can wait long enough to actually see if that really happens, there is a debate about which one of the theories is correct," says Rajesh.

"My own personal view is that there isn't an incompatibility between these different pictures," adds Srikanth Sastry, Professor at JNCASR. "We just don't know how to put it all together."

A rugged landscape

Despite the uncertainties, the allure of an alleged, albeit unattainable, temperature at which ideal glass could emerge was very attractive to theorists. In the mid-1980s, American physicists Theodore R Kirkpatrick, Devarajan "Dave" Thirumalai, and Peter Wolynes developed the random first-order transition theory (RFOT), a mathematical theory that uses an energy landscape to describe what might happen at this temperature.

Imagine a rough terrain with multiple valleys, each valley corresponding to a different, stable configuration of the liquid's atoms. The valleys are associated with having low energy and being stable, with atoms needing extra energy to jump from one valley to another. The number of these valleys also represents the system's configurational entropy.

Initially, the liquid's temperature and energy are high – it can quickly flit from valley to valley, exploring various configurations. As the liquid cools, its energy drops and it becomes harder for the liquid to jump between the valleys. This causes the moving atoms to slow down, as they keep getting stuck in one of many "metastable" yet disordered states. As it cools further, the entropy decreases and the number of stable valleys reduces, but they are all as deep as ever – making it harder and harder for the cooling liquid to escape any valley it gets trapped in.

Even as one rolls about in this hypothetical landscape, we must remember that atoms slow down when glass forms – the liquid becomes so viscous that it basically stops flowing. "What does the vanishing of the entropy have to do with why the viscosity changes so rapidly?" asks Srikanth. "This is one thing that has driven the field – seeking answers to this very simple-sounding question."

In a system like glass, there are many atoms packed close together, each interacting with the other in uniquely different ways

Scientists have tried to connect entropy to dynamics in RFOT – as the entropy,

An "ideal" mirror

The almost-perfect mirrors of the Laser Interferometer Gravitational-Wave Observatory (LIGO) – twin facilities in the USA used to detect gravitational waves from the distant universe – are made entirely of glass. Our bathroom mirrors consist of metals that reflect light, covered by a glass shield. LIGO's laser would cook any metal it lands on, hence its mirrors are made up of 36 layers of carefully crafted glass.

Glass usually allows most light to pass through and only reflects a small amount. In LIGO's mirrors, each layer reflects a bit of light – and the rays all combine in a way that the mirror is 99.9999% reflective. The slight imperfection arises from how glass atoms can sometimes switch between two different configurations, which minutely affects how the laser light travels between the mirrors. For a system set up to measure gravitational waves the size of about a thousandth of an atom, this imperfection is an issue.

It turns out that ideal glass may offer a solution. While trying to understand the glass transition from a thermodynamic perspective, physicists have now developed an ideal glass-like substance – "ultra-stable" silicon glass. With fewer imperfections, it may be more ideal for some layers in LIGO's mirrors.

or the number of valleys, goes down, the atoms spend more and more time in a single valley, slowing down the whole process towards ideal glass. But more work needs to be done to bridge this gap rigorously, Srikanth says.

Ultimately, according to RFOT, at T_K, this entropy will drop to zero. Only the deepest valley will remain, and the cooling liquid will freeze into a single, stable, amorphous state – ideal glass.

Italian physicist Giorgio Parisi, who won the Nobel Prize in 2021, came up with a calculation that showed that something like this could actually happen. But it only works in a scenario with infinite dimensions, not in our real 3D world.

Grappling with the peculiar yet profound glass problem has allowed scientists to explore other physical and even biological puzzles

In a system like glass, there are many atoms packed close together, each interacting with the other in uniquely different ways. Modelling them as an infinite dimensional system makes it slightly easier to make some assumptions, says Rituparno. "In the infinite dimensional limit, logically your number of neighbours are infinite," he adds. "So, fluctuations play less of a role." Fewer dimensions means fewer surrounding atoms, and the more that each atom will be affected by its neighbours. If there are infinite neighbours, it is a tad easier to average out the effects. This gives scientists a template to work with.

"It is a good step, because now they are trying to extend that theory from infinite dimensions to finite dimensions," says Rituparno.

The glass paradigm

From inching closer to accessing deeply supercooled regimes to understanding an energy landscape in infinite dimensions, physicists have explored the glass problem from many different lenses. But it remains hard to crack using the tools that we currently have.

Daniel Fisher, Professor of Statistical Physics at Stanford University, says that the fundamental problem – how some glass-forming liquids seem to slow down so much in a narrow temperature range – remains unsolved. "A lot of the theory has focused on the initial [slowing down] part, rather than what it looks like once [the viscosity] is sailing up dramatically," he says.

"Constructing a full-fledged theory for the second part is harder than for the first part," says Giulio Biroli, Professor of Theoretical Physics at École Normale Supérieure, Paris. "It's a really new phenomenon, so one cannot take a block of theory that was already developed for something else and change it a little bit," he adds. And any fresh theoretical ideas are hard to test because of the supremely slow dynamics. "If there was a breakthrough in the way we simulate or experimentally probe glasses, this could be very beneficial to develop more theory," says Giulio.

Artificial Intelligence (AI) could be one way out. Using machine learning, one could potentially simulate the viscosity increasing dramatically, Daniel says, by building simple, predictive models that successively capture the sluggish dynamics over much longer timescales. Giulio, who is currently testing the use of AI in speeding up simulations of glassy systems, also thinks this might help. But for the moment, we don't know whether it works for sure, he says.

Nevertheless, grappling with the peculiar yet profound glass problem has allowed scientists to explore other physical and even biological puzzles. The study of active glass is an example. "In an active glass, you have a dense suspension of active particles," says Prerna Sharma, Associate Professor in the Department of Physics, IISc. "And because it's so crowded, [the system] is not going to rearrange very fast; the dynamics are going to slow down."

Instead of lifeless particles that only vibrate when heated, tightly-packed active particles can propel themselves using their own energy and settle into glassy systems of their own. Physicists working on active glasses have shed light on some bizarre biological behaviours, like how densely-packed bacteria could lead to bacterial glass or how, by changing its own shape, a single cell can squeeze its way out of a tightly packed tissue layer (think metastatic cancer).

Even the concept of an energy landscape has been applied in different contexts, like figuring out how proteins fold, how memory might form, and how machines could learn.

"The glass problem is a paradigm of how complex the behaviour of a physical system will become when there is the possibility of multiple stable states," says Srikanth. "So, even if you don't have a complete understanding, whatever understanding you have can take you far."

(Edited by Ranjini Raghunath)

Guests Come First

- Bitasta Das

Photo: Bitasta Das

A day in the life of Geetha Ramaswamy

A drizzle coats the pathway as Geetha walks steadily towards IISc's Main Guest House (MGH). Today, she had commuted from her home in Benson Town to IISc by auto rickshaw. The previous evening's downpour had left her scooter marooned on campus. She quickens her pace to be in the office by 10 am.

'I welcome everyone with respect and make sure that they feel comfortable'

Geetha is a personal secretary in charge of MGH and the Centenary Visitors House (CVH). As soon as she reaches MGH, she is met by the secretary to the Minister of Education, Dharmendra Pradhan. The Minister and his team have been staying at the guest house for the past two days while visiting IISc for an official meeting. The Minister wanted to meet with the IISc Director before leaving for the airport. Geetha quickly calls the Director's secretary and arranges the meeting at the guest house. Before she knows it, her day at work has begun, and she plunges into the bustle.

Geetha sits at her desk and carefully lists the day's tasks in her diary. "This ensures that I don't miss any work," she says. It's a practice she has followed throughout her 33-year-long career at IISc, to help her stay consistently organised and efficient. She then makes a few calls to the Public Relations Office and arranges vehicles for the renowned mathematician Manjul Bhargava and several other members of the team, who are also staying at the guest house. After seeing them off, Geetha welcomes the Director and accompanies him to meet the Minister. "Nobel laureates, ministers, heads of various institutes, faculty members from various institutions and other countries. I welcome everyone with respect and make sure that they feel comfortable," she says, with a smile.

Geetha gets lunch boxes packed for the Minister's guests, since their odd flight timing meant that they would miss getting lunch. The team heads off to the airport, saying a cheerful goodbye to her. She inspects the rooms to see if they are properly cleaned and the appliances are functioning properly. She then visits the kitchen and instructs the staff regarding the day's arrangements. "The majority of the cooking is done at CVH, and food is brought from there for the guests at MGH. Here, we have only minimal arrangements for cooking, like tea and coffee, dosa, poori, chapatti, and other small snacks," she adds.

From typing to hospitality

Geetha joined IISc in 1992 after stints at other organisations. She completed her diploma in Secretarial Practice from the Regional Vocational Training Institute for Women (RVTI) – now known as the National Skill Training Institute for Women – in 1989. Immediately after that, she registered at the Employment Exchange. "I could not afford to idle away my time. I had to support my family, just as my elder sister was doing. With two younger siblings and our father already retired, the responsibility was clear," Geetha reminisces.

Photo: Bitasta Das

Geetha with housekeeping staff at CVH

Photos courtesy: Geetha Ramaswamy

(Left) Geetha with entrepreneur Kiran Mazumdar-Shaw; (right) Geetha with chess grandmaster Viswanathan Anand

She began her career with an internship at the Khoday Breweries Limited factory in Bengaluru, a rigorously managed organisation, where she developed a strong sense of punctuality and discipline. There, she completed an eight-month internship. With this experience in hand, she decided that it was time to seek a permanent job, leading to her first full-time position at Festo Controls Private Limited. While working there, she secured a government position as a stenographer at Karnataka Soaps and Detergents Limited (KS&DL), a far more attractive position than one in the private sector. "If I had continued working at KS&DL, I would have been the Senior Manager heading a separate zone," Geetha says.

On bus rides, Geetha would catch glimpses of IISc and was enchanted by the beauty of the campus

Her daily commute – involving bus changes and long walks – taught her the value of every paisa. On those rides, she would catch glimpses of IISc from the bus and was enchanted by the beauty of the campus. As luck would have it, one day, while reading the newspaper, she came across a job advertisement for a stenographer at IISc. On 24 July 1992, she joined the Institute along with four friends – Amudha, Kavitha, Kalpana and Mangala. "Anandhi is the first friend I made at IISc. We met during our written exam. She is now at the Gate Office of IISc," Geetha reminisces. They remain her closest friends to date.

Growing with IISc

Her first position was in the Schemes Section, where she was tasked with clearing backlogs of paperwork. "We had to manually note down all records related to CSR and DST. We worked mostly with a Facit typewriter, and there were only two or three computers at that time," she recalls. After spending six months there, she was transferred to the team that published the *Journal*

of the Indian Institute of Science. "Assistant Editor Srinivas Rao was in charge of the journal section at that time. He was a meticulous taskmaster, constantly directing me to the journal section to follow the correct writing style. My responsibility was to assist in finding the references, visit faculty members of various departments for corrections, forward journal copies to referees, follow up, visit the printing press, and so on," she says.

After Srinivas Rao, NM Malwad, the librarian, took over the charge of the journal. Around this time, the journal began publishing thematic issues, and Geetha continued to assist in its production. She also handled students' thesis submissions. "In those days, PhD theses were submitted on CDs along with the hard copies. I used to catalogue them," she says. She worked in the library until 2006. After that, she joined the Centre for Electronics Design and Technology (CEDT), now the Department of Electronic Systems Engineering (DESE).

"Prof K Gopakumar, who was a member of the journal committee, was looking for an office assistant and asked me if I was interested. I readily said yes to it!" The work there was fun, she adds. Working with students, travelling with them on tours, handling their academic paperwork and scholarships, and organising seminars and workshops gave her a lot of joy. She spent nine years at the department before seeking a transfer to the guest house. "I always believe that one should keep learning new things for self-growth," she quips. The Registrar, V Rajarajan, approved her request, and she was transferred to the guest house in 2018.

"Assistant Registrar Selva Kumar P was supervising the guest houses at that time. He had worked in five-star hotels and brought several years of valuable experience from his background in hospitality. I learnt everything that I am today from him," Geetha remembers. Not long after Geetha joined, COVID-19 struck. "It was a tough time, but we did not give up," she says. The guest houses were converted into quarantine facilities for students and visitors. "We took utmost care; food and other essential things were provided to the occupants wearing protective gear," she recalls.

Keeping things moving

Around mid-day, Geetha gets ready to visit CVH, as she does every day, to inspect and ensure that all operations are running smoothly. On her way to CVH, she makes several calls, contacting the staff members against the guest house complaints raised. She meets a staff member bringing lunch to MGH on a two-wheeler trolley. They exchange a few words and continue on their paths. Geetha says that she always offers words of encouragement to her colleagues, ensuring that they don't become complacent or weary of routine tasks. "I want them to be mentally present in their work, not just physically; without support and encouragement, hospitality services are difficult."

Upon reaching CVH, she exchanges a few words with the receptionist and reviews the guest register. She then proceeds to the kitchen to ensure that the food is prepared in line with Standard Operating Procedures. She explains that numerous checks are required in the kitchen; for instance, ensuring that vegetables are washed and prepared according to the guidelines. Similarly, the shelving period must be monitored carefully, with anything past its date promptly discarded. Even the cooking oil is strained and sent back to the vendor, never reused.

'I always believe that one should keep learning new things for self-growth'

She checks with the guests to see if they are comfortable and enjoying their stay, with proper food. She receives approving nods from many of them. Geetha explains that it is essential to book slots for lunch in advance at CVH so that they can prepare the exact amount of food. "We try to avoid surplus and shortage," she adds. She has her lunch in the dining hall after the guests have finished eating. Geetha then heads upstairs to check the rooms.

Surrounded by a thick tree cover, CVH often has to deal with insects crawling inside the rooms. The staff are always on their feet to keep these critters at bay. "The accommodation at CVH, unlike MGH, is for longer durations. Many foreign guests stay here; also, new faculty members get transit accommodation before they are allotted quarters. We must prepare food that is closer to common liking," she explains.

An Institute-approved vendor is responsible for taking care of the food and housekeeping of both the guest houses. The menu is decided at the beginning of the week. Geetha mentions that there have been occasions when guests have been overbearing. She adds that on those occasions, it is essential to handle the situation carefully. "I have met our Finance Minister, Nirmala Sitharaman, industrialist Anand Mahindra, chess grandmaster Viswanathan Anand, and other famous people at the guest house."

Looking ahead

After checking the rooms at CVH, Geetha heads back to MGH. She has made a few requests to the administration for improving the facilities of the guest houses – wheelchairs for the elderly and differently-abled visitors, a few canopies to sit under in the lawn, and a section to showcase IISc's merchandise, and some pictures of the Institute to hang in the hallways. She says many of the requests have been approved, and the arrangements will be made soon.

After several enjoyable years at the guest house, Geetha recently moved to another administrative section. She says she deeply values her more than three-decades-long association with IISc. "Every day, while offering my prayers to the gods, I also offer my gratitude to Swami Vivekananda, Dr BR Ambedkar and JN Tata. I am also in debt to my loving parents, my husband, and other family members; without their support, my professional journey would not have been possible," she says. As another fulfilling day draws to a close, Geetha glances at the sky to see if it might rain this evening, wondering whether to ride her scooter home or take an auto rickshaw.

(Edited by Ashmita Gupta)

Microbe Slayers

- Kavi Bharathi R

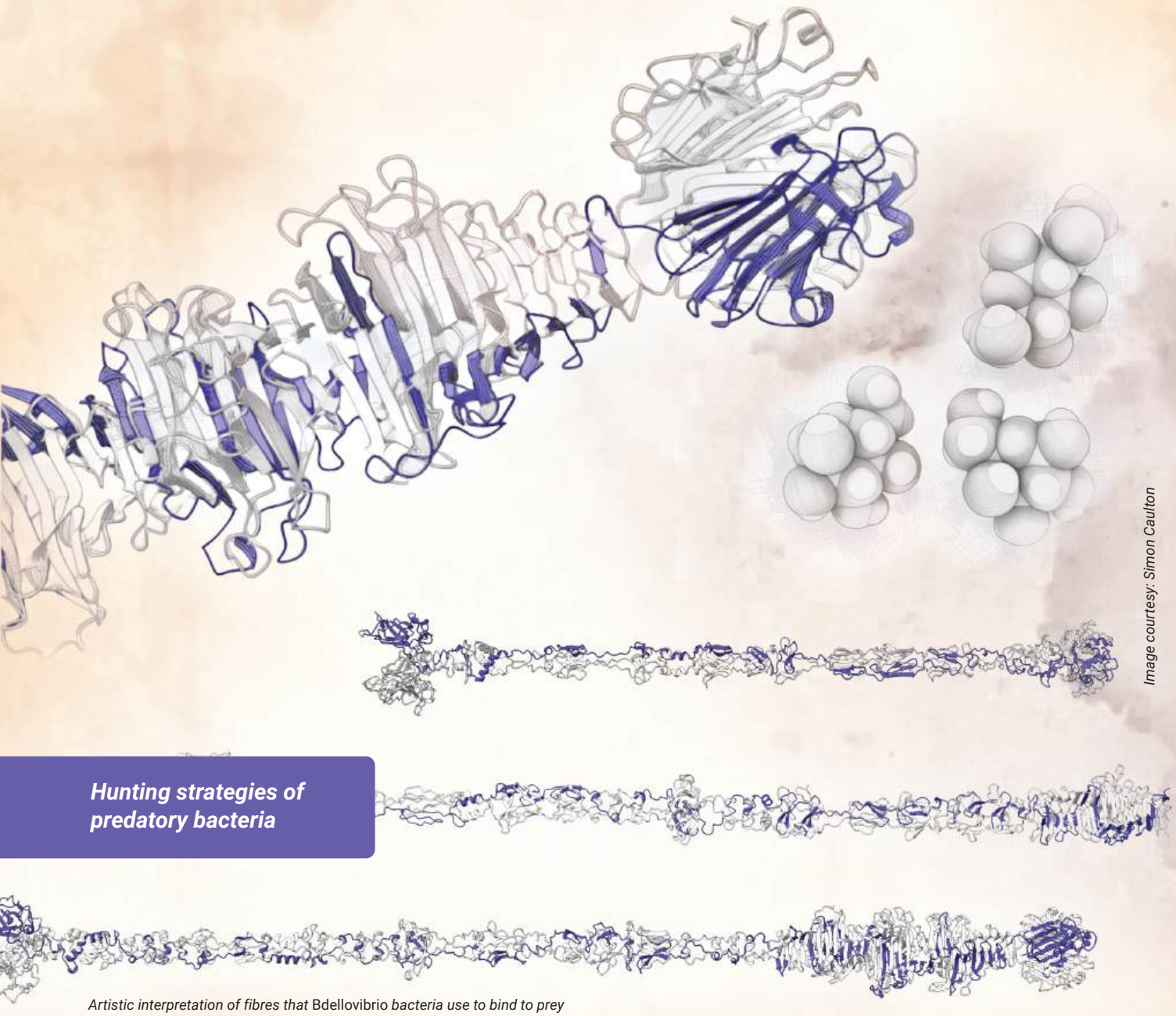


Image courtesy: Simon Caulton

Hunting strategies of predatory bacteria

Artistic interpretation of fibres that Bdellovibrio *bacteria use to bind to prey*

In 1900, a young medical student named Alexander Fleming was studying at St Mary's Hospital Medical School in London. Fleming also served in the London Scottish Regiment of the Territorial Army, where he became an expert marksman. His talent for shooting caught the eye of the captain of St Mary's rifle club, who hatched a clever strategy – if Fleming chose a research career over surgery, he would stay at St Mary's and in the rifle club. The captain succeeded in his plan and persuaded Fleming to pursue research under Almroth Wright, a pioneer in vaccine therapy and another member of the rifle club.

It was a decision that changed the course of clinical medicine. While serving in the Army medical corps during World War I, Fleming witnessed the death of fellow soldiers due to infections from field wounds. Antiseptics failed to kill certain bacteria that thrived deep in these wounds. Returning from the war to his lab at St Mary's in 1922, Fleming discovered lysozyme, an enzyme found in tears, saliva, skin, hair, and fingernails that inhibits bacterial growth. At that time, very few people realised that this discovery was just the beginning of a new age of antimicrobials.

A few years later, Fleming was studying *Staphylococcus* bacteria at St Mary's Hospital. One day in September 1928, after returning from a long vacation, Fleming was surprised to see that the Petri plate he had forgotten to discard had a mould growth and a zone of clearance – a bacteria-free circle around the mould – indicating that the *Staphylococcus* bacteria in that zone had died. Piqued by this observation, Fleming investigated further and identified a compound secreted by the mould that effectively killed the bacteria, which he initially referred to as 'mould juice'. This compound was later named penicillin.

Fleming faced challenges in purifying penicillin from his mould juice, and it was not until 1940 that scientists Howard Florey and Ernest Chain were able to purify and demonstrate penicillin's therapeutic effect against various infectious diseases, saving millions of lives in World War II. The trio was subsequently awarded the Nobel Prize in Physiology and Medicine in 1945, marking the rise of the antibiotic era.

Antibiotics are the byproducts of a millennia-old evolutionary arms race

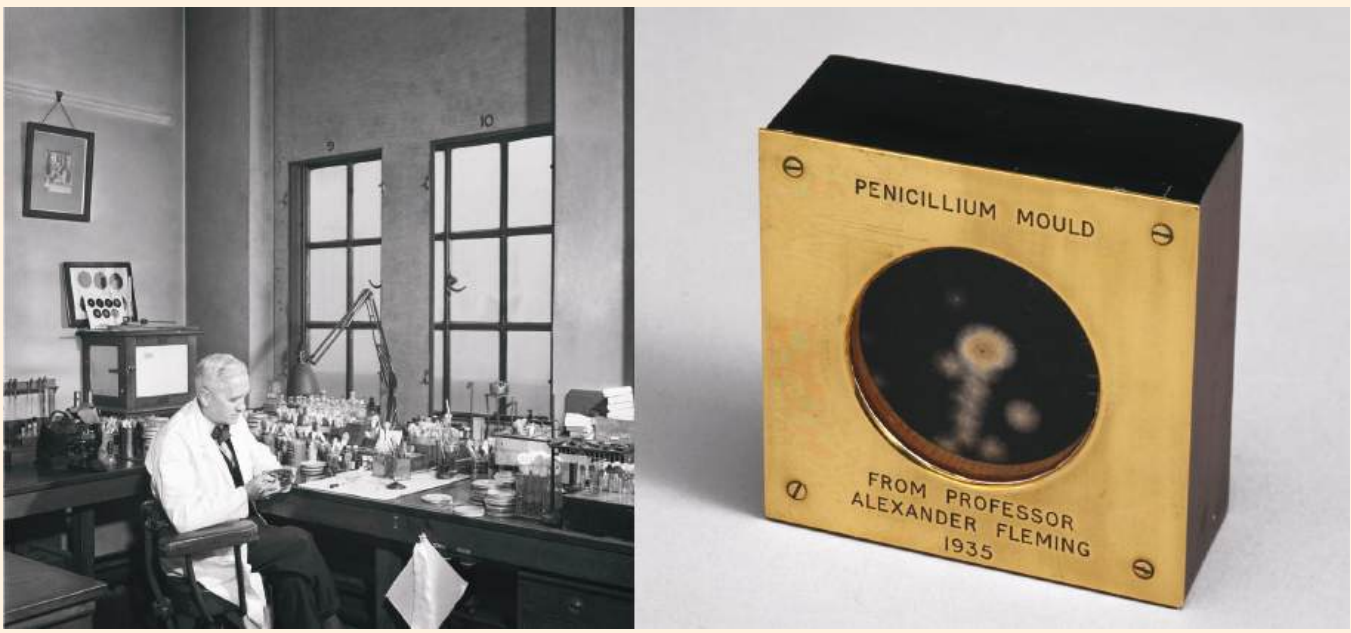
Fast forward 97 years, and this golden era has become overshadowed by the rise of antimicrobial resistance (AMR), fueled largely by the overuse of antibiotics. While much is known about how antibiotics like penicillin have saved lives, a lesser-known fact is that they are largely defensive chemicals produced by bacteria to attack other bacteria or organisms like yeast when they compete for food, resources, and space. They are the byproducts of a millennia-old evolutionary arms race.

"We must remember that neither antibiotics nor antibiotic resistance is new. Antibiotics have always been used by microbes to compete with one another," says Saheli Saha, former PhD student in the Department of Microbiology and Cell Biology (MCB), IISc.

Scientists like Saheli are increasingly realising that bacterial predation is more than just a story of war and death. These interactions are not limited to microbes in the wild – our body too houses trillions of bacteria engaged in complex combative and cooperative interactions. Some probiotic bacteria help to maintain harmony in our gut, while others may fight with them, disrupting this balance. This imbalance can lead to dysbiosis – a condition in which harmful bacteria outnumber beneficial ones, which is often worsened by the overuse of antibiotics. "One of the leading theories is that this dysbiosis is a result of competition for nutrients or space," explains Akshit Goyal, faculty member at ICTS-TIFR, Bengaluru.

Understanding the delicate balance of bacterial harmony is critical, given that the number of bacteria in the human body is approximately equal to the number of human cells. More broadly, exploring competitive bacterial

Photos courtesy: Picryl/Wikimedia Commons



Alexander Fleming in his lab at St Mary's Hospital, London, where he discovered penicillin, the world's first antibiotic

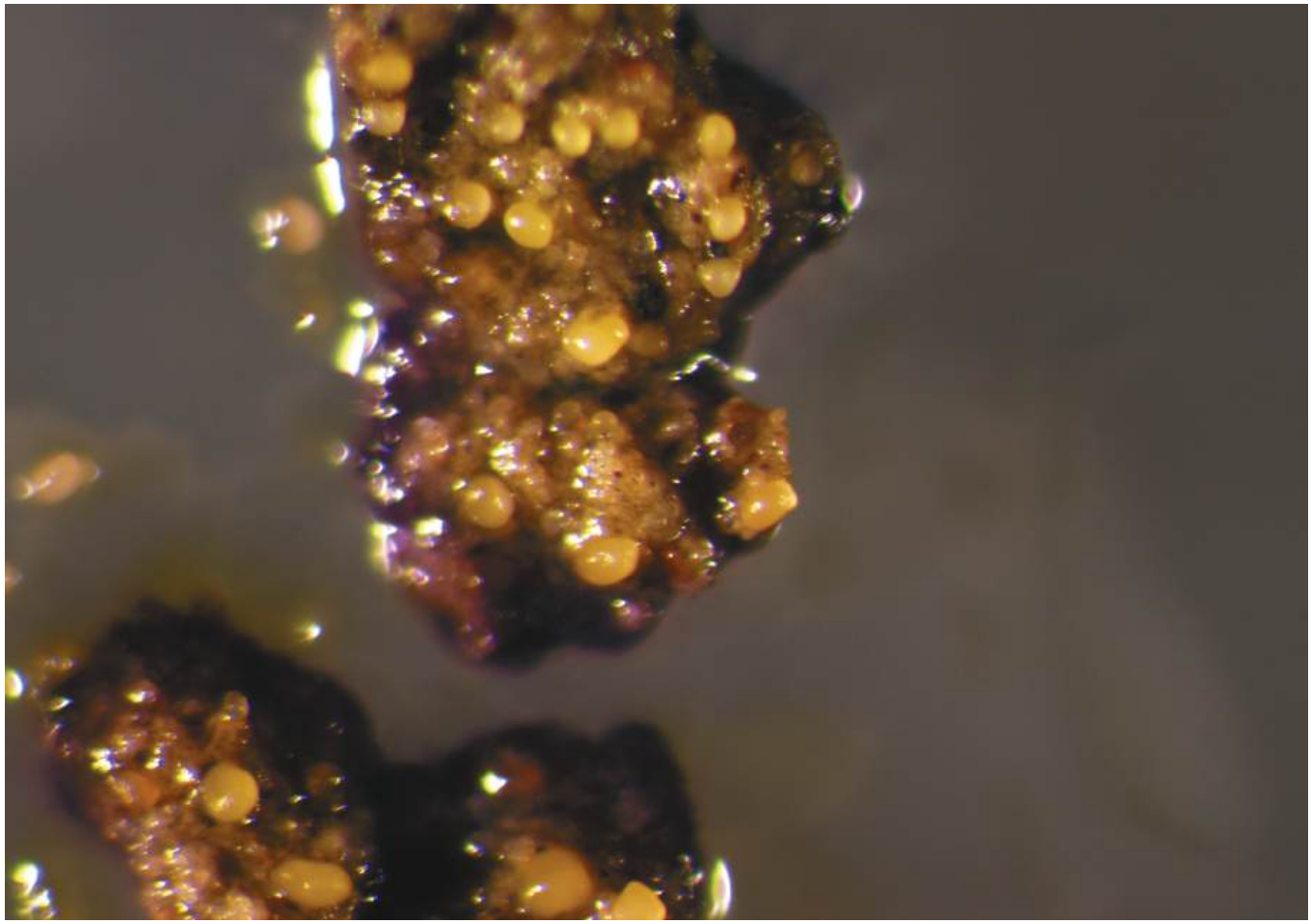


Photo courtesy: Samay Pande

Fruiting bodies of Myxococcus xanthus *formed on soil particles after the soil was inoculated onto selective agar*

interactions can potentially lead to new antimicrobial therapies. In the quest to combat AMR, scientists are turning to nature's fiercest fighters.

Hunting in packs

Living in the soil beneath our feet, *Myxococcus* sp. is a fascinating bacterium known for its fearsome predatory skills. It attacks its prey – usually other bacteria, fungi or amoeba – by lysing it (breaking down its cell membrane) from the outside. It releases a cocktail of different chemicals like toxins, antibiotics, and enzymes that digest its prey. "*Myxococcus* can make a soup of its prey and just drink it up," says Samay Pande, Assistant Professor in MCB.

Myxococcus also hunts through contact; it releases lytic enzymes when it touches its prey, basically stabbing and killing it.

But what makes its attack style truly remarkable is that it does not hunt alone, but as a coordinated pack, like wolves.

"It is not just one cell that does it. Every [*Myxococcus*] cell releases these enzymes, and they hunt and eat together," Saheli adds.

To hunt in packs, *Myxococcus* employs several tricks, such as coordinated swarming and cell-to-cell signalling, which can fool and lure prey.

"There is an old study published in *Nature* in 1993 titled 'Fatal Attraction,' which demonstrated that the prey, *E.coli*, shows chemotaxis – it moves towards the predator *Myxococcus xanthus* colony. This happens because *M. xanthus* secretes an attractant compound that lures *E.coli* towards it," Samay explains.

Strangely, *Myxococcus* does not always die, even when starved. Sometimes, they can also enter a dormant state in which a few cells can come together and form a hibernation structure called a fruiting body. When conditions become favourable again, they re-germinate, start hunting and eating their prey, releasing, among other chemicals, antibiotics.

Samay notes that the ability of *Myxococcus* to produce varied chemicals and attack a wide range of bacteria, fungi, and amoeba makes it a vital source for new antibiotics. "Resistant bacteria are no longer killed by antibiotics, but they still haven't developed resistance to predation [by other bacteria]," he says. "Microbial predators have ways to kill antibiotic-resistant bacteria, so a solution already exists."

What makes* Myxococcus*' attack style truly remarkable is that it does not hunt alone, but as a coordinated pack, like wolves

Poisoned darts

Unlike *Myxococcus*, which attacks in groups, some bacteria are solitary hunters, such as *Vibrio anguillarum*, a coastal ocean dweller. It can lyse and consume the cellular contents of its prey by using a nanoscale speargun-like

weapon called the type VI secretion system (T6SS). This weapon has a contractile part that looks like an injection needle with a tip bearing toxins. The bacterium injects this contractile part into neighbouring cells to deposit the toxins. To avoid accidental death from being stabbed, its relatives carry antidotes to the toxin, whereas non-relatives, lacking such protection, often meet a grim fate.

Having the T6SS provides a competitive advantage by removing rival bacteria like *Vibrio cyclitrophicus* that compete for the same resources. With a broad host range, T6SS-equipped bacteria employ a variety of killing mechanisms. Some methods involve chopping DNA fragments inside prey cells, while others target their cell wall, the outer layer. These aggressive predators also, at times, kill prey not just for food but also for movement – they use a fast-acting toxin that essentially clears any cells and cell debris in their way.

Some *Vibrio* species with T6SS also drill holes into the prey's cell membrane and inject toxins into cells, making them leaky. This leakage results in the loss of nutrients, which the killer can utilise for their own growth. When *V. anguillarum* is unable to grow normally, it can damage neighbouring cells and thrive on the released contents. "It is like you are stabbing someone and just letting the blood slowly come out," explains Glen D'Souza, Assistant Professor at Arizona State University (ASU).

The ability of such bacteria to inject toxins with high precision could come in handy in developing new drug delivery systems for humans as well. Existing treatment regimens involve antibiotic pills – when taken orally, they are absorbed into the blood and carried across the body by the circulatory system. But harnessing *V. anguillarum's* steerable nanoscale needles could help scientists develop more targeted delivery systems.

Eating from within

Unlike other bacterial predators, *Bdellovibrio bacteriovorus* – found both on land and in water – kills its prey from the inside. Its name comes from the Greek word for leech (*bdella*), both for its shape and way of life. Its curved body allows it to physically enter the prey's periplasm – a gel-like space sandwiched between the latter's membrane layers. Inside, it builds itself a cosy niche and starts consuming the cell from the inside.

"These extraordinary physiological adaptations are still not understood fully – how they manage to cut a hole in the membrane, come through it, and then seal the hole behind them. It's just amazing when you watch it happen; you almost can't believe it," explains Andrew Lovering, Professor at the University of Birmingham.

When *Bdellovibrio* invades a prey cell, the latter takes on a circular shape – a process known as the rounding effect. Scientists initially thought that this change was to provide the predator ample room to reproduce, but soon they realised that there was more – the effect also stopped other predators from coming in. "The rounded cell sends a signal to other predators that the prey cell has already been invaded, and they have to go find another one," adds Andrew. *Bdellovibrio* genomes encode receptors that allow them to sense chemicals that pinpoint the prey's whereabouts.

In addition, the prey population does not gain resistance to *Bdellovibrio* because of its unique attacking strategy, which involves a mix of physical and chemical combat. Andrew says, "The prey cannot easily escape predation by picking up a mutation or extra genes that provide resistance. Therefore, investigating natural predators of bacteria reveals effective targets for antimicrobial intervention and could open up new possibilities for developing antibiotics."

'If we try to understand these bacterial interactions, we can use them like contract killers – find targets and deliver toxins'

However, to exploit such predation strategies, scientists will still have to decode their complex interactions fully. In *Vibrio*, for instance, we do not fully know how they locate the prey. "Their foraging cues are not known," Glen says. "If we try to understand this, we can essentially use them like 'contract killers' – we can train the [predatory] bacteria to go and find specific targets and deliver toxins. This could be a potential [solution] … to tackle antibiotic resistance."

Andrew also points out that such strategies could be used in combination with existing antimicrobial strategies. "Using combination therapy generates much fewer issues of resistance; you could even use two different predators as long as they didn't attack one another."

Samay, however, cautions that any new therapeutic solutions will need to be made "future-proof" to avoid the obsolescence that antibiotics fell prey to. "All infectious agents can evolve rapidly. Even in the case of antibiotics, the mistake was that we did not ignore [the possibility of resistance], but we sort of pushed taking care of it to a later time," he explains. "Now, all of us are aware and cautious. We must not repeat the same mistake."

(Edited by Ranjini Raghunath, Abinaya Kalyanasundaram)

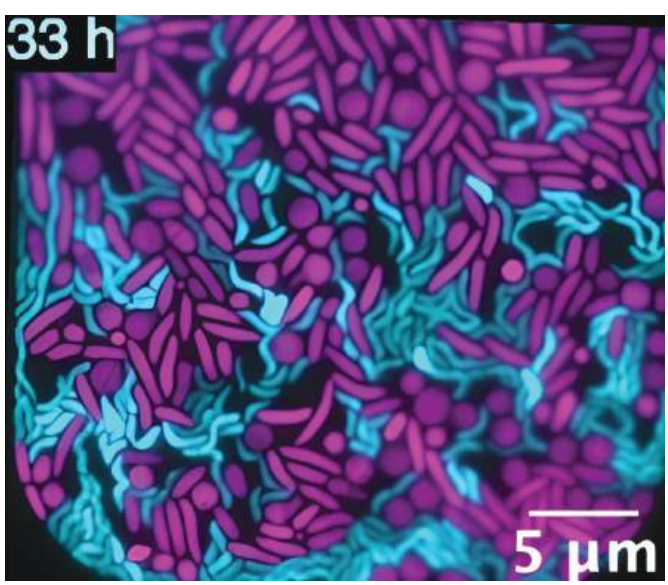


Image courtesy: Glen D'Souza/ASU

Vibrio anguillarum *(cyan) prey on susceptible* Vibrio cyclotrophicus *(purple) in nutrient-poor conditions. Lysed/killed prey cells become spherical since toxins attack the cell wall*

Connecting...

- Divyanshu Bhatt

Image courtesy: Wikimedia Commons

Socialising in the digital age

A quiet, contemplative painting, Melancholy (1891) by Norwegian artist Edvard Munch, reflecting the emotional stillness that accompanies isolation

Imagine sitting at Sarvam, basking in the bliss of a good hair day. The weather is pleasant, the sun is timid and a cool breeze is playing its part – the quintessential hyper-marketed Bengaluru weather. Around you, everyone chats happily. There is a reassuring calm within the chaos. A casual blink, flash! You find yourself in another reality; a world no one else sees but you. Panic-stricken, you look around, but any trace of companionship is gone. There is no one to speak or listen to, no one to reach out to, and no one to comfort you.

While this terrifying little thought experiment is hypothetical and may sound eerily similar to the plot of *Stranger Things*, the sensation of being trapped with no one else around is very real. So real, in fact, that the World Health Organisation declared "loneliness" a global health threat in 2023.

Psychology Today defines loneliness as "the distress that arises when there is a gap between the social connections we desire and those we actually experience." Recent studies paint a troubling picture of loneliness as a Trojan horse that quietly seeps into our modern lives. The burning question is: Why are we witnessing a surge in loneliness? What is it about loneliness that makes it such a persistent part of human experience, and how might we begin to heal from it?

At first glance, the idea seems paradoxical; some readers might even question the very premise of discussing loneliness in the 21st century. After all, isn't everyone just a tap away on Instagram, WhatsApp, or Snapchat? And

yet, experts keep reminding us that digital hyperconnectivity does not always translate into genuine human connection. In fact, adolescents, the so-called "natives" of technology and social media, are reporting some of the highest levels of loneliness in recent years. Depending on the country, estimates range from 14.4% to 33%, with numbers rocketing to nearly 50% during the COVID-19 pandemic.

For college students, the vulnerability runs especially high. Thrown suddenly from the comforts of their school life into the demanding chaos of university life, many find themselves juggling heavy workloads, navigating new social circles, and adjusting to the loss of a steady family support system – a barrage of changes that can invite a feeling of alienation and isolation. Some studies suggest that in various countries, moderate and severe loneliness is reported in 30-60% of college students.

'Social media has built a shiny illusion of being connected 'anytime, anywhere,' but in reality, we're drifting farther apart'

"I think people today are lonelier than ever before. More and more of us are slipping into the 'reel' world rather than being present in the real one," feels Sreenjoy Saha, a second-year Master's student in the Department of Microbiology and Cell Biology (MCB). "Social media has built a shiny illusion of being connected 'anytime, anywhere,' but in reality, we're drifting farther apart. Even on campus, where the number of acquaintances keeps climbing, the circle of true friends feels smaller and smaller. This stings especially hard during festivals, when you are away from both friends and family."

His words echo a sentiment that is shared by many others on campus, across disciplines. A chatter that led this scribe to wonder if this was just a passing feeling or part of a larger pattern. To unravel the truth, I conducted a mental health survey, adapted from the UCLA (University of California, Los Angeles) Loneliness Scale, where participants answered questions about feeling isolated, left out, and lonely. A total of 141 students across undergraduate, Master's, PhD, and postdoctoral programmes responded.

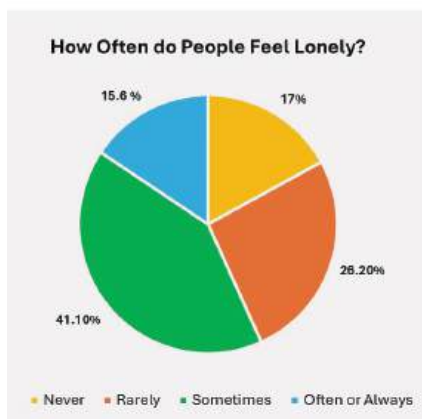
The results were sobering. Over half of all respondents (56.7%) reported 'feeling lonely' at least sometimes, and about one in six (15.6%) said they often or always felt lonely. The sense of disconnection ran deeper still, with 57.4% admitting to feeling left out, and 58.1% feeling that they lacked companionship.

When it came to friendships, 8.5% admitted to having no close friends on campus. The effect of loneliness was also gendered – female students (61.6%) were affected more often than males (53.3%). Respondents in relationships were considerably less likely to feel lonely (41.5%), compared to those who were single (63.3%).

These numbers and percentages paint loneliness as a very real picture on the canvas of student life. But prevalence doesn't always suggest harm. Some traditionalists and naysayers can easily dismiss this as just another "generational construct." After all, the earliest mentions of the word loneliness date back to the late 16th century. And even in the 18th century, the newly industrialised society did not see loneliness as a dire concern. So, is loneliness just another "modern problem" that the younger generation claims to suffer from?

As it turns out, biology addresses this concern. A plethora of studies reveal that social pain, because of exclusion or loneliness, activates brain regions that are involved in physical pain, such as the dorsal anterior cingulate cortex. The cost doesn't stop there; loneliness is also linked to faster cognitive decline, poorer mental and physical health, greater risk of cardiovascular disease and dementia, and a higher risk of mortality.

Image: Divyanshu Bhatt



Results of a survey amongst 141 IISc students conducted by the author, showing that 56.7% of respondents reported feeling lonely at least sometimes, highlighting the widespread and often unspoken nature of social isolation

So, biologically at least, loneliness isn't just in our heads; it is part of how we are wired. This begs the question: Why would evolution preserve such a need for companionship and make its absence hurt so much?

The answer lies in our social roots. Humans didn't evolve to survive alone; our ancestors thrived in groups; survival of the community often meant survival of the individual. To keep these bonds strong, our brain developed ways to make us crave connection. The Evolutionary Theory of Loneliness explains it simply: loneliness is like a signal, warning us when our social bonds are at risk. Just as physical pain motivates behaviours to protect the body, loneliness motivates behaviours that protect our social self from isolation and exclusion.

While loneliness may have originally evolved as a survival mechanism, it has morphed into a pressing concern in modern life, thanks, in part, to highly fragmented social structures. People leave homes, crossing borders and oceans in search of better opportunities, leaving behind, even if only temporarily, their support system of family and friends.

"Certainly, with rising individualism, our brains are facing a mismatch. Designed for living in close-knit groups and interacting frequently, we now find ourselves in fragmented communities that our minds were never built for," says BG Shridhar, Clinical Psychologist at the IISc Wellness Centre. "The outcome is isolation, visible even in IISc hostels, where students often don't know their own neighbours. Apart from this, another factor that dictates people's vulnerability to loneliness is the coping mechanisms they have come up with to deal with solitude."

Whether loneliness becomes a fleeting feeling or a persistent shadow often depends on individual personalities and the art of dealing with the stresses of modern social life.

"How modern society's structure has impacted loneliness is complex and multifaceted," says Peter J Richerson, a renowned biologist and distinguished Professor Emeritus at the University of California Davis.

"Ancestral societies were highly variable but generally small and intimate. I imagine that people with weak skills at forming social ties can become very lonely in the modern world, whereas in traditional societies, they would have been more or less forced to interact with family and local community members. In modern large scale societies, extroverts and those open to new experiences can build large circles of friends and mostly thrive. Introverts perhaps tend to get lost."

An interesting revelation from students was their view of social media, not as a lifeline keeping humanity connected – as I had expected – but as a house of cards against loneliness.

While loneliness may have originally evolved as a survival mechanism, it has morphed into a pressing concern in modern life

The popular consensus was that while texts and calls may be soothing in the moment, they cannot replace the warmth and reassurance of physical presence. Research backs up this idea as well. The richest social bonds are formed by in-person interactions, while superficial or passive contact, such as brief chats or social media likes, has little impact on loneliness and can even deepen it. What's more, studies consistently report a bidirectional link between social media use and loneliness – those who feel lonelier tend to use social media more, and heavier use often feeds further loneliness, like a self-fulfilling prophecy.

Now that Pandora's box has been opened, the natural question is, what can we do to feel less lonely and a little happier? As is often the case, the problem itself hints at the solution. Although loneliness is often thrown around as a "one-size-fits-all" term, it has layers. For instance, it is not the same as social isolation – the objective state of having little or no contact with others. Loneliness, instead, is a subjective phenomenon that arises when there's a discrepancy between the social connections one has and those that one desires.

"Although many students are surrounded by friends, they often experience a sense of loneliness due to the absence of emotional support and a genuine sense of belonging. The quality and emotional depth of friendships play a great role in overall well-being", says Sayeda Tamanna Yasmin, Psychiatric Social Worker at the IISc Wellness Centre.

Because loneliness is so deeply personal, any solution must aim not only at increasing social connection but also improving one's perception of said connection. Practically, this means reaching out, sharing one's feelings, and being vulnerable with the right people. Simple shared experiences like open-for-all game nights, movie outings, coordinated lab breaks or planned meals can go a long way in boosting emotional well-being.

Even small gestures, like checking in on classmates or chatting briefly with someone you know, can create meaningful bonds. And yes, it also means being open to trying out new experiences with strangers, even if the idea sounds nerve-wracking.

"When it comes to loneliness, the first step toward healing is understanding where it really comes from – being over-absorbed in work, one-sided friendships, or not having meaningful connections at all," remarks Shalini John, Consultant Clinical Psychologist based in New Delhi. "The truth is, no single remedy fits everyone. Simply 'making more friends' doesn't always help. Sometimes, it requires a quiet moment of reflection – Are your friendships mutual? Have they weathered ups and downs?"

According to Shalini, a useful way institutions can contribute towards this is by encouraging fun-based and non-competitive group activities, like academic projects or collaborations or even informal get-togethers.

"These teach people how to navigate group dynamics, understand each other, and discover what makes them feel seen and valued," Shalini explains, while adding that therapy also helps, as it enables people to open up to others. "A golden rule that I always recommend is to talk to at least three people who are close to you every day. Simply talking helps a lot," says Adarsh B, Consulting Psychiatrist at the IISc Wellness Centre.

At the same time, managing loneliness also means cultivating realistic expectations and looking inward. Caught in the whirlwind of work and hustle for the next "good thing", we often forget to check in with ourselves. What do we want from friendships? Do we have people who will genuinely celebrate our happiness? If not, do we want someone like that in our lives?

To that end, maybe the first step toward connection is honesty – with others, yes – but also with ourselves.

In the age of constant motion, where something or the other is always going on – work, social media, endless entertainment, incendiary news – we rarely pause and reflect on our social bonds. Yet, regardless of whether we like it or not, our brains are wired to survive in a social world, and no matter how much we distract ourselves, at the end of the day, we can't escape millions of years of evolution.

Not yet, anyway.

Divyanshu Bhatt is a Master's student at the Centre for Neuroscience, IISc, and a science writing intern at the Office of Communications

(Edited by Sandeep Menon)

Photo courtesy: Yogesh

An example of community building in action: IISc students on a trek to Ramdevara, Karnataka, coming together, forming bonds, and building camaraderie

CONNECT ASKS

What's your secret to making friends on campus?

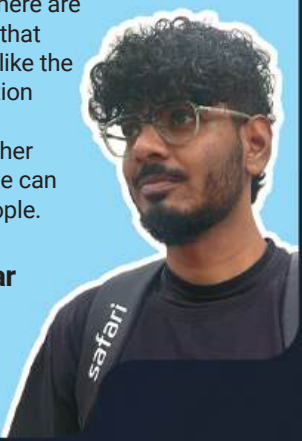
I started making friends at IISc mainly at the mess where we would meet to chat over snacks and tea. Gradually, as classes and labs began, our conversations shifted to exchanging experiences from different places. That is how you gradually bond, and friendships start forming. I realised that simply being someone who listens can help build trust, which is the foundation of friendship. IISc offers varied opportunities to meet people from diverse backgrounds. With feasts and festivals celebrated so enthusiastically, it becomes easy for anyone who wishes to connect and make friends.

Abhinanda Ghosh
BSc (Research) student

We spend time mostly with our classmates. The most important thing is that we should have friends from other departments. Initially, I did not have any friends outside the department; now I have started [looking for them]. I met my best friend on campus through someone who is my relative, whom I initially did not know was my relative and later came to know that he was my relative. Joining events is very helpful in getting friends – I recently joined a plantation drive on campus.

Manpreet Yadav
MSc student, Division of Chemical Sciences

I met my best friend in the Office of Communications; as it was my first time on campus, I was checking out goodies, and so was he. People at IISc are very friendly, so asking for help and making friends is very easy. The campus provides ample opportunities – like the Nature Club of IISc, which offers treks where I met people from diverse branches and backgrounds, including PhD students. There are so many events that take place here, like the monthly meditation rounds, sports activities, and other events where one can interact with people.



Satyam Kumar
MTech student, Department of Electrical Engineering

Do what you like – I play foosball in the hostel, and I met a lot of people through that. Playing together, I slowly bonded with many people. You need not push yourself too much – have a happy time, relax, and find something out of your comfort zone. You will probably find things you are good at that you never knew, and through that, you will also make a lot of friends. I used to be an introvert. I had a cultural shock when I saw that there was this huge line-up of events, including the DJ night, and so many happenings on the campus.

Preranna Sheet
Integrated PhD student, Division of Biological Sciences

How I met my best friend on campus is quite a story. I have many best friends on campus, but this is because of my relationship with physics. When I was in my first semester, I was struggling a lot. There was this guy who was my hostel neighbour, who helped me a lot in understanding the basic concepts and with whom I also cherished playing cricket. Talking about upcoming festivals and the academic background that we come from, and even asking what kind of research the other person is doing are very good icebreakers. People feel comfortable talking about their expertise; they are really interested in expressing what they are doing and how that makes a difference in our day-to-day lives.

Priyanshu Paswan
BSc (Research) student

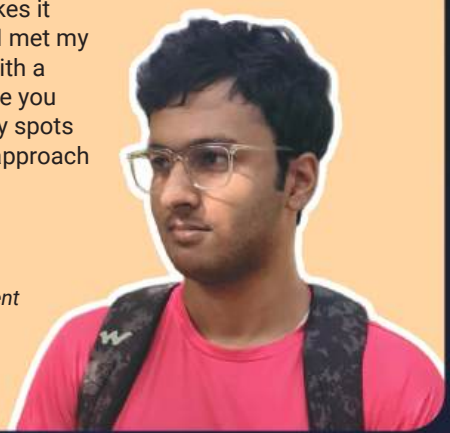
I randomly met my friends here on the way to class, and at Sarvam. Just be open to talking to people. Don't always be into yourself; open up.

Ananya Priyadarshi
Integrated PhD student, Division of Biological Sciences

I have been here only for a few months – I haven't had the opportunity to make a best friend here yet. Fortunately, I will, in the future. It is an institute for science; it is always better to collaborate and work in search of a scientific temperament.

Darpan Chakraborty
Integrated PhD student, Department of Physics

It started from the first year, when we were all assigned the same hostel. We have been going to the mess, classes, and doing projects together. It was pretty easy to meet and make friends. We have a lot of things in common, which makes it very easy to make friends here. I met my best friend here – just started with a basic introduction like 'Where are you from?' Hostel and mess are easy spots to make friends. But you could approach anyone anywhere.



Jithendra Rao Kasibhatia
BTech (Maths and Computing) student

(Compiled by Ashmita Gupta, Kavi Bharathi R, Sandeep Menon)

‘You need special crazy people... to do science’

- *Interview by Sandeep Menon*

Photo: Rohini Subrahmanyam

Yuri Kivshar is among the foremost authorities in metamaterials as well as nonlinear physics and nonlinear photonics, having made several pioneering contributions to these fields. The award-winning scientist is also a Fellow of the Australian Academy of Science, Optica, the American Physical Society, the International Society for Optics and Photonics, and the Institute of Physics. The Australian-Ukrainian scientist visited IISc in October 2025 to deliver talks at several departments on campus, highlighting the interdisciplinarity of his work and the wide-ranging research interests under the metamaterials umbrella at the Institute. Yuri sat down with CONNECT to speak about his work, developments in the field, his time at IISc, and his fondness for finding fellow 'crazy people,' among other things.

Can I start with an obvious question? What are metamaterials?

'Meta' means 'beyond' in Greek. So, metamaterials are materials beyond normal, which may have unusual properties. In our business, we are talking of electromagnetic metamaterials – materials that allow you to control light in different ways. If you take normal materials, they may reflect light, absorb it, or be transparent. But metamaterials can have properties which do not exist in nature, like a negative value for the index of refraction (an optical phenomenon in which light bends in the direction opposite to the expected).

Some ideas go back to 1968, to the Russian scientist Victor Veselago. In reality, the first structure was fabricated around 25 years ago. But then, of course, there were a lot of developments and publications. These materials are found in the military, radio waves, security screening, MRI, and now, photonics and optical applications. We are trying to implement some of the metamaterial concepts, like optically induced magnetism and negative refraction, in these devices.

So the first thought came in the 1960s. Why did they think of such a thing?

It didn't start out as a material but as a crazy idea. It was published in Russia, not in a scientific journal but in something like *Scientific American* (a popular science magazine). People thought that it was a crazy idea and that it was impossible. It took some time – a team in San Diego, who knew about the paper, managed to demonstrate it. Then we all jumped onto it.

You work a lot on metaphotonics. What is that?

Initially, metamaterials were all about microwaves and radio physics ... we took it to optics. The inspiration was that it had a lot of nice properties and it would be very beneficial in optics. We suggested using their optical resonances.

What you do is you create structures made of very dense, high-index metamaterials, so that when light penetrates the electrics, the wavelength of light becomes lambda divided by refractive index – making it smaller. Then it can excite strong resonances to enhance properties and generate both electric and magnetic resonances. That way, we can generate optical magnetism – specific states of light which emphasise the importance of the magnetic component of electromagnetic waves. I am not sure if it is clear to everyone, but that is the idea (*laughs*).

What are the possible applications?

There are many. You can't beat optical fibres in telecommunications. What you can do is that on the tip of a fibre, you can put a metasurface – a structure made of subwavelength elements. The edge of the fibre can launch different images in different modes, so instead of big devices, it can be just one properly structured layer.

'In principle, a lot of fundamental problems have already been solved, but for implementation and application, we need cheaper technology. It takes time'

You can also do this with lenses in cameras; there are many lenses in high-end cameras and you can make them smaller. They can be made with

Image courtesy: Australian Academy of Science

Yuri Kivshar at the Nonlinear Optics Laboratory, Australian National University, in discussion with his postdoctoral fellow Pavel Tonkaev

Photo courtesy: PRO office, IISc

Yuri Kivshar delivering a lecture at the Faculty Hall during his visit to IISc in October 2025

one or two metasurfaces, which can have different resonators a few hundred nanometres in size, and each one decodes different information like phase, light, wavelength, and so on. Then you can introduce many things like holograms – several functionalities can be introduced, and everything will be smaller.

We also know how to make sensors to put on our phones to check for diabetes. In principle, we can do it, but the phone will cost a lot more because the cost of fabrication is very high. However, there are several companies working on that.

There are materials now that can learn and change properties based on exposure, right? Is that something metamaterials can do?

That is called tuneability. A normal lens has a particular focus at a distance, but with a surface metalens, you can make it very focused. In principle, a lot of fundamental problems have already been solved, but for implementation and application, we need cheaper technology. It takes time.

Do you get unexpected results while seeking to solve problems?

All the time (*laughs*)! New physics often comes from resonances or field enhancements inside these structures.

In 25 years, how far have we come with this technology?

We didn't have much 10-15 years ago, but a lot of groups are working on it now. My big surprise was that since the last time I was in India, 10 years ago, there have been dramatic changes. All the scientists at IISc we talked to had international experience. They have clear ideas and a taste for science.

You've been in IISc for a few days now. What has your experience been like?

I gave a colloquium in the old [Main] building; there is a lot of heritage there. I gave one tutorial lecture, and I am giving two more. I try to present different things. There is a huge interest. Even if people here aren't directly working on metamaterials, they're exploring related areas – 2D materials, resonant structures, antennas. All of this can come under the umbrella of metamaterials.

You do a lot of fundamental research, but also serve in advisory roles ...

Yeah, but I see myself as a scientist driven by fundamental research.

My question is: Is science pushing the industry, or is the industry pushing the science?

Good question. My general impression is that the industry is behind because of the cost. Thirty years ago, nothing like this existed at all. Fabrication has improved, and many facilities have come. But it is still very expensive. Industry works well when the cost is reasonable. So, at the moment, it is science-driven.

So, you are more driven towards fundamental research?

Yes, because I am having fun. I have a few grants that suggest some applications, but they don't push me. There are different types of activities. There are those targeted for specific devices and parameters. I am targeting specific properties. I know what we want, but we have no idea what should provide these properties. So, we are doing basic research to find the type of structures that will provide the properties. We are not optimising them. We need proof-of-principle, but we are doing it at a basic level. It is exciting because it is a generation of new things. I enjoy that. That is what scientists are about.

You gave a talk about invisibility cloaks ...

It was an initial hype of metamaterials. The initial concept was very nice, because you can learn how to bend light to hide objects. Usually it [works] for single frequencies and small objects. To extend it to real life takes a lot of effort and time. In principle, everything is possible; there might be some military projects (*laughs*).

So is this invisibility achieved by reflection, refraction, or some other properties of light?

Invisibility by negative refraction. How do you see objects? Light comes, it is reflected (off an object) before reaching my eyes. Now, imagine I put a shield around you for negative refraction: so the light bends the opposite way, going around the object instead of scattering off it.

'Imagination is a good thing, but you still need to think about how to implement...'

You are creating fresh new materials with properties that do not exist. So are you only limited by your imagination while creating these?

Ah, interesting. Initially, it was important

[to know] which material to use. We used metals and alloys, but it did not work because there was a lot of absorption. Later, we switched to electrics. Imagination is a good thing, but you still need to think about how to implement that. I should say that there are probably no limits, but there are limits in implementation because you need to think about what materials can be used, what to measure, and so on.

Do you ever wonder about the direction in which this technology is going?

There are different needs and directions – quantum technologies, defence, communications. But in the end, it all comes down to people and funding. There are not a lot of crazy people who want to do science.

My theory is simple. Every society has a certain percentage of crazy people. If you want to get money, you don't need to be very smart. So you need special crazy people who are happy with a scientist's salary [to] do science, do things that are fun and chase that pleasure. India might be different. With India's large population, that percentage still translates into many passionate scientists.

I assume you are one of those crazy people?

Definitely! You ask my family, and they will agree. I work weekends and after hours …

Is it the craziness that keeps you interested?

Yeah, it is what makes me happy. I was speaking to your professors here; there are so many bright people who came back from overseas and want to work in India. One of the things we do is create ideas and pass them to others who will fabricate and implement, but I was pleased to hear from one of the guys here that he wanted to do it by himself, with his students. He is finding connections, looking for special glasses, and he found a company that makes those. He could send an order abroad, but he spent time finding it locally, and then the local companies will develop because there is a demand from science. That is what I call crazy people, and a majority of them work for free.

Can you talk about your time growing up in the Soviet Union? There is a rich legacy of science there, so what was it like?

I am from Kharkiv, Ukraine; it was a special place. I think I was very lucky. I am not doing propaganda, but you should understand that there is some kind of nostalgia. The country was closed, and there were no grants or competition. People published in normal journals, they got a salary. It was a way to work on improving your skills and knowledge while having fun. There was not much travel. We had a society which appreciated science very much, and not money. Scientific discussions and trying to find the truth were the important driving forces.

Image courtesy: Australian Academy of Science

Yuri Kivshar, with his colleagues Benjamin Eggleton (left) and Min Gu (centre), after receiving the Thomas Ranken Lyle Medal at the Australian Academy of Science in 2007

When I first went to Moscow, I was giving a seminar. If you do that here, everyone listens. But in the Soviet Union, people were quite aggressive – sometimes not for the right reasons. But you had to defend your knowledge.

People are not stupid; they might ask some questions which you didn't think about. So, you needed to survive. The organiser told me: "If you survive for 10 minutes, believe that you are already a winner." I survived for more than that. In the West, it is different.

'Don't forget about the heritage you have here (at IISc). I was really impressed by the environment and history here. It motivates the younger generation'

You left Ukraine a long time ago now, having shifted to Australia. Have you gone back?

I left the Soviet Union before it collapsed, in 1989, and moved to Australia in 1993. I was in Spain, Germany, and France in between. I used to visit Russia often before the war. Now, I can't travel there because I have a Ukrainian passport. And I can't travel to Ukraine either because of what is happening there.

There is a lot of science happening all over. I guess someone needs to tell the stories …

That is very important. My mother was a factory worker. I liked school, but I had no idea about the profession of scientists. Suddenly, I met people who explained how [science] works. This is where you come in, connecting the public to science. Don't forget about the heritage you have here (at IISc). I was really impressed by the environment and history here. It motivates the younger generation. And if you do that, maybe we can increase the percentage of "crazy people" to do great science.

(Edited by Ashmita Gupta, Ranjini Raghunath)

The Scientist and The Artist

- Yashashree Prabhune

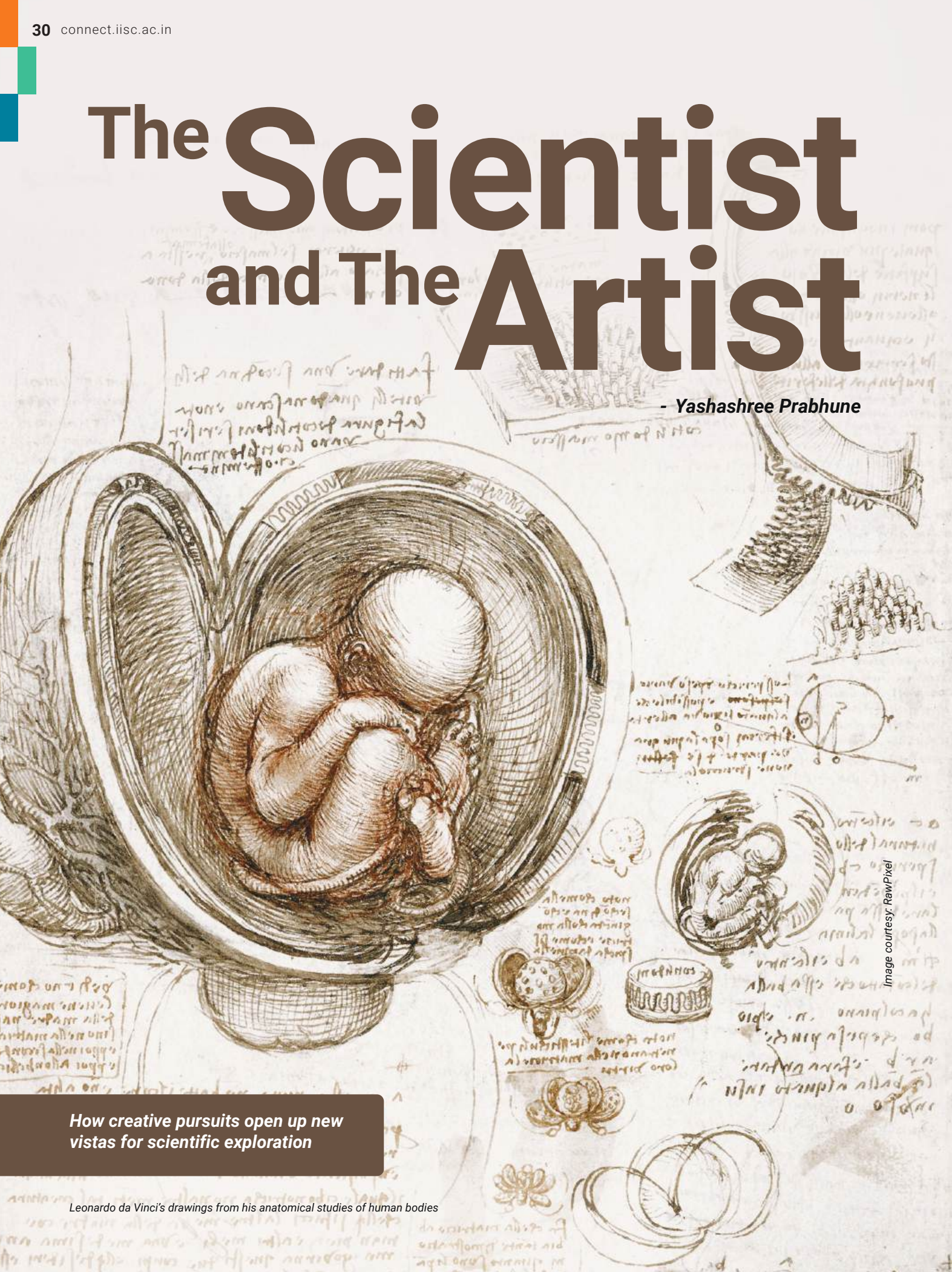


Image courtesy: RawPixel

How creative pursuits open up new vistas for scientific exploration

Leonardo da Vinci's drawings from his anatomical studies of human bodies

On a sunny day in the 1600s, in the picturesque town of Lombardy, Italy, an artist was busy in a hospital. This might sound strange, but it was a perfectly ordinary occurrence in the life of Leonardo da Vinci. The fifty-something-year-old was studying anatomy at the University of Pavia, observing the human body's inner workings and drawing them in careful detail. He filled his notebooks with over 200 diagrams of the heart, bones, and other organs, accompanied by precise notes. But it would be decades before the world realised the true value of these figures. While the surviving drawings were collected and preserved separately, most of his anatomical studies were used to inform principles and rules for anatomical sketching, compiled in his book, *A Treatise on Painting (1651)*.

Today, Leonardo is renowned worldwide as an artist, the person who created some of the most famous paintings in the world. But few know that he was also a man of science. Inspired by everything from human emotions to bird flight, he was a prolific scientific illustrator, engineer, and researcher who studied machines and men with equal zeal. Alongside the many Renaissance paintings he's known for, he also designed inventions like the earliest forms of aeroplanes, bridges, war machines, and even a keyboard-like musical instrument.

Scientists are exploring various art forms to think, feel, and understand science differently

It's hard to say if Leonardo was more of an artist or a scientist. But it is clear that he was endlessly curious about the world and adept at blurring the lines between disciplines, as have many others before, during, and since his time. Take, for example, Richard Feynman. The Nobel Prize-winning physicist found deep fulfilment in painting, which he called "an appreciation of the mathematical beauty of nature, of how she (nature) works inside."

Since the dawn of civilisation, art, music, and storytelling have been integral aspects of being human. While not everyone claims to be an artist, most of us have, at some point, turned to creative expression – doodling during lectures or scribbling angsty poetry to navigate the growing pains of adolescence. Creativity seems to be an intrinsic feature of being human, and scientists, too, are exploring various art forms to think, feel, and understand science differently.

"Philosophy has had a big influence on my scientific thinking," says Partha Ghose, a Kolkata-based physicist who practices several arts like writing, theatre, and music. "I've always drawn deep inspiration from Rabindranath Tagore's songs – especially the ones about nature and our place in it. They remind me that science is just one way of engaging with the world."

For behavioural ecologist Sambita Modak, the arts are inseparable from scientific inquiry. "An early exposure to the works of Leonardo da Vinci played a vital role in my interest in the art and science of observation and inquiry, which most likely explains my current interest at the intersection of art, science, and technology," she says. An alumna of the Centre for Ecological Sciences (CES), IISc, Sambita works at the intersection of ecology and art, translating her understanding of the natural world to the latter. "Art initially served as a refuge for introspection, self-regulation and grounding, but it also sharpened qualities essential to science, such as patience, keen and inquiry-driven observation, and a willingness to experiment," she says.

Parallel processes

Sambita began experimenting with art right from the age of four. Her interest in science developed in parallel, encouraged by a family that fed her curiosity with books about both worlds. That dual interest guided her all the way to a PhD in behavioural ecology, and, by the end of it, a desire to unite

Image courtesy: Sambita Modak

A quick pen-on-paper sketch by Sambita of a researcher and gibbons during field work in Barekuri, Assam, documenting different postures and movements of gibbons

Image courtesy: Sambita Modak

Sambita's digital drawing of a juvenile female Western Hoolock gibbon, an endangered species, also the only ape species found in India, from Barekuri village in Tinsukia, Assam. The sketch was developed for Gibbon Moves, an ongoing game development project in collaboration with primatologist Ishika Ramakrishna

her love for art and ecology in a space where the two could deepen one another. "I think it ultimately boils down to the childhood dream of unravelling the secrets of the universe, to understand the world around us better – from natural processes and patterns of the world around to the human life and psyche," she says.

'Music is my solace and a source of creativity that powers my professional life as a scientist'

Over the past few years, she has found interesting parallels in her art and scientific processes. "The choice of tools or medium [for my artwork] is primarily determined by the subject or intent of the creative project, much like [how] the scientific question determines the study method, setup, analytical approaches, and so on," she explains. For example, for commissioned projects involving scientific or wildlife illustrations, she uses digital tools as they allow for easier revisions and tracking versions of an artwork through its progress. In contrast, for quick live drawings in the field, she prefers pen and brushpen on paper.

Sambita also draws inspiration from other artist-scientists, literary works and movements, like the Oulipo movement, a French method of exploring mathematical rules applied to literature. One example of this is the lipogram, or writing without using a specific letter. A 2001 book inspired by this concept, *Ella Minnow Pea*, is a fascinating example. The story follows a series of letters between characters who live on a fictional island called Nollop, as they have to progressively discard using various alphabets banned by the government.

While the members of the Oulipo movement remain an exclusive society, the intersection of maths and art has a long history, and especially in an Indian context – in the ancient practice of classical music.

Of course, music has no boundaries and there are infinite traditions in a country brimming with cultural diversity. But what is understood to be 'Indian classical music' takes two major forms – Carnatic, in southern India, and Hindustani, of northern India. Both boast of a long interwoven philosophy of technicality and creativity. The arrangements of the ragas, an exclusive concept of Southeast Asian music (which American musician Walter Kaufmann said "cannot be explained in one or two sentences"), follow rules of their own. Mathematical arrangements and constraints of various notes differentiate ragas from each other, yet there is space in between for free composition.

Hindustani, in northern India. Both boast of a long interwoven philosophy of technicality and creativity. The arrangements of the ragas, an exclusive concept of Southeast Asian music (which American musician Walter Kaufmann said "cannot be explained in one or two sentences"), follow rules of their own. Mathematical arrangements and constraints of various notes differentiate ragas from each other, yet there is space in between for free composition.

It's this blend of discipline and imagination that drew Debojyoti Chakraborty to the world of Indian classical music. "Music is my solace and a source of creativity that powers my professional life as a scientist," says Debojyoti, a scientist at CSIR-IGIB, New Delhi, and a lifelong sitar player. He believes that the mathematical

Photo courtesy: André Wirsig

Debojyoti Chakraborty with his sitar

underpinnings of both art and science bring about a shared understanding of their technical aspects. "Scientific logic and hypothesis-driven questioning have taught me the importance of approaching Indian classical music from an analytical point of view," he adds.

Sambita echoes this sentiment. "I believe the artist's sensitivity to patterns – spotting both trends and outliers – closely parallels the analytical skills expected of scientists. In that sense, creating art parallels some aspects of designing a scientific study: a cycle of observing, questioning, experimenting, interpreting, and producing a shareable output."

A growing number of scientists are now using their art to communicate science

Debojyoti believes that Indian classical music has two hardcore components – technical virtuosity, where the musician hones his skills through rigour, discipline and practice; and spontaneous creativity, which comes with lifelong listening, imbibing, learning, researching and contemplating. "If you ask me, both these components are necessary to be a good scientist as well. Rigour and problem-solving are daily aspects of experimental research, and I find a lot of similarities in how I approach music and science," he adds. "Just like how, as a musician, I am enthralled by the numerous possibilities of elaborating a *raag* or *taal*, my mindset in approaching a scientific problem is guided by the acceptance that several alternate theories always exist for coming to a solution, and these need to be experimentally validated."

The language of science

Visit your closest library. Most likely, there are books that tug at your nostalgia with their cream covers and cosy animals. *The Tale of Peter Rabbit* and other such works in the series were a labour of love by Beatrix Potter, an English author with a deep love for the countryside (so much so that she purchased and owned lands there just to preserve them). Beatrix was also a gifted mycologist and science illustrator, and loved studying almost all branches of the natural sciences out of sheer curiosity. Limited by the constraints placed on Victorian women, she still managed to study fungi as an amateur and gave the world illustrations that are still referenced today.

Image courtesy: Maria Sybilla Merian/Wikimedia

Maria Sybilla Merian's drawing showing the stages of the giant sphinx moth from her seminal book Metamorphosis insectorum Surinamensium

In contrast, Maria Sybilla Merian was a German scientist and artist whose illustrations revolutionised the field of entomology, or the study of insects. She utilised her artistic education to write two books and document the life cycles of more than 150 insect species. Before then, the prevalent view about insects was that they spontaneously generated from mud or other nonliving parts of nature. Her books were fundamental in understanding how insects grow, live, and reproduce.

Like her, a growing number of scientists are now more intentional than Beatrix in using their art to communicate science. Creative power is how scientific ideas are untangled, and it is what helps make these ideas more accessible to scientists and non-scientists alike.

"After many years of trying to communicate science – often with only modest success – I have realised something important: most lay readers, for whom much of this effort is intended, instinctively shy away from technicalities, abstractions, and even the simplest calculations. This is the "Two Cultures" divide," says Ghose, who has extensive experience in filmmaking, producing documentaries, and has authored several books on science communication.

The "Two Cultures" divide is a concept put forward by scientist-novelist CP Snow, addressing the alienation of science and the humanities. He believed that a polarisation between the two fields was holding progress back. "If we wish to bridge it," Ghose continues, "we must speak in the language they find most natural and inviting – the language of literature. The best science communicators have always known this. Technicalities build walls; stories build bridges."

Photo courtesy: Partha Ghose

Partha Ghose rehearsing for a play 'South Pacific' by Calcutta Club

"For me, art sharpens scientific understanding while also opening new ways of engaging wider audiences with ecological and scientific ideas," adds Sambita, who has found new ways to engage with people through installations, and has organised workshops around coexistence with species.

Democratising science through art

In recent years, there has been an uptick in events, festivals, and exhibits designed to bring science to the public, like the 'Art of Science' at Binghamton University or 'Cosmic Titans: Art, Science, and the Quantum Universe' at the University of Nottingham, held this past year. Closer home in India, institutions like the Tata Institute of Fundamental Research and the Nehru Science Centre host art outreach programmes in various forms.

Science Gallery Bengaluru is one of the few institutions in the world dedicated to an artistic exploration of science. Along with displays of scientific concepts, they host a year-long exhibition centred on a broad scientific topic and its relation to the world at large. This year's exhibit, "Calorie", explores links that nutrition and health have to history, politics, psychology, and the environment, conveyed through art exhibits and interactive events. They are also involved in outreach programmes like the "Experimentors", a mentorship initiative to train young adults in interdisciplinary science-art initiatives and help them engage with visitors.

"It's about becoming a bridge between visitors and the idea behind the works being presented," says Tejashree V, an Experimentor currently at the Science Gallery. "We are trained by scientists, researchers, and artists, and being here is recognising that art and science go hand in hand."

"Simply the act of everyday conversation makes not only the visitors understand the scientific themes more deeply, but us too," adds Vinaya Krishnan, another Experimentor.

Art, being a reflection of human society's desires and fears at a specific time period, can make or break what science looks like to the public. Medical dramas like *Grey's Anatomy* inspired people to become doctors. *Interstellar's* popularity set the stage for countless conversations and increased public interest in space and quantum physics. Indian films like *Mission Mangal* have served as powerful tools to convey aspects of rocket science to everyone, regardless of the depth of their knowledge in those fields.

Without understanding, there is ignorance and fear. The anti-science movement currently spreading across the USA is a sad example of what happens when people stop believing in or are misinformed about scientific advancements. The use of art to convey science in a democratic, understandable, and interesting way can serve as a critical factor in increasing public participation in decision-making related to science and research.

Art and science will always be two branches of the same idea – a desire to explore and understand the mysteries of this world. They are the two arms reaching out into the abyss of ignorance, looking for the light of knowledge. In Ghose's words, "Together, they give us a fuller, richer picture of reality."

Yashashree Prabhune is a fourth year BTech student at DY Patil University, Navi Mumbai, and a science writing intern at the Office of Communications

(Edited by Abinaya Kalyanasundaram, Ranjini Raghunath)

Photo courtesy: Science Gallery

Visitors interact with 'Stuff change', an interactive installation about stomachs, at CALORIE, Science Gallery, Bengaluru

Behind the Biosafety Doors

- Shruti Sharma

Photo: KG Haridasan

Rohan Narayan retrieving frozen cell lines used for studying viral infections

Staff who support high-stakes research

A long walk downhill on Silver Oak Marg leads you to the quiet edge of campus, where the bustle of the main roads fades into the murmur of trees. The air feels cooler here. Just past the Combustion Gasification and Propulsion Laboratory (CGPL), there is a gate on the left. A guard sits nearby, a friendly dog dozes beside him, and white *Datura* blossoms lie scattered on the road like fallen stars. The scene is tranquil, almost deceivingly so, because just beyond this stillness stands one of the most secure and high-stakes spaces on campus.

Past the gate, on the right, a modest building comes into view, pale and unassuming, with an entrance that requires biometric access. Inside, staff members move briskly through the corridors, exchanging notes, carrying equipment, planning the day's routines. Its corridors carry the sharp tang of disinfectant, the occasional hiss of a gas cylinder being changed, and the steady whirr of freezers holding biological samples at -80°C.

'CIDR stands as a critical national resource dedicated to tackling some of the world's most urgent health threats'

The Centre for Infectious Disease Research (CIDR) is one of the youngest research spaces on campus – a place where scientists study infectious agents such as *Mycobacterium tuberculosis*, HIV, SARS-CoV-2, and other viruses that cause diseases like the flu, hepatitis, dengue, and Zika. Though the Centre, in its current form, was inaugurated in 2013, its roots go back over a decade earlier when IISc's first infectious disease research initiative was launched in 2002.

"CIDR stands as a critical national resource dedicated to tackling some of the world's most urgent health threats," says KN Balaji, the centre's Convenor and Professor at the Department of Microbiology and Cell Biology (MCB). "It enables scientists to safely and rigorously study these dangerous microbes and accelerate the development of much-needed diagnostic tools, therapies, and vaccines."

To make such research possible, CIDR houses multiple Biosafety Level 2 and Level 3 (BSL-2 and BSL-3) labs, each designed to handle microbes posing varying levels of risk. In the BSL-2 spaces, pathogens that pose a moderate risk are handled with protective lab gear and sealed safety cabinets. The BSL-3 labs, however, are engineered for more stringent containment – sealed rooms maintain negative air pressure so that nothing escapes, HEPA filters purify every breath of air, and double-door autoclaves and air showers separate clean zones from contaminated ones. Inside, researchers in layered protective gear carry out their experiments surrounded by the steady hum of instruments and safety monitors.

In addition to advancing infectious disease research on campus, CIDR also functions as a collaborative centre, sharing its high-containment infrastructure with researchers from other institutes, according to Balaji. In recent years, it has become home to three independent labs filled with doctoral students, project assistants, and postdoctoral researchers, bringing an academic rhythm to this research space. "Essentially, CIDR is not just studying future pandemics, it is actively empowering the wider scientific community to develop solutions for pressing public health concerns," adds Balaji.

What also keeps this carefully controlled environment running is the commitment and hard work of several staff members, some of whom have been with CIDR from its early days. Among them is Bharathi Dakshinamurthy, a former staff member, who remembers a time when the building had neither sound nor science – only dust, silence, and the promise of what it could become.

From the ground up

Back in June 2013, when Bharathi first stepped into what was to become the CIDR building, she felt an overwhelming sense of desolation. "There was nothing – not even chairs or tables," she recalls. "We carried furniture and bookshelves from the Dorabji Tata Centre." The Sir Dorabji Tata Centre for Research in Tropical Diseases, earlier housed on the first floor of the Society for Innovation and Development (SID) building, had just closed, and many of its items were moved to CIDR. Slowly and painstakingly, the skeleton of a research facility began to take shape.

Snakes would sometimes slither in through the gates, and dust hung heavily in the air. There was no bio-waste system, no safety office, and for a while, no generator. "Whenever the power went out, we rushed with samples in ice boxes to the [nearby] animal centre," she says. Even after the generator came, the wiring was confusing, with power coming from multiple substations. "We had to keep track of everything," she adds.

In those early years, under the guidance of the founding convener Dipankar Nandi, Professor at the Department of Biochemistry, and Amit Singh, Professor at MCB, CIDR began establishing its first BSL-3 lab, which opened for tuberculosis research in 2014. Over the next few years came the Animal BSL-3 (in 2017), then the construction of new labs funded by a grant from the Infosys Foundation (in 2019), and finally, the viral BSL-3 facility (in 2020). Through every phase, Bharathi helped manage purchases, coordinate logistics, and worked to ensure every detail, from chemicals to compliance documents, was in place.

When the pandemic hit in 2020, her responsibilities multiplied overnight. "I worked all the days; even caught COVID-19 myself, twice, maybe thrice," she recalls. The central government had instructed IISc to set up a COVID-19 diagnostic lab. What followed was a collective effort – guided by the Divisional Chair and faculty members, including faculty members Amit Singh, Shashank Tripathi, and Deepak Saini and supported by several postdoctoral researchers who were on campus then. "We set up the diagnostic lab on the second floor of the Infosys wing," Bharathi adds.

Photo courtesy: Bharathi Dakshinamurthy

Bharathi Dakshinamurthy worked at CIDR from 2013 until her retirement

Those weeks felt endless, she recalls. Vendors supplying consumables and kits for the diagnostic tests were scared to cross police checkpoints in the city and deliver them inside the campus. "One said, 'Madam, the police will beat me up,'" Bharathi recollects. "I wrote hundreds of permission letters, stamped and signed, convincing them that it was safe." She also arranged PPE (Personal Protective Equipment), diagnostic kits, and even snacks for people working late at night. "It was chaotic, stressful, and unforgettable."

'I worked all the days; even caught COVID-19 myself, twice, maybe thrice'

Bharathi is happy at how far CIDR has come. "Compared to big departments, we grew very fast. When I joined, it was just snakes and us. In 12 years, it has become so big."

Running around

It was Bharathi who brought Ramesh KC to CIDR in 2014. A friend had introduced them, and soon after, she asked him if he would consider joining their small team. "Only Bharathi madam and Yathiraj [another staff member at CIDR] were here when I joined," he recalls.

Ramesh's journey to IISc has been far from straightforward. Before coming here, he had worked in fabrication shops, a cloth store, and later in a software company that maintained ATMs. After joining CIDR, he began working on general maintenance and cleaning – connecting gas cylinders, checking incubators, autoclaving waste, and ensuring that the labs stayed functional. Over time, his responsibilities grew. Today, he handles the upkeep of the viral BSL-3 facility, oversees power systems, and coordinates with the maintenance team of the biosafety labs.

Ramesh dislikes sitting idle. His day begins around 9.30 am and often stretches well past evening. If a power line trips or a diesel tank runs low, he stays back until the problem is fixed. He also assists in the animal BSL-3, where strict protocols need to be followed to ensure that nothing harmful leaves the facility. "If an animal model dies, we freeze it, autoclave it, and only then discard it," he explains. During the pandemic, Ramesh remembers receiving COVID-19 samples for analysis at odd hours, whenever the calls came.

Photo: KG Haridasan

Ramesh KC cleaning and preparing a mice cage

On festival days, when the staff, students and faculty members gather together, Ramesh enjoys the brief sense of pause. "Those days feel good," he says, his eyes brightening. Even on other days, he adds, that sense of shared responsibility endures. "We support each other and get things done."

Outside of work, Ramesh has a fascination for languages. He speaks Kannada, Tamil, Telugu, Malayalam, Hindi, English, and even understands bits of Marathi and Rajasthani – picked up over years of talking to people from across the country. "If you know many languages," he says, "you can talk to anyone."

Fixing things

As Ramesh prepares to get back on his rounds, he is joined by S Sendil Raj, another staff member. Sendil grew up inside the IISc campus. His father had worked here decades ago, and Sendil himself was born on campus. He now lives just outside the D gate.

Sendil joined CIDR in 2015 from the Department of Developmental Biology (DBG), where he worked in faculty member Upendra Nongthomba's lab. Around that time, faculty member Amit Singh was setting up his lab at CIDR, and through that connection, Sendil moved into the new building. He started his journey as a lab attendant in Amit's lab, and over the years, became the go-to person.

If the autoclave breaks down, he fixes it. If the CO_2 cylinders run low, he replaces them. When the power fails, he's the one refilling diesel in the generators. He handles liquid nitrogen, prepares cleaning reagents, checks the incubators, coordinates billing, and even manages paperwork when needed. "I do almost everything in the lab," he says, with a laugh.

Sendil's workday rarely fits in a nine-to-five frame. He comes at 10 am and often stays past 6 or 7 pm. "Sometimes there's emergency work at night," he says. "If the generator runs out of diesel or a burning smell comes from a wire, we have to go immediately."

His job was even more demanding during the pandemic. "We sanitised labs 5-6 times in a week. We wore double masks and PPE kits even outside the BSL-3 lab for hours. Everyone was scared." He still recalls his neighbours eyeing him warily, as if he carried the virus home in his pocket.

Sendil has worked across campus for over 30 years, from the Department of Biochemistry to the Animal Centre to DBG, where he still helps with Drosophila media preparation in the evenings. Outside of work, he's an active presence in campus sports – often seen on the badminton court or at the swimming pool, where he once coached faculty members and their children. Like Ramesh, Sendil echoes the sense of togetherness he feels with the other staff members at CIDR. "If one person can't come, the other does the work. We don't say, 'this is your job, that is mine.'"

Photo: KG Haridasan

S Sendil Raj carefully handling autoclaved Milli-Q water for lab use

Sendil is also well-regarded among the students. "They get along with me very well. If they need anything, I'm always ready to help." After a decade of working at CIDR, he remains deeply attached to the place. "I got many offers. Better pay too. But I never left. This place feels like home."

Balancing science and safety

Soon after Rohan Narayan joined IISc as a postdoc in December 2019, COVID-19 hit. The timing turned out to be critical – it was when CIDR's viral BSL-3 began coming up. Before arriving in Bengaluru, Rohan had already spent years immersed in the world of viruses. He earned his PhD from Cardiff University in the UK, working on the dengue virus, which gave him both technical experience and biosafety training in high-containment environments. That expertise would soon become invaluable.

At IISc, Rohan's postdoctoral research naturally aligned with managing the viral BSL-3. "It was not officially part of my job description," he explains. "But since I was already familiar with BSL-3 systems and interested in them, I took it up."

As one of the first researchers to work in the facility, Rohan helped shape its functioning from scratch – helping draft standard operating procedures, setting up safety protocols, and training users. "Using the guidelines available from ICMR, CDC, and WHO, we developed SOPs and adapted them to our settings," he says.

Managing a BSL-3 lab is far from routine. Each day involves coordinating with CIDR staff, the BSL-3 construction agency staff, and faculty-in-charge, Shashank Tripathi. Rohan's role involves ensuring biosafety compliance, monitoring research instruments, and supervising users. He now works closely with Balasubba Reddy, a Technical Assistant who joined CIDR in 2023 and helps oversee the BSL-3 operations – from checking incubators, freezers, and temperature controls to monitoring negative air pressure systems. He also handles service calls when equipment fails, manages billing and user access, and coordinates maintenance visits. "Every day is different," he says. "Some days are smooth, some days can get hectic – especially when the power goes."

Rohan stresses the importance of following biosafety rules. "Whatever is inside must not leave the BSL-3 lab without complete sterilisation – and you have to protect yourself, too," he adds.

To him, the BSL-3 lab runs more on collective effort than hierarchy. The cleaning staff, maintenance engineers, and researchers all play a crucial role. "It's a team effort," he says.

He personally trains every student who enters the facility – from donning and doffing PPE to handling spills and emergency procedures. Inside the BSL-3 lab, the physical and safety constraints make even simple experiments arduous. "Wearing PPE can be a little uncomfortable, and everything takes longer inside BSL-3, but you have to strictly follow the rules," Rohan points out.

As part of the COVID-19 response, he and other researchers worked to isolate the SARS-CoV-2 virus from patient samples. Using Vero cells (mammalian cell lines used to study viral infection), Rohan watched the infection unfold under the microscope in real time – infected cells fusing into large clusters called syncytia. "It was a stark reminder of what the virus does in the body," he recalls.

Those months of the pandemic were a mix of intensity and isolation. "It was lonely," he admits, "but there was so much work. I was busy most of the time."

Five years on, Rohan continues to balance his postdoctoral research with his managerial responsibilities. "It's been a constant learning experience," he reflects. "During my PhD, I just worked in a facility. Here, I helped build one."

When the lights dim at CIDR and the last centrifuge hums to a stop, the building does not fall silent. Ramesh checks the power lines one last time before heading home, the careful click of switches marking the end of his day. From the corridor outside Amit's lab, Sendil's laughter floats softly through the air. The centre's pulse continues in the quiet movements of the staff members who deeply care about it.

Photo: Shruti Sharma

Balasubba Reddy at work handling BSL-3 lab administrative operations

Shruti Sharma is an Integrated PhD student at the Department of Biological Sciences, IISc, and a science writing intern at the Office of Communications

(Edited by Ranjini Raghunath)

Crowdsourcing Conservation

- Ashmita Gupta

Photo courtesy: Suhirtha Muhil

Primary school students at Irala, Andhra Pradesh, run to hug a giant Jamun tree during an outdoor training session on trees and climate change conducted by SeasonWatch Team members Suhirtha Muhil M and Muhammad Nizar K

How citizens are helping collect research data

On the rare occasion that you break away from the tedium of overflowing inboxes to listlessly stare into space, something extraordinarily fascinating could catch your attention. It could be a stray dragonfly perched on the window ledge, or perhaps a tree with a huge canopy farther away. It could be said tree's oddly bending trunk that holds your interest, or the beautiful blooms decorating its branches. Either way, that tree now occupies a tiny corner of your mind and likely your camera roll.

This simple act of observing and documenting is what brought pini-beraliya (*Doona ovalifolia*) – once declared extinct in the wild – back to life and into the scientific spotlight. For decades, a single cultivated specimen of this tree existed at the Royal Botanic Gardens in Sri Lanka's Peradeniya like a living relic. In 2018, however, gem miner and plant enthusiast Lasith Prageeth, in response to a Facebook post that requested sightings of the species, shared photos of a towering tree from his village, Ayagama. Flower specimens that Lasith collected a year later led botanists to confirm that the forest giant was alive after all!

The discovery set off a wave, with conservationists tracing a few more surviving trees along riverbanks in Sri Lanka's western provinces. Today, Lasith and local school children have become the unlikely stewards of the species. Every few days, they water and nurture hundreds of its saplings in community-run nurseries. What started as a chance click shared online has since mushroomed into a national effort to restore one of Sri Lanka's critically endangered trees.

Armed with smartphones, internet access, and curiosity, citizens are now helping collect real scientific data

Thousands of kilometres away, a similar spirit of collective curiosity has transformed birdwatching into a powerful tool for ecological research. Loyal birders recorded and uploaded more than a million observations of about 118 bird species across the Western Hemisphere on eBird, a citizen science platform launched by the Cornell Lab of Ornithology in 2002. Using the data from 2002 to 2014, the lab created a vivid, continent-spanning animated map of the species' annual migration between their breeding and wintering grounds in North, Central, and South America – something no single researcher could have tracked alone. This also revealed some fascinating insights into the birds' preferred routes, movements and behaviour.

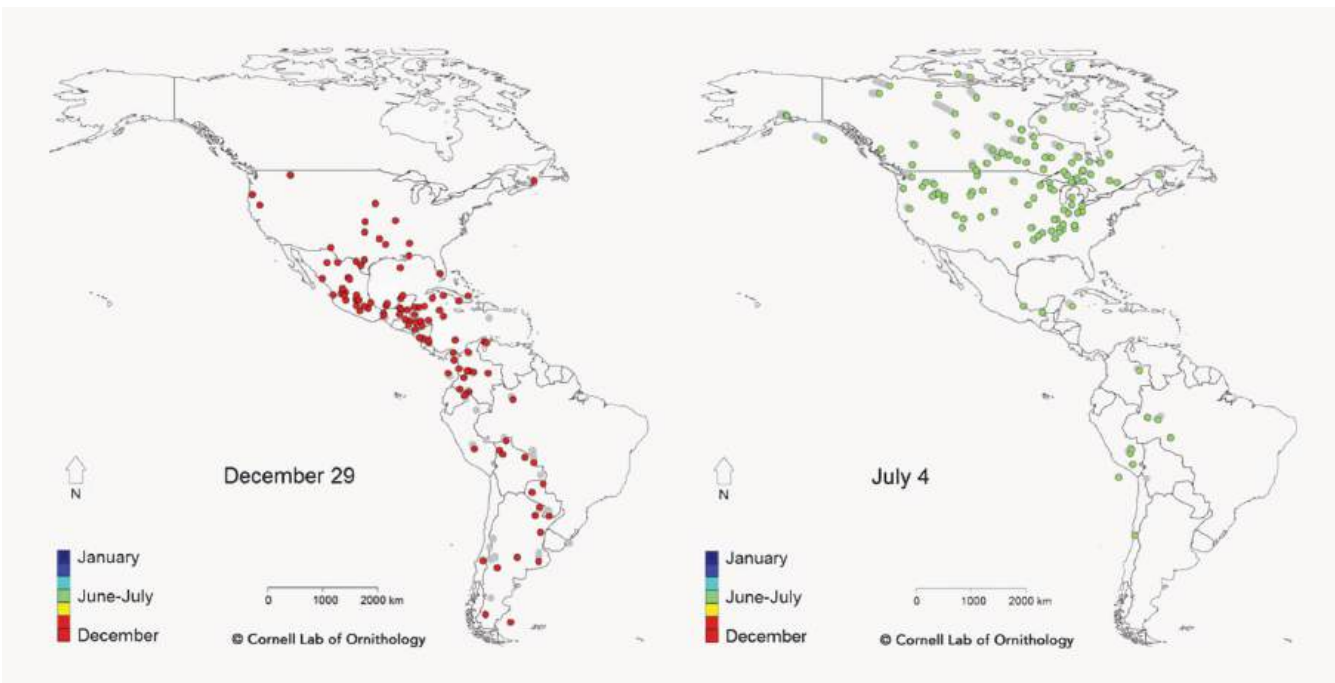
Around the world, such collaborations between everyday nature enthusiasts and scientists are blurring the lines of how ecological research takes place. Armed with smartphones, internet access, and curiosity, citizens – from students and birders to farmers and divers – are now helping collect real scientific data. This participatory movement, known as citizen science, is transforming how biodiversity is documented, monitored, and protected.

"Citizen science produces data at larger spatial and temporal scales and resolutions than individual projects can," says Kartik Shanker, Professor and Chair of the Centre for Ecological Sciences (CES), IISc. "But it may be even more important as a tool for citizen engagement."

Climate clues

In India, citizen science in ecology became more widespread in the early 2000s, when naturalists and scientists recognised the power of collective observation in a biodiversity-rich but data-poor country. The India Biodiversity Portal (IBP), launched in 2008, was one of the first attempts to build an open-access database where anyone could upload and validate species sightings. It was followed a few years later by a Nature Conservation Foundation initiative

Image courtesy: Cornell Lab of Ornithology/eBird



Scientists at the Cornell Lab of Ornithology created a migration map showing the annual movements of 118 bird species, using data from eBird. Each dot represents a different avian group

Photo: Dinesh Valke

*The captivating golden flowers of the Indian Laburnum (*Cassia fistula*) tree, which are used in the Vishu celebration in Kerala*

called SeasonWatch. Launched in Kerala in 2014, it enlists interested individuals, even schoolchildren, to record when trees flower or fruit – revealing how climate change may be altering the rhythm of India's seasons.

For instance, the flowering of the golden cascade or Kannikona (*Cassia fistula*) would historically peak during the festival of Vishu, when it would be a part of the festivities. However, locals reported on SeasonWatch that the flowering now peaked earlier than Vishu, and seemed to recede during the festival. They also found fewer flowers throughout the year.

"We asked locals to record these observations and upload this data on our portal to confirm that there were notable changes in flowering patterns. Although this data isn't yet enough to prove that climate change is altering flowering patterns, it lays the groundwork for much-needed baselines of fruiting and flowering periods – data that is scarce in India. Tracking deviations from these baselines could reveal the impact of climate change on trees," says Sayee Girdhari, Project Coordinator for SeasonWatch.

Another interesting pattern that came to light through citizen contributions was that the timing of flowering and fruiting shifts significantly based on latitude. Flowering begins sooner in the south (like Kerala or Tamil Nadu) and then progresses north, forming a wave pattern through Maharashtra and finally reaching Delhi.

Since its inception in 2014, SeasonWatch has accumulated over nine lakh observations

The other perk of this project is public engagement. Since its inception, SeasonWatch has accumulated over nine lakh observations. Active participants (those who have added at least one observation) include 2,890 individuals and 3,476 schools, including schools participating through the Malayali newspaper Mathrubhumi's SEED (Student Empowerment for Environmental Development) programme. Some committed participants, like teachers and students in Kerala, have been making observations for over 10 years since the project began.

"We work with trees, which is not a very charismatic group," says Sayee, with a laugh. "By involving people in such a project, they begin to view trees as friends and develop an emotional connection with them. Trees attract so much biodiversity and form beautiful, interesting relationships with other fauna. Our citizen scientists get to observe other organisms' life cycles as well. So, trees become sort of a segue into learning more about nature and connecting with ecosystems around them."

Diving deep

While projects like SeasonWatch reveal changes unfolding on land, other citizen scientists have been documenting equally profound shifts below the sea's surface.

In the Andamans, islanders had long noticed dramatic changes in coral and fish populations since the 2004 tsunami. These changes started

getting recorded more systematically through ReefLog, a citizen science initiative launched in 2015 by the Dakshin Foundation, a non-profit led by Kartik Shanker.

ReefLog is driven by the desire to get locals to participate in the conservation of the ecosystems that they are a part of. Citizen divers are trained by diving professionals to conduct surveys and collect data on coral and fish populations.

"During one of my interactions with a veteran dive professional from Havelock, I learnt that there was this particular reefscape close to Long Island that was full of vibrant stag horn corals. It was completely wiped out after the tsunami, and now, barrel sponges are taking over that same area," says Samar Ahmad, Programme Associate at ReefLog.

"Another recent observation by the dive professionals in Havelock Island is a sudden population increase of a fish called the common bluestripe snapper (*Lutjanus kasmira*). A few years ago, the species was present in individual groups of maybe 10-20. Now, at the very same dive site, there are some 80-100 individuals together at any given time," she adds.

On the other side of the Indian Peninsula, a Dakshin Foundation researcher, Mohammed Serfas Khan, is actively tracking the movement of green sea turtles in the Lakshadweep Islands. One of the chapters in his research involves identifying individual turtles using high-resolution photographs of their unique facial patterns (a method known as photo identification), which are similar to human fingerprints. These photographs of turtles were captured by local scuba divers from the various islands of Lakshadweep.

"These local divers don't require any GPS. They know exactly where to find the turtles," says Serfas, with a grin.

Citizen-collected visual data can sometimes reveal fascinating adaptations in animals

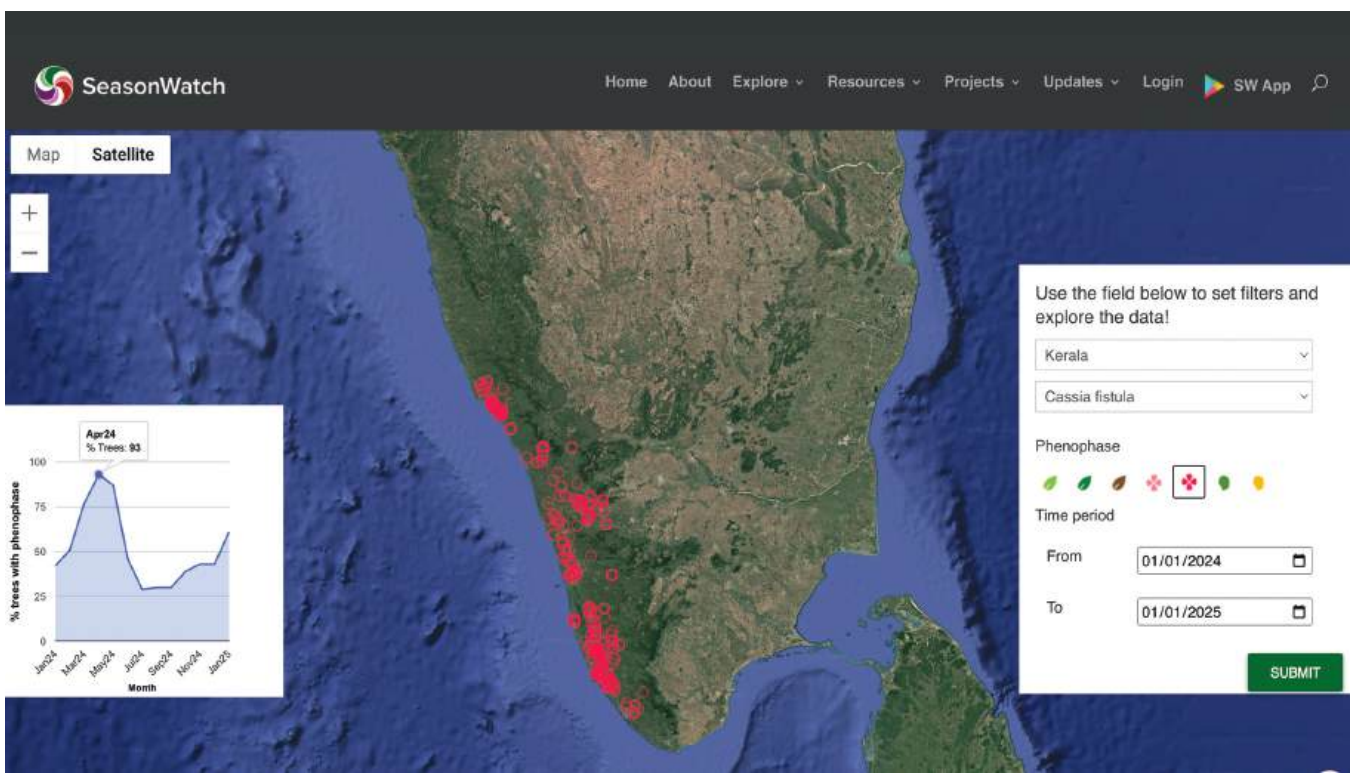
The project began in 2016 and aims to map green turtle movements and seagrass habitats for their conservation and management. When the project started, a key driver for the research was addressing the human-turtle conflict prevalent at that time – turtles were altering fish nurseries due to overgrazing in seagrass meadows, inadvertently impacting local fishermen. But now, things have improved.

"The project has helped change the local perception of turtles from pests to valuable organisms. Scuba divers and locals have learned more about turtles, leading to increased respect for the green turtles," says Serfas.

Citizen-collected visual data can sometimes reveal fascinating adaptations in animals. For instance, in one of the videos recorded by the divers, a green turtle was seen navigating a plant defence strategy rather cleverly.

The tall and long-lived seagrass species in Lakshadweep have naturally been replaced by shorter, fast-growing species to combat overgrazing by sea turtles. Their shorter length makes it harder for the turtles to graze effectively as the blades are closer to the sand. The video captured by the citizen scientist diver showed the green turtle adapting to this challenge by pushing the sand aside with an indelicate swish of its front flippers before diving in to chomp on the seagrass.

Image courtesy: SeasonWatch



A screenshot from the SeasonWatch dashboard showing citizen documentations of the flowering patterns of Cassia fistula *in Kerala between January 2024-2025*

Photo courtesy: Rizal MA

Divers attempting to photograph a green turtle in Lakshadweep

Another example of video evidence bringing new animal behaviour to light lies in ecologists Sangeeta Sharma Pokharel and Nachiketha Sharma's 2022 study on elephants' response to death. Witnessing instances of an elephant's death is rare in the wild, and Sangeeta had only ever observed one case in three years of intensive field work. So, she and her colleague turned to online videos for data.

By mining publicly available footage on YouTube, using search terms such as "death of elephants" and "elephant reactions to death," the study identified 24 cases revealing how elephants interacted with deceased family members, such as patting them with their trunks. In a BBC article, Nachiketha called "calf carrying" – where elephants picked up a dead calf with their trunk or tusks and dragged it – the "most striking thing" observed.

A double-edged sword

While these videos offered insights into how elephants behave, they also raised the possibility of bias. For instance, the researchers had no way of confirming if the animals' behaviour was organic or influenced by human presence. Citizen science, which relies heavily on voluntary contributions, has inherent risks of such bias.

In the ReefLog initiative, where participants collect data on multiple species, observers are likely to over-report conspicuous or charismatic species. Conversely, cryptic or unremarkable species are often under-reported due to their reduced detectability during surveys. "It's like how, in birdwatching, nobody reports the crows and the doves, but everybody is reporting the raptors," Samar says.

Moreover, data collection is geographically and seasonally skewed because most dives happen at popular tourist areas and during the peak diving season (November to March/April), leaving less-visited reefs and other months underrepresented.

To manage these biases, ReefLog filters the observations and seeks out confirmation from professionals at dive centres and other fish and coral taxonomy experts.

Platforms like iNaturalist employ similar methods, preventing any AI-generated content from misleading data entries. Samar notes that she often encounters videos on social media that are so difficult to discern as real or AI-generated. "Fortunately, some people who use AI to generate content are using tags like 'AI-generated' in the captions," she says.

Another flipside to this wave of digital documentation is that not all recordings are driven by curiosity – some are fuelled by the irresistible lure of a selfie. In a viral clip from August 2025, a tourist in Karnataka was seen trying to snap a selfie with an elephant. The wild animal, however, was not impressed and began to chase the man, reportedly pantsing him. According to a bystander, the sudden camera flash provoked the elephant.

'Citizen science projects have the power to change local perceptions around species'

Samar acknowledges that citizen science may contribute to the burden of unregulated tourism. "If the government and the local authorities can bring in responsible tourism, then the benefits of citizen science would definitely outweigh the risks," she says.

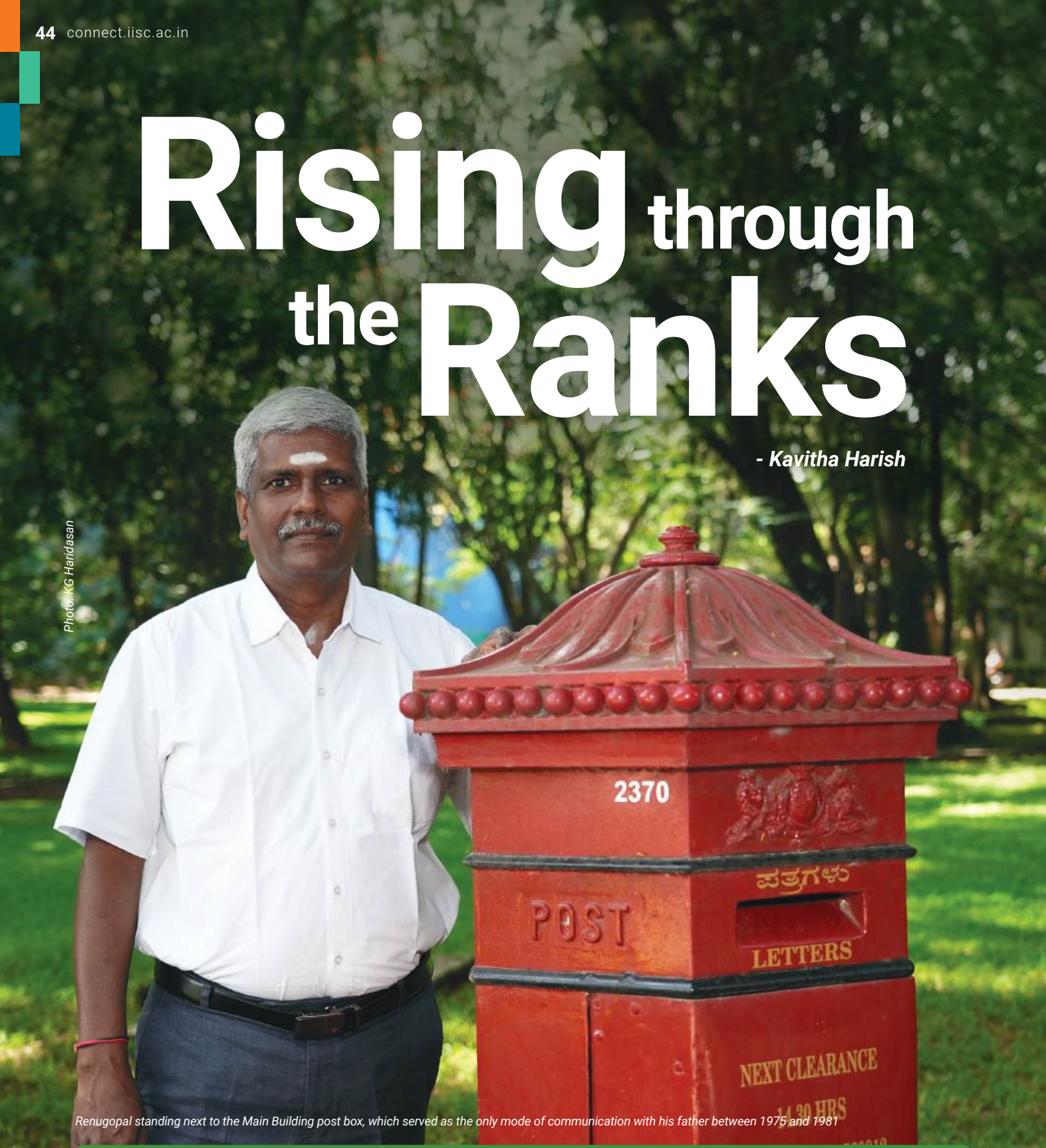
Citizen science may not solve the biodiversity crisis overnight. But it might be changing something more fundamental: our relationship with the living world. In a time of algorithmic feeds and synthetic media, it's certainly teaching people to pause and really *look* again – to pay attention, to record, to care. Serfas notes, "Citizen science projects have the power to change local perceptions around species. For the contributors, it can create a sense of pride, curiosity, and appreciation."

(Edited by Abinaya Kalyanasundaram)

Rising through the Ranks

- Kavitha Harish

Photo: KG Haridasan



Renugopal standing next to the Main Building post box, which served as the only mode of communication with his father between 1975 and 1981

Renugopal Murugesan first visited IISc in 1977, at the age of 14, when his father was employed as a construction worker at the old Physics department building. He joined his father as a daily wage labourer in 1981 and later worked as a mason. With the support of IISc faculty and staff, he learnt typing skills and eventually secured a permanent clerical position. Over four decades, he has worked in two departments across the Institute, retiring in 2024 as a Superintendent in the Director's office. Speaking to CONNECT, he reflects on his life's journey from construction work to clerical duties, campus memories, and life after retirement.

Tell us about your childhood. Where did you grow up?

I come from Vadavetti, a small village in Tamil Nadu's Villupuram district. My father walked to Bengaluru in search of work. I still remember the day he left – it was a drizzling November afternoon, sometime around 1971 or 1972. My earliest connection with Bengaluru dates back to 1973, when I was 10 years old, and my father was engaged in the construction of a house on Palace Cross Road, which, I learnt much later, belonged to Prof Satish Dhawan. Eventually, my dad moved to IISc, where he worked as a labourer and a security guard during the construction of the Centre for Scientific and Industrial Consultancy (CSIC) building in 1975.

How did you move to IISc?

I first came to IISc in May 1977 during my summer vacation, while I was in class nine. The first floor of the old Physics Department (now the UG building) was under construction; my father was employed here, and my elder brother was assisting him. Although the brief visit seemed unremarkable at the time, it turned out to be the beginning of my lifelong association with IISc.

'My mother would gather dried wood for cooking near the Main Building, and every day she prayed to JN Tata for her two sons to secure jobs at IISc'

Later, we moved to and stayed in a temporary shed at the National Centre for Science Information (NCSI) construction site, where the present Office of Communications building now stands. My mother would gather dried wood for cooking near the Main Building, and every day she prayed to JN Tata for her two sons to secure jobs at IISc. In 1986, her prayers were answered – both my brother and I were eventually appointed as regular employees at the Institute. My elder brother, too, built his career at IISc, serving in the Centre for Cryogenic Technology until his retirement.

What did your initial work involve? How did you shift to becoming a clerical staff member at the Institute?

After completing my class 12 education in a Tamil-medium school in my native place, I joined the Institute in December 1981 for a construction job with my father. My salary then was Rs 6 per day and eventually rose to Rs 30. Within 18 months, I learnt masonry and got higher pay. I vividly remember my first day as a mason on the terrace of the 'A' mess building, now housing Nesara. During this time, I also attended English typing classes and cleared the Senior Grade.

In February 1984, I joined the Molecular Biophysics Unit (MBU) as a temporary mali-cum-helper in Prof MRN Murthy's lab, earning Rs 500 per month, which was, interestingly, less than my mason's wage. Prof Murthy ensured that I received a khaki uniform like regular employees. In a photograph from a 1985 International Conference on Crystallography, I am wearing those same khaki pants with a complementary departmental T-shirt.

What was your work like at MBU?

My initial duties involved preparing a mixture of manure, sand and soil, sowing seeds and transplanting saplings, infecting mature leaves with a virus, and harvesting plants grown in the Glass House – the same building where I had once worked as a casual labourer for Rs. 7/- per day. On my first day, while washing glassware soaked in sulphuric acid, Prof Murthy advised me to take a lunch break (it was already 2 pm) and later assured me that I would one day rise to a better position, a promise that came true within two years.

I will always remain grateful to Prof V Sasisekharan, the Chairman of MBU, and Mrs Sasisekharan for treating me like their own son and standing by me through every step of my journey. Even today, I feel the strength of their blessings and the warmth of their unwavering support.

Did you take up further education?

Soon after joining MBU, I enrolled in evening BCom classes at MES College, gaining admission instantly when the principal saw the MBU Chair's recommendation letter on an IISc letterhead. Although I maintained over 90% attendance, I could not complete the degree due to my limited English proficiency.

How was your work life at MBU? We understand that you received immense support from the faculty and students.

I was warmly welcomed by faculty members and students in MBU, who supported me with gifts such as an accountancy textbook (from Patanjali SR), a calculator (from N Ramesh), and an English–Tamil–English dictionary (from B Gopalakrishnan). They even set up a table, chair, and bookshelf for me in their workspace, where a candid photo of me was once taken and gifted by Kumud Majumdar. Malini Rajagopalan taught me spoken English in the evenings and still chats with me from the USA. Sundaramurthy M, Pradeep Parrack, Indira Chandrasekar, Latha Kadalayil and many other colleagues showered their concern and treated me as their own brother.

How many departments have you worked in? We understand that you have been a part of this Institute for more than 40 years.

I began my career in 1986 as a Lower Division Clerk at the ISRO-IISc Space

Photo courtesy: Renugopal Murugesan

Renugopal at MBU in 1985, wearing a complimentary departmental T-shirt from the International Conference on Crystallography and khaki pants provided by the department

Photo courtesy: Renugopal Murugesan

The Sasisekharans (centre and right) reassuring Renugopal (left) on his wedding day

Technology Cell (STC), working there until 1 November 2006. I was then transferred to the Director's Office, where I served until my retirement as Superintendent on 31 July 2024.

Can you share any memorable experiences at STC?

When I joined the STC as an LDC (Lower Division Clerk) on 4 April 1986, I vividly remember the 1987 conference on Fault Tolerant Computing at Hotel Ashoka, co-sponsored by STC. On the day of the event, Prof Shrivastava, the convenor, ensured that I stayed for lunch, walking with me into the dining hall so I wouldn't feel out of place among distinguished participants. His kindness left a lasting impression on me. I fondly recall the farewell arranged for him at STC in 1989 when he moved to the Ministry of Human Resource Development on deputation, and his 80th birthday this year.

'Throughout my years in STC, I always found warmth and support from seniors and colleagues'

At STC, I had the good fortune of forming close bonds with S Pradeep, Charlie Oomen, AG Sreenatha, Nagajothi, M Kumar, Subash, Elavarasan and Thangamatheswaran. Elavarasan took my wedding photographs even though his own wedding was only a few days later in Coimbatore. I was especially fortunate that faculty members like Pradeep and Charlie stood as guarantors for me to secure a housing loan from HDFC Bank, which enabled me to purchase a residential plot in Tatanagar, where I currently live. My colleagues, AT Janardhanan, Chinnaraju, and R Suresh Kumar, were more than just co-workers – they became like members of my extended family.

On my superannuation day, 31 July 2024, Prof Gopalan Jagadeesh honoured me with his lab team and faculty from Aerospace Engineering, a gesture made more special by our earlier collaboration on the 2005 International Conference on Shock Waves, where my wife and I helped him in the Conference Secretariat and compiled over 1,000 pages of proceedings in LaTeX. Throughout my years in STC, I always found warmth and support from seniors and colleagues, regardless of my youth or modest designation.

We'd love to hear about your experiences working in the Director's office. How many Directors have you worked with?

I had the privilege of serving in the Director's Office and working closely with three Directors – Prof Balaram, Prof Anurag Kumar, and Prof Rangarajan – an experience that allowed me interactions few could dream of. I also engaged with Council Chairs and members, Deans, and many other officers, past and present, as well as seven Registrars of the Institute.

Many people have called me "Renu", but when Prof Balaram said it, there was always a warmth and familiarity that felt deeply personal and made me long to hear it again each time. The last time he called me that was in early 2024, when he briefly stepped into the Director's Office on his way to the Faculty Hall, smiled, and said, "Renu, I came just to say hi to you," before hurrying off.

What are some memorable events that you were part of at the Institute?

I had the privilege of witnessing the Institute's Platinum Jubilee in 1985, when the Honourable Vice President of India, Shri R Venkataraman, addressed the gathering. A grand lunch was organised for the Institute community, and I was fortunate to be part of it. In 1987, I contributed to the symposium on *Three Hundred Years of Newton's Principia*, organised by the STC, assisting Prof Shrivastava in preparing the proceedings.

In the following years, I had the opportunity to contribute to several milestones, including the Golden Jubilee of the Department of Aerospace Engineering in 1992. During this time, I had the privilege of walking alongside Dr APJ Abdul Kalam on the staircase of the Main Building toward the Faculty Hall. With his hand resting on my shoulder, he

Photo courtesy: Renugopal Murugesan

Renugopal (seated, right) during his felicitation ceremony before retirement in 2024

warmly enquired about my native place, and I mentioned that I had read the Tamil version of his article "*Metal Birds*" in *India Today* magazine.

During the Institute's centenary celebration in 2009, Prof AG Menon, Chair of the Archives and Publication Cell (APC), entrusted me with collecting the reminiscences of distinguished retired faculty members and officers for a publication. He graciously acknowledged my contribution and included my name in the preface of the book.

One of the most memorable aspects of my service was assisting Prof Rangarajan, the current Director, in convening meetings for the establishment of the Medical School, including initiating a file titled "*Postgraduate Programme on Medical Science*". Over the years, I also had the privilege of witnessing visits by numerous dignitaries, including Presidents, the Vice President, the Prime Minister, Shri Ratan Tata, and the Maharaja of Mysore.

Did you stay on campus? What was it like?

Yes, I lived on campus from 1981 to 1993 and again from 2000 to 2008. In the early 1980s, the Institute community was small, and most employees were permanent, so everyone knew each other well, including their families. Until the early 1990s, it was common to drink water from any roadside tap on campus. Those were simpler, quieter times, when the Institute truly felt like a close-knit family.

We heard you also helped publish students' theses and books.

Beyond my office duties, I dedicated much of my personal time to earning additional income. Over the years, I typed nearly 134 doctoral and master's theses, often working late at night to ensure accuracy, clarity, and timely delivery. This journey also reflected the evolution of technology – I started with WordStar, ChiWriter, LaTeX, and eventually adopted MS Word. I also prepared hundreds of research papers, project proposals, reports, books, and conference proceedings. This work gave me a quiet and lasting sense of fulfilment.

What changes have you seen in how the Institute has evolved over time?

Over the last four decades, the Institute has grown from around 400 students and over 100 faculty members in the 1980s to more than 5,000 students and 500 faculty members today. Significant infrastructure developments – including the construction of the new hostel blocks to provide ample student accommodation – have supported this growth. In the past, students would gather each July outside the Main Building, requesting hostel extensions, a scene that is unlikely to recur in the foreseeable future.

Photo courtesy: Kumud Majumdar

Renugopal writing accountancy records in 1985, in the MBU students' sitting room, where he used to sleep at the time

How are you spending your retired life?

After retirement, I visited my village and nearby temples. I now live in Tatanagar, Bengaluru, with my wife and daughter, and am engaged with a private organisation.

What would you have done if you had not got a job at the Institute?

Maybe my life would have taken a different direction if I had become a civil contractor. I might have built houses and buildings. My hands would have continued to hold the hammer and chisel, shaping walls. But joining the Institute changed that course. From the day I entered the Institute, the hammer was replaced by the keyboard, and the chisel by the mouse.

I wish to mention some of my unforgettable incidents, including visits to Gymkhana to listen to music, paying 5 paise per song chosen from the catalogue on the tape recorder. Those old cardboard boxes, discarded by the Department of Chemical Engineering, became my makeshift bed from 1981 to 1984. And the post box near the Main Building was the lifeline of communication between my father and the family. The kind staff of the Department of Physics often helped my father so that our reply by postcard reached him.

Initially, our stay was in the outhouse of the current preschool (Bungalow No 10), where Prof PS Narayanan was staying. I will never forget pulling the trolley along these roads, from one building to another, loaded with sand, gravel, mud, and cement for construction. Back then, I never imagined that one day I would be driving my own car on the very same roads.

My first home was a temporary shed, shared with the contractor's storage area for construction materials. It stood opposite what is now the library parking area, where the UG building (formerly the old Physics building) stands today. Whenever our little house became too cramped, I would find a place to sleep in the corridors of different campus buildings, alongside many construction workers. At the age of 14, from that humble home, I found joy in watching the bright glow of the JRD Tata Library's tube lights.

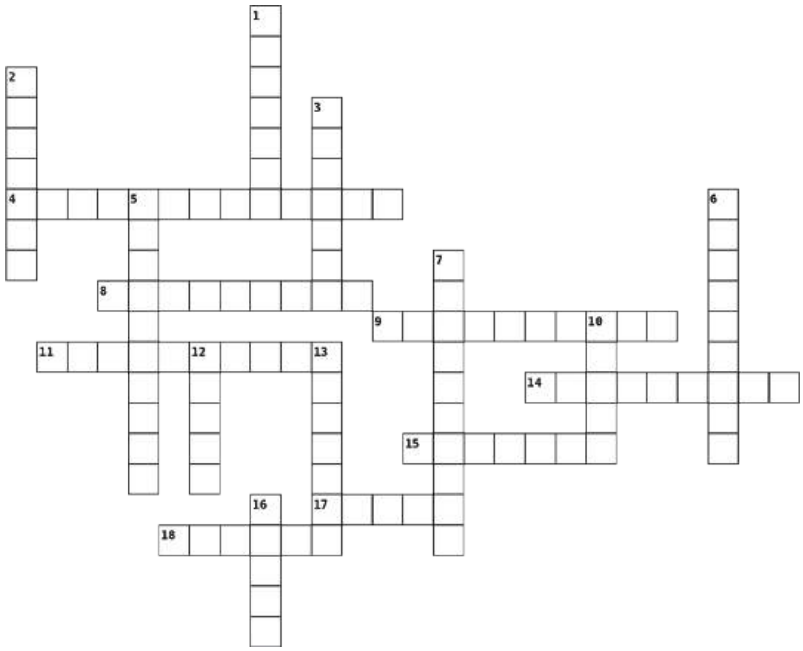
If I fail to remember the support received from the entire community of our Health Centre for my family during this period, it would mean forgetting one of the greatest acts of kindness we have ever experienced.

My journey from construction worker to superintendent was made possible by the support and recognition from the students, staff, and faculty of this Institute. There is a Tamil saying: "*Poovodu serndha naarum manakum*" (*Even the thread accompanying a flower will become fragrant*). I believe that joining IISc gave a lot of fragrance to my life.

(Edited by Kavi Bharathi R, Ranjini Raghunath)

Fun Corner

CONNECT CROSSWORD



ACROSS

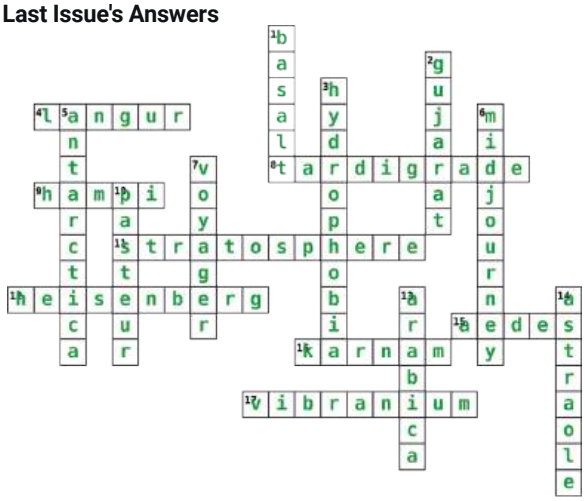
4. Artificially engineered materials with unusual electromagnetic properties
8. Poisonous plant that is fictionally depicted to repel werewolves
9. World's first antibiotic
11. Branch of science that studies low temperatures
14. Human body system that regulates hormones
15. Part of a whale for which it was hunted, used to produce oil
17. Bond formed by transfer of electrons
18. Main ingredient of most glass

DOWN

1. World's longest-running space mission
2. Nobel Prize-winning physicist who was also an artist
3. A polygon with ten sides
5. Bacterial species that hunt in packs
6. Primary chemical used in the time-of-death calculation
7. One of the blackest black materials in the world
10. Technology that uses lasers to map surfaces
12. Bird documentation app used by thousands worldwide
13. Country with thickest permafrost in the world
16. Snake that gives birth to live young

Send your completed puzzles to **connect.ooc@iisc.ac.in**
The top 3 winners will be announced in the next issue!

Last Issue's Answers



LAST ISSUE'S WINNERS!

1. **Arnab Nath**, Integrated PhD student, Department of Developmental Biology and Genetics
2. **Swapna Kunhiraman**, Study Coordinator, Department of Biochemistry
3. **Radhika M**, Assistant Project Engineer, Centre for Campus Management and Development

Life on Campus

By **Kadheeja Raseena**,
MTech Student, Department of Instrumentation and Applied Physics

CAMPUS CARTOONS


Abstracts | Abinaya Kalyanasundaram