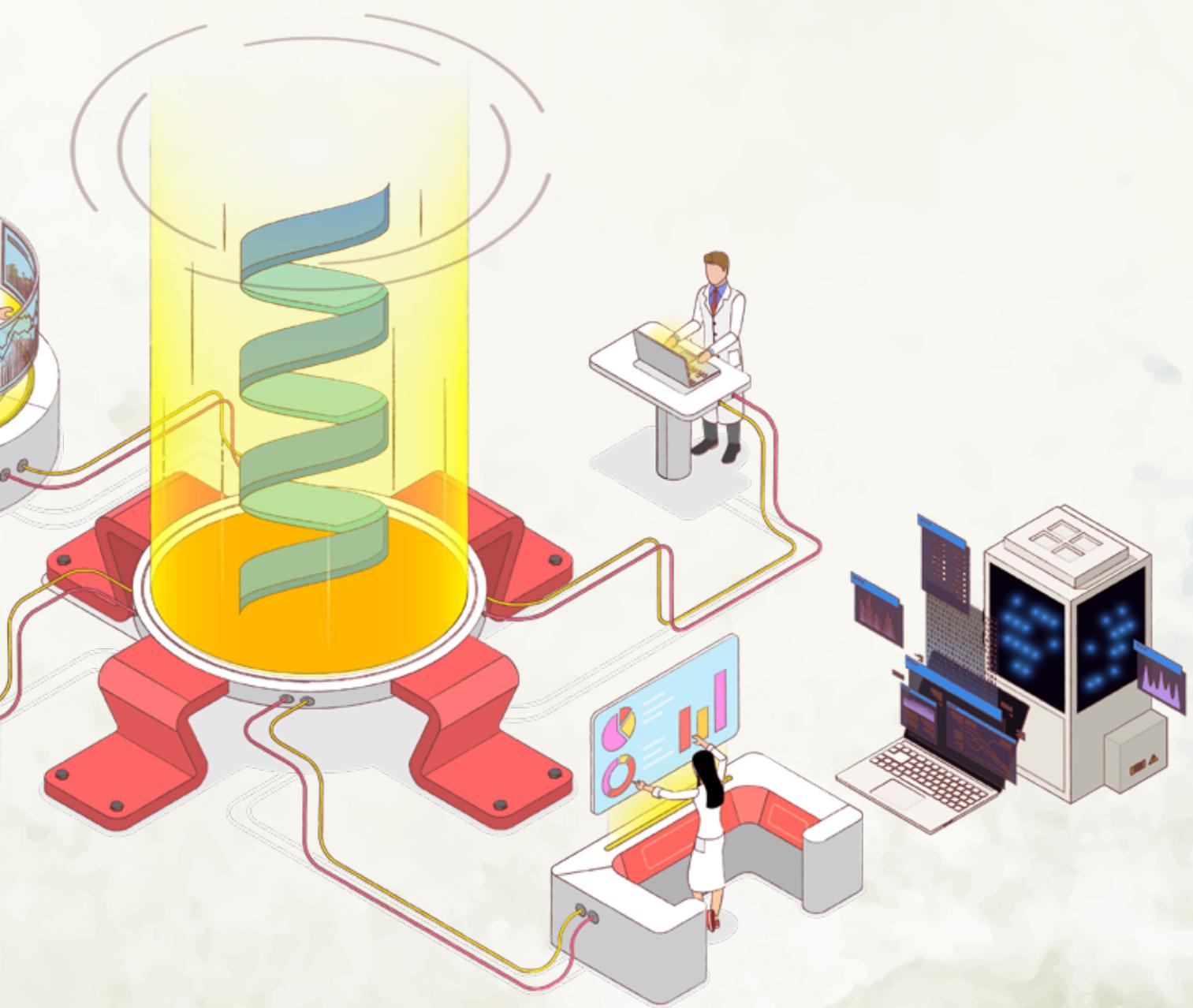




National Centre for Biological Sciences
Tata Institute of Fundamental Research

TRANSCRIPT

Of our research, people, and culture



July-September 2025 | ISSUE 03

Mapping the Hidden Architecture of Proteins with CAPS



Prof. R. Sowdhamini

For decades, **Prof. R. Sowdhamini**'s research at the National Centre for Biological Sciences (NCBS) has focused on a foundational problem in biology: how proteins are built, how they fold, and how they relate to one another across organisms.

Her group, the Computational Approaches to Protein Science (CAPS) lab, develops tools and databases that help researchers interpret protein sequences and connect them to structural and functional insights. This work stems from her early training, which combined chemistry, peptide design, and computing—an uncommon mix at the time but one that proved crucial for large-scale bioinformatics.

Prof. Sowdhamini's work started with structural analysis at a time when genome sequencing was still emerging, and protein engineering was a new concept. This led her towards computational design of disulphide bonds in proteins, studies of protein folds, and eventually onto predicting a protein's 3-D fold from its sequence alone. She recalls, "During my PhD, we created a database of 65 unrelated protein structures—a huge task back then—to understand how regularly certain folds, helices, and strands, occurred and combined. That analysis is what really got me interested in protein folds. I was working in

Prof. Tom Blundell's laboratory in the UK to study protein fold prediction and domains."

This curiosity shaped the founding of CAPS in 1998. One of its early contributions was the development of methods that use structural motifs—recurring geometric patterns—to detect distant similarities among proteins. Another was cascaded sequence searches, where each detected hit becomes the next query, allowing researchers to uncover deeper relationships between protein families and superfamilies. These approaches became essential building blocks for one of the group's major achievements: the GenDIS3 database.

GenDIS3 bridges the growing gap between the rapidly growing pool of protein sequences and the relatively smaller number of known 3-D structures. It performs a one-time exhaustive 'all-against-all' search between sequence and structural databases, using structural motifs, cascaded searches, and faster tools such as context-specific BLAST to execute what is now an enormous computational task. *"Each one-time search requires an enormous amount of storage and computing bandwidth,"* Prof. Sowdhamini notes. *"Our first run took three months nonstop, and now the same task takes six to nine months even with a twenty-fold increase in computing power due to ever-increasing numbers of protein sequences in databases."*

Since its inception, CAPS has pursued a wide range of computational biology projects in collaboration with institutions like Tata Institute of Fundamental Research (TIFR), Bharathidasan University, Université de La Réunion, Université Nantes, Indian Institute of Science, University of Agricultural Sciences (GKV), and MS Swaminathan Research Foundation. These collaborations enable the group to perform long-length detailed analysis on particular protein families.

For instance, back in the early 2000s, the group began by examining non-catalytic trypsin-type serine protease enzymes in *Drosophila*, showing that they function in early development and immunity. This work expanded into comparative studies of serine proteases in plants and later into prolyl oligopeptidases (POPs) across plant and bacterial genomes, and eventually, gut microbiomes. Using structural modelling and molecular dynamics, they recently explored if gluten intolerance could be addressed by inducing stable binding within the genome with POP bits.

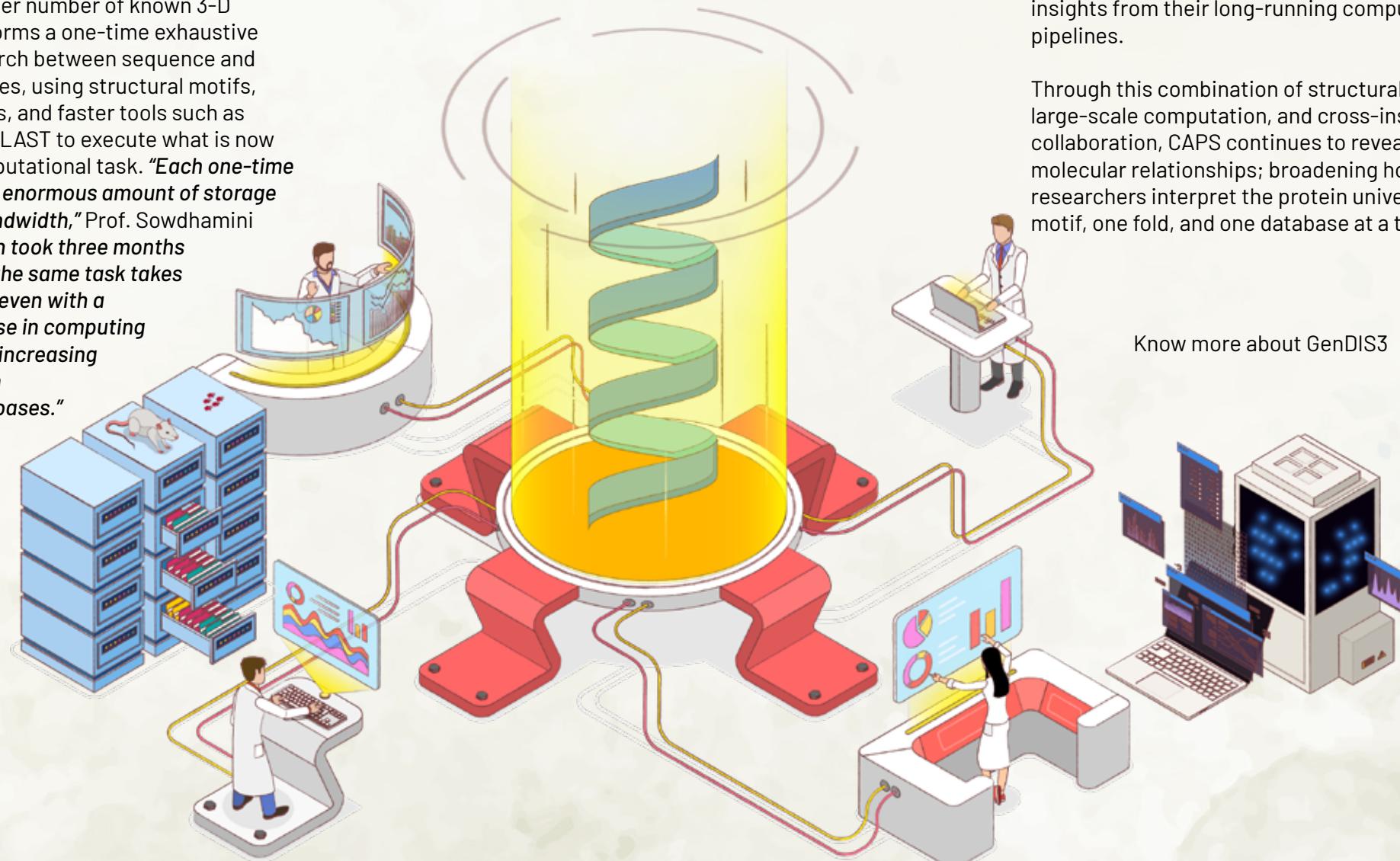
Parallelly, they worked on odorant binding proteins and olfactory receptors in rats and mosquitoes from a repellent perspective. Extending the work to honeybees (*Apis florea*), computational analysis revealed around 123 olfactory receptors (ORs) where previously fewer had been reported.

Studying plant stress, the group developed algorithms for detecting transcription-factor binding sites and built 3-D models of ion channels in stress-tolerant rice varieties. *"We were recognised as food heroes, but this led us to apply bioinformatics tools to medicinal plants, assembling their genomes or transcriptomes. This is now helping us appreciate the science of medicinal plants since these plants are rich in secondary metabolites,"* says Prof. Sowdhamini.

As the field moves deeper into the AI-driven AlphaFold era, her group plans to expand its use of structure prediction models to design experiments towards drug discovery and probe protein interactions more effectively. They aim to advance ongoing collaborations, explore secondary metabolites further, and build on insights from their long-running computational pipelines.

Through this combination of structural insight, large-scale computation, and cross-institutional collaboration, CAPS continues to reveal hidden molecular relationships; broadening how researchers interpret the protein universe, one motif, one fold, and one database at a time.

Know more about GenDIS3



Publication highlights

Red Foxes Assess and Adapt to Dog-Related Risks in the Trans-Himalaya



Herman Ramesh and colleagues studied how red foxes survive among free-ranging dogs in the Spiti Valley. Foxes showed increased vigilance in high dog-density areas, carefully timing their activity to avoid encounters. Surprisingly, fox populations were higher where dogs were abundant, likely due to food availability from human settlements, showing that foxes adapt behaviourally to coexist with competitors.

Read the full article here: <https://news.ncbs.res.in/research-explained/how-red-foxes-survive-among-free-ranging-dogs-indian-trans-himalaya>



Relocated Villages Provide New Habitats for Large Herbivores

Yashaswi Rao's study in the Satpura Tiger Reserve examined how large herbivores like sambar, chital, gaur, nilgai, and wild pigs use areas converted into grasslands after villages were relocated. The research found that over time, sambar, chital, and gaur increasingly utilised these sites, benefiting from reduced human disturbance. However, wild pigs showed a decline in usage, possibly due to their

adaptability to human-altered environments. While village relocations, complex for both people and wildlife, can enhance habitats for certain wildlife, the outcomes vary across species.

Read the full article here: <https://news.ncbs.res.in/research-explained/village-relocations-redraw-wildlife-map>



Ecological Factors Determine the Evolution of Antipredator Strategies



Dr. Krushnamegh Kunte's team, as part of a global study found that the effectiveness of animal defence strategies, like camouflage or warning coloration, depends on ecological factors such as predator competition and habitat brightness. They found that in areas with high predation pressure, camouflage is more effective, while in brighter

environments, warning colours may be better. The results shed light on how animals' survival tactics evolve based on their surroundings and pressures.

Read the full article here: <https://news.ncbs.res.in/research-explained/ecological-factors-determine-evolution-antipredator-strategies-animals>



Social Status Influences Stress Responses

Prof. Sumantra Shona Chattarji's study found that social rank affects how rats respond to stress. Dominant rats showed resilience and no signs of backing down when facing an unstressed opponent, while subordinate rats exhibited increased stress responses and changes in brain structure. This research highlights the impact of social status on mental health.

Read the full article here: <https://news.ncbs.res.in/research-explained/social-status-shapes-how-we-handle-stress>



How Do Species Survive in Harsh Environments?

Dr. Deepa Agashe's research on red flour beetles revealed that populations with faster larval development and higher reproductive rates are more likely to adapt and survive in new, harsh environments. Female lifespans and reproduction speeds played an important role, with populations

declining initially, before bouncing back and recovering—called evolutionary rescue.

Read the full article here: <https://news.ncbs.res.in/research-explained/how-does-species-fight-extinction>



Parkinson's Disease Affects Cells Beyond the Brain

Prof. Gaiti Hasan's team has discovered that early-stage Parkinson's disease linked to the PLA2G6 gene mutation causes widespread cellular dysfunction. Using induced pluripotent stem cells (iPSCs) from patients, they observed impaired mitochondrial function, disrupted calcium metabolism, and altered energy production pathways in both brain and non-brain cells. Parkinson's is a multisystem disorder and these early cellular changes could potentially serve as biomarkers for early diagnosis.

Read the full article here: <https://news.ncbs.res.in/research-explained/cellular-changes-linked-parkinson%20%99s-disease-observed-cells-across-body>



No Blueprint? Organ-Building is a Mechanical and Molecular Process

Dr. Raj Ladher's team at NCBS studied how cells in the developing inner ear organize themselves to form functional organs without a pre-existing blueprint. They discovered that specific proteins, like myosin II, create mechanical tension at cell junctions, guiding cells into precise positions and orientations. This process ensures the cochlea's structure is correctly formed, which is crucial for proper hearing function.

Read the full article here: <https://news.ncbs.res.in/research-explained/how-do-cells-build-organs-without-blueprint>



Unveiling the Origins of a Key Enzyme in Multicellularity

Prof. Raghu Padinjat and Prof. R. Sowdhamini's team at NCBS discovered that the enzyme phosphatidylinositol 5-phosphate 4-kinase (PIP4K), which regulates growth and insulin metabolism, is found exclusively in multicellular organisms. Their research traced the enzyme's evolutionary history, revealing its presence in early metazoans like sponges and choanoflagellates, suggesting that PIP4K played a crucial role in the evolution of multicellularity.

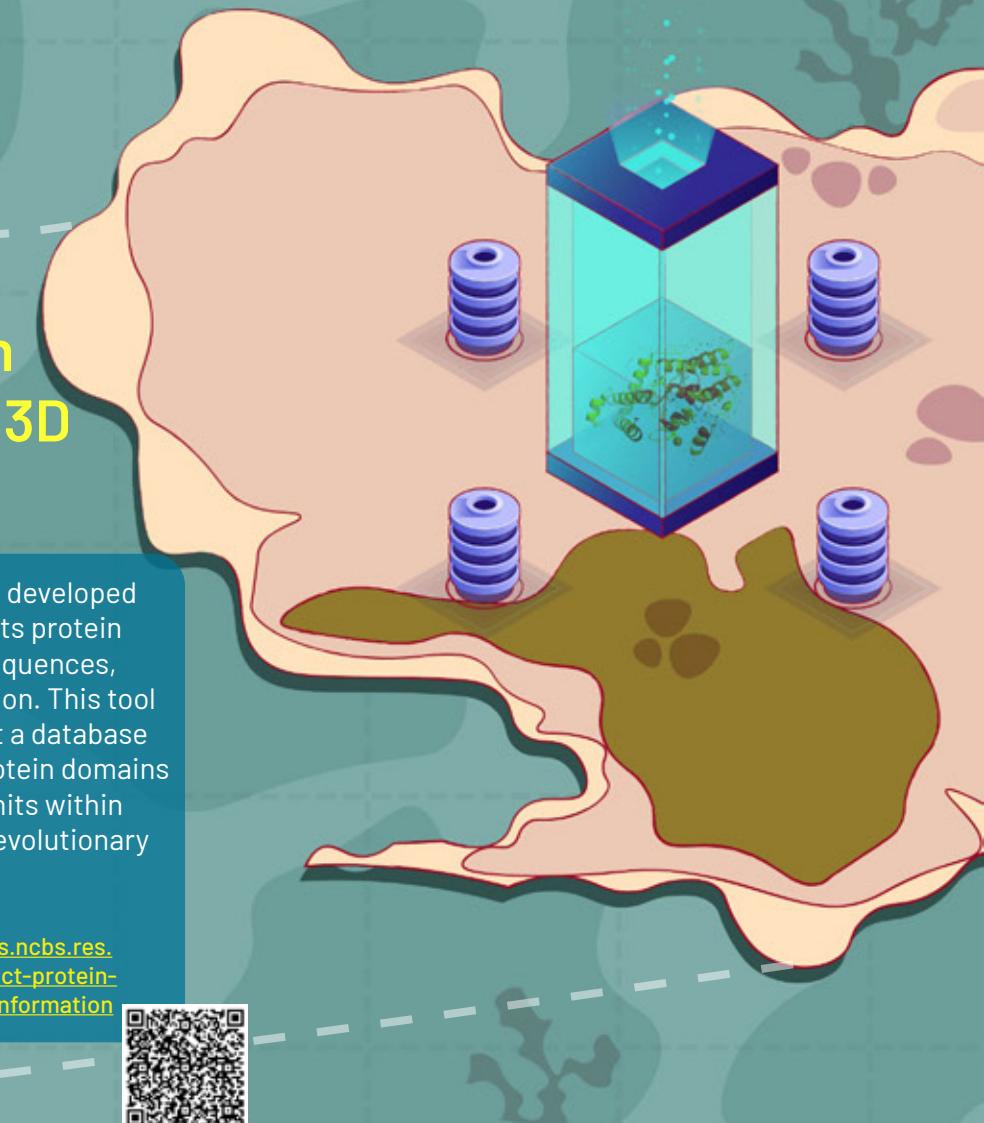
Read the full article here: <https://news.ncbs.res.in/research-explained/tracing-origins-key-enzyme-multicellularity>



Predicting Protein Function Without 3D Structures

Prof. R. Sowdhamini's team at NCBS developed the GenDiS3 database, which predicts protein functions by analysing conserved sequences, even without 3D structural information. This tool compares unknown proteins against a database of known and well-characterised protein domains (distinct structural and functional units within proteins), helping detect even faint evolutionary traits between matched proteins.

Read the full article here: <https://news.ncbs.res.in/research-explained/new-database-predict-protein-function-without-complete-3d-structural-information>



The RDO: Strengthening Research through Funding, Collaboration, and Strategy

When the Bangalore Life Sciences Cluster (BLiSC) came together in 2009, bringing National Centre for Biological Sciences (NCBS), the Institute for Stem Cell Science and Regenerative Medicine (inStem), and the Centre for Cellular and Molecular Platforms (C-CAMP) under one umbrella, it was clear that a shared research ecosystem would need an integrated support structure.

The Research Development Office (RDO) was born from that vision in 2010, designed to be more than a grants office: a central hub to enable collaboration, global communication, strategic growth, and diversify funding sources for the cluster.

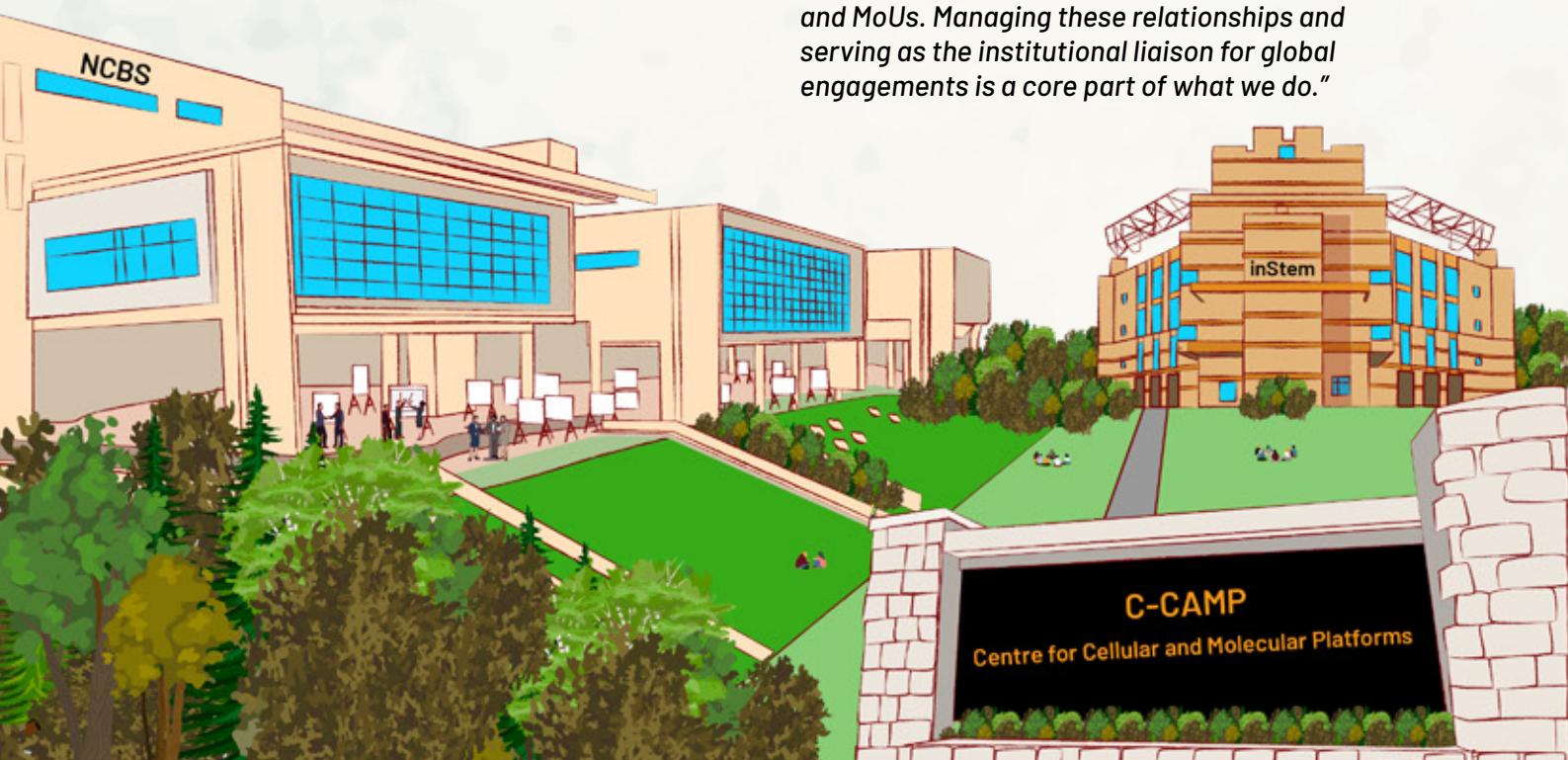
The many facets of the RDO

The RDO was conceptualised by Prof. K. VijayRaghavan and Prof. Satyajit Mayor, and its founding head, Dr. Savita Ayyar, helped shape its early systems for research management and institutional coordination. Under Dr. Savita Ayyar's and then Dr. Vineetha Raghavan's leadership, the RDO evolved from focusing solely on grants to a multidisciplinary office supporting

research and program management, global research partnerships, communications, and helping other institutions set up similar units. Today, led by Dr. Malini S. Pillai, and strengthened by the vision and steady support of the current Director, Prof. L. S. Shashidhara, and the Dean of Research, Prof. Vatsala Thirumalai, the office stands as a core institutional pillar within NCBS supporting researchers through all stages of their work.

The office's mandate is both operational and strategic. It coordinates grant applications and proposals, oversees collaborative agreements, manages reporting and compliance, and liaises with national and international partners. Within NCBS, it works closely with the academic, accounts, and administrative offices to align research activities with institutional goals. Externally, the RDO builds partnerships with research institutions, funding agencies, and industry collaborators within India and abroad.

Dr. Pillai adds, *"We also engage with international partners and embassies, often hosting delegations (in collaboration with our Meetings Office), identifying areas of synergy, and facilitating collaborations through agreements and MoUs. Managing these relationships and serving as the institutional liaison for global engagements is a core part of what we do."*



15 Rewarding Years, and More to Come

Over fifteen years, the RDO's impact can be seen in the infrastructure, networks, and professional practices that shape research at NCBS today. It has helped establish major shared institutional facilities such as the National Electron Cryo-Microscopy Facility (cryoEM) and the National Mouse Genome Engineering Facility, both of which now serve as national resources. It has contributed towards and coordinated large, multi-institutional programmes and has supported the establishment of joint post-doctoral programmes with several institutions such as the University of Cambridge, Imperial College London, etc.

The RDO also contributes to strengthening the capacity for the scientific administration community beyond NCBS. *"We have mentored other institutions in establishing their own research development or grants offices. We are quite proud of our involvement in helping build this community, and giving back at a national level"*, adds Dr. Pillai.

Within the campus, the RDO's coordination has improved processes for postdoctoral funding, travel and training awards, and communication between research groups. Through collaborations with funders, it supports outreach, education, funding workshops, grant writing courses, and capacity-building efforts that connect NCBS science to broader audiences and communities.



Adds Dr. Pillai, *"The HUL Women in STEM Fellowship is a doctoral programme we recently facilitated through CSR funding from Hindustan Unilever Ltd."*

Looking ahead, the RDO aims to deepen its focus on measuring research impact, moving beyond counting publications to assessing the societal, educational, and technological outcomes of research. Says Dr. Pillai, *"This effort will help provide a clearer picture of how science transforms lives and knowledge, and guide the future direction of research at NCBS."* Diversifying funding by obtaining and integrating funding from CSR and private philanthropies, as well as International funding sources, for research is another future goal.

From its pioneering start focusing on grant and research management, to its role today as a facilitator, collaborator, and mentor, the RDO continues to evolve in the core capacity of supporting research, with a future-facing vision.

Event Highlights

Physics of Life: Celebrating Madan @65

A one-day meeting at NCBS brought together colleagues, collaborators, and former trainees of Prof. Madan Rao to celebrate his 65th birthday and his pioneering work in active matter and the physics of living systems. The scientific talks and personal recollections shared throughout the day highlighted his profound impact on both the field and the many researchers he has mentored over the years.



Navigating Inclusive Publishing and Editorial Careers with Nature Portfolio

Dr. Snigdha Tiwari, Senior Editor at *Scientific Reports*, delivered an insightful session on inclusive publishing within the Springer Nature ecosystem. She highlighted the journal's focus on methodological rigor, reproducibility, and the value of incremental, interdisciplinary, and negative results in reducing publication bias. The talk also introduced editorial career pathways and offered practical guidance for early-career researchers on aligning submissions with journal scope, writing strong manuscripts, and navigating peer review.



The Trial of Abdus Salam at NCBS

"The Trial of Abdus Salam", a play based on the 1979 Nobel-prize winning theoretical physicist, was staged at Dasher Auditorium, NCBS. Supported by the Rohini Nilekani Centre for Brain and Mind, the play offered glimpses into the final days of the life and contributions of the Nobel laureate.



Orientation Program for the GS 2025 Batch of PhD & Integrated PhD Students



An Orientation Program for the GS 2025 batch of PhD and Integrated PhD students was organised by the NCBS Academic Office on 1st–9th August 2025.

Several speakers, including Dr. Dimple Notani, Prof. L. S. Shashidhara, Dr. Rakesh Mishra, and Prof. R. Sowdhamini addressed the students, emphasising the importance of science and research, working for societal impact, and the legacy of the BLiSC campus.

8th Hands-on Workshop on "Integrated OMICS" (Genomics, Proteomics, and Bioinformatics)

Held on July 14th–18th, 2025, this workshop at NCBS and inStem provided participants with practical training in integrated omics technologies. The program covered various aspects of genomics, proteomics, and bioinformatics, equipping researchers with the skills necessary to analyse complex biological data. The workshop featured lectures, hands-on sessions, and discussions led by experts in the field.



Workshop on Managing Large Collaborative Research Projects – Level II



The advanced two-day workshop brought together researchers and project managers to explore advanced strategies for managing multi-institutional research collaborations. Organised by the NCBS R&D Office, the workshop offered

lectures and hands-on activities covering project governance, collaborations, resource allocation, financial management, effective communication at the policy level, and risk assessment in large-scale research environments.

NCBS Open Day

NCBS hosted its annual Open Day on September 12th, 2025 with the theme "Biology Across Scales." Open to all, the event featured interactive exhibits, laboratory tours, and presentations, providing visitors with insights into the diverse research conducted at NCBS. The Open Day served as an opportunity for the public to engage with scientists and learn about the latest advancements in biological research.



Multiscale Modeling with MOOSE

25–26 September 2025 at CHINTA, TCG CREST, Kolkata

We invite applications from undergraduate, masters, and PhD students and postdoctoral researchers interested in Neuroscience to join a hands-on workshop on neuronal modeling.

This workshop will introduce participants to modeling across multiple scales, from biochemical pathways to large biological neural networks using MOOSE, the Multiscale Object Oriented Simulation Environment.

Up to 20 students will be selected for participation. All participants will be provided accommodation and partial reimbursement of travel expenses.

Organized by:

Subhasis Ray
CHINTA, TCG CREST
Kolkata

Upinder Singh Bhalla
NCBS, TIFR
Bangalore

Apply online at:
<https://mooseneuro.github.io/workshops>
Application deadline: 31 May 2025 11:59 PM IST
Queries: mooseneuro@gmail.com



Multiscale Modelling with MOOSE

MOOSE (Multiscale Object-Oriented Simulation Environment) is a neuro-simulation platform developed at NCBS to model neural systems across various scales. In collaboration with CHINTA, TCG CREST Kolkata, and the Kavli Foundation, Prof. Upinder Bhalla and Dr. Subhasis Ray organised a hands-on workshop on 25th–26th September 2025 at CHINTA, Kolkata. The workshop introduced participants to modelling across multiple scales, from biochemical pathways to large-scale neural networks.

Public Talk by Dr. Manu Prakash: Story of Frugal Science

Supported by The Murty Trust, this talk by Dr. Manu Prakash was held at NCBS. Dr. Prakash, known for his work on low-cost scientific instruments like the Foldscope (an origami microscope) and Paperfuge (hand-powered centrifuge), shared insights into the development and impact of frugal science and emphasised the importance of accessible and affordable scientific tools in addressing global challenges.



Accolades and Recognition

Prof. Uma Ramakrishnan elected as an Associate Member by EMBO

The European Molecular Biology Organisation (EMBO) has elected Prof. Uma Ramakrishnan as an Associate Member for 2025. Her research focuses on the population genomics of endangered species, including tigers, to understand genetic variation and its implications for conservation. This recognition acknowledges her significant contributions to molecular ecology and conservation science.

Read the full article here: <https://www.embo.org/press-releases/outstanding-life-scientists-elected-to-the-embo-membership/>



Prof. Sankaran awarded the J.C. Bose Grant by ANRF-India



Prof. Mahesh Sankaran was awarded the 2025 J.C. Bose Grant by the Anusandhan National Research Foundation (ANRF). This prestigious grant supports his project titled "Grasslands in the Anthropocene: Global Change Impacts on Grassland Dynamics in the Indian Subcontinent," which aims to investigate how climate change and human activities are influencing grassland ecosystems in India.

Read the full article here: <https://news.ncbs.res.in/spotlight/prof-mahesh-sankaran-awarded-2025-jc-bose-grant>



Fellowships

Five students have secured the prestigious National Post Doctoral Fellowship (N-PDF) by the Anusandhan National Research Foundation (ANRF), India. This fellowship supports their outstanding and innovative work in their chosen fields.



Dr. Mousumi B.

Dr. Pratik Kumar's lab

This fellowship supports her innovative work in chemical biology, aiming to develop a chemical toolkit for organelle-specific manipulation of cellular processes.



Dr. Avijeet Kulshrestha

Prof. Shachi S. Gosavi's lab

This fellowship will support his work on developing novel computational approaches to simulate viral protein-driven membrane fusion.



Dr. Pallavi Sabharwal

Prof. Vinothkumar Kutti Ragunath's lab

The fellowship will support her investigation of the molecular mechanisms by which the membrane enzyme MprF contributes to antimicrobial resistance in pathogenic bacteria.



Dr. Satheeswaran B.

Prof. Vatsala Thirumalai's lab



Dr. Aanchal Panchal

Prof. Sanjay P. Sane's lab

Collaborations

Gender In/Of Science: Feminist Conversations

Conceptualised by Prof. Gita Chadha, Professor at Azim Premji University, and previously Honorary Senior Fellow at the NCBS Archives and Obaid Siddiqi Chair 2023-24, this seven-part podcast series turns a critical lens on masculinity within scientific spaces. Through conversations with six male NCBS faculty members, it examines how the "man of science" identity has been shaped by notions of objectivity, detachment, and authority, and asks whether these separations from emotion, politics, and aesthetics are necessary. The series, dedicated to Prof. Obaid Siddiqi, invites reflection on how gender and power operate within the culture of science, and what shapes these identities and dynamics.



Special mentions

Rare Black Tiger from India on National Geographic Cover



A striking photograph of a rare black—or pseudo-melanistic—tiger from Similipal National Park, Odisha, has become the iconic cover of National Geographic Magazine. The image, captured by wildlife photographer Prasenjeet Yadav highlights the work of evolutionary ecologist Prof. Uma Ramakrishnan and her team at NCBS, who have studied Similipal's tigers to uncover the genetic

basis of their distinctive dark appearance. Their research revealed that a single mutation linked to inbreeding gives rise to the tiger's unique pattern, explaining how half of Similipal's tiger population shows pseudo-melanism, further highlighting the importance of genetic studies in conservation efforts.



