ncbs

National Centre for Biological Sciences
Tata Institute of Fundamental Research

ANNUAL REPORT 2022–2023

NATIONAL CENTRE FOR BIOLOGICAL SCIENCES

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Centre Director's Note

LS Shashidhara
Centre Director, NCBS

It is my pleasure and honour to present you the annual report of NCBS-TIFR for the year 2022-23. The year started with multiple big announcements, the first of such kind in the history of NCBS. One, a donation of Rs 100 crore from Rohini Nilekani Philanthropies to set up a Centre for Brain and Mind jointly by NCBS and NIMHANS. The Center seeks to develop novel approaches to the diagnosis and clinical management of several neuropsychiatric disorders. It will use state-of-the-art research to drive discovery in brain science and work actively to apply the outcomes to the care of patients with mental illness. Two, setting up of a new field station in Coorg in Karnataka to take up long-term projects such as the impact of climate change on ecological balance. Three, setting up of an international laboratory "Self-organisation and Control in Biological Systems: from molecules to cells and tissues" (SCALES) funded by CNRS, France. This International Research Laboratory will nurture research in a collaborative spirit within a consortium of 26 research groups, 11 NCBS faculty and 15 faculty of Turing Center for Living Systems (CENTURI) in Marseille, France. Four, financial support and mentorship from Arcadia to further strengthen Archives@NCBS – specifically focused on the Contemporary History of Science in India.

All the above milestones are due to the immense effort of Satyajit Mayor (Jitu), the former Director of NCBS, who stepped down in February 2023 and I had the privilege to succeed him. In his 10 years as Director of NCBS, Jitu took NCBS to new heights. Under his leadership, NCBS has become a place of high performance. This is evident by the recognitions received by its faculty in just one year. Uma Ramakrishnan and Upinder Bhalla were awarded the Kalpana Chawla and Sir M. Visvesvaraya awards, respectively, by the Karnataka State Council for Science and Technology. Two of our faculty (Sandeep Krishna and PV Shivaprasad) were selected as Fellows of Indian National Science Academy this year, Mukund Thattai was awarded the Infosys Prize 2023 in Physical Sciences. Three of our faculty are selected for the highly competitive DBT India-Wellcome Trust Alliance Senior Fellowship. While Uma Ramakrishnan had her fellowship renewed (a rare distinction), Dimple Notani and Hiyaa Ghosh were selected for the Senior Fellowship for the first time. Satyajit Mayor is awarded the most prestigious Philip Leverhulme International Professorship. Uma Ramakrishnan was awarded the 2023 Molecular Ecology Prize by Molecular Ecology Journal, while Vatsala Thirumalai was awarded the ACTECH Distinguished Alumni Award, 2023 by ACTECH, Chennai. We also have two INSPIRE faculty awardees amongst us this year. Arjun Srivathsa and Mahi Bansal.

While the Covid-19 pandemic is not safely behind us, thanks to the scientific community, which quickly developed and deployed effective and safe vaccines, NCBS continues to actively participate in monitoring the dynamics of SARS-CoV-2. Capitalising on the momentum built during Covid-19 on public health research and strategies, NCBS is an active member of a large consortium – APSI- in developing processes, low-cost tools and analytical techniques for environmental surveillance for several viral and bacterial pathogens. The outcome of this project is expected to develop ways to make the country well-prepared and ever-vigilant to deal with any disease outbreaks and prevent the next pandemic. The year ended with the Bill & Melinda Gates Foundation choosing NCBS as a lead institute to put together a multi-institutional multi-city consortium to carry out a One-Health project.

NCBS's commitment to addressing concerns of climate and environment, conserving biodiversity and wildlife, science outreach and popularisation, and promoting scientific temperament is only strengthening with time. We have further strengthened meetings, science communication and outreach office by inducting three young, but highly qualified people: Vaishnavi Sridhar, Ipsita Herlekar and Rupsy Khurana. Among the major events are a series of events and a film festival by Bengaluru Sustainability Forum, which is anchored at NCBS and funded by Wipro Foundation. Another milestone this year is the opening of the new campus of Science Gallery Bengaluru, which was until recently housed at NCBS. The Gallery has already started many activities and soon a multi-media exhibition on Carbon. Dr Jahanvi Phalkey, Director of the Gallery is awarded this year's Infosys Prize 2023 in Humanities, another pride moment for us this year. Indiabioscience, which is anchored at and managed by NCBS, is growing stronger and has a change in leadership with Karishma Kaushik taking over as Executive Director from Shantala Haridas. IndiaBioscience is back to organising in-person mentorship workshops, in addition to conducting several online activities as part of its community building and network programs. Acquiring covetous and immensely valuable MS Swaminathan and Coleman papers is the highlight of this year for our Archives@NCBS. Gita Chadha has joined as this year's Obaid Siddiqi Chair. Gita has initiated productive discussions about feminist and more marginalized perspectives in the Sciences and will enrich our archives in these domains. The previous Chair, GN Devy gave courses and conducted formal and informal discussions on "What is Science" on topics like who we are and how we have evolved through the millennia as a people of many origins, languages, world-views and cultural identities.

To connect Science@NCBS to the larger society, we signed MoUs with major Forest Research and Education institutions in the country for long-term collaborations. We have already begun conducting joint courses and workshops on conservation science for forest officers and in the coming months our partnership will expand to joint research projects. We are also an active partner of a couple of large consortia of clinicians and researchers of Bengaluru city to innovate on diagnostics/prognostics and therapeutics to reduce the burden of infectious diseases, cancer and rare genetic disorders.

NCBS is a member of the Bangalore Life Science Cluster (BLiSC). The other member institutions of BLiSC include Institute of Stem Cell Science and Regenerative Medicine (inStem; established in 2009), an autonomous body under the Department of Biotechnology, Government of India; The Centre for Cellular and Molecular Platforms (C-CAMP; established in 2009), a for non-profit initiative of the Department of Biotechnology, Government of India and Tata Institute of Genetics and Society (TIGS; established in 2017) a for non-profit initiative of Tata Trusts. BLiSC represents the best of fundamental and translational research with an excellent ecosystem for innovation and entrepreneurship. With time, BLiSC is further strengthened with our commitment to work together as one campus sharing all facilities and bringing benefits of collective expertise and resources to all members.

All our recognitions and accomplishments are due to the excellent work of faculty, students and other research scholars, well supported by our colleagues in technical, engineering, administrative and finance & accounts sections. The commitment of our staff working long hours and serving beyond the call of duty has enabled us to reach where we are today. I am confident that we will continue to excel in all our endeavours with the help of such dedicated colleagues.

It is difficult to cover highlights of all publications from NCBS in the year 2023. Each research outcome/publication from NCBS is unique and significant. Purely as examples, a few are listed here. Discovery of a novel molecular motor involved in membrane trafficking by Shashi Thutupalli's group, which was published in Nature Physics (an indication of the interdisciplinarity of his research); demonstration of benefits of redundancy in tRNA pool when nutrients are plentiful, while it is expensive under conditions of nutrient limitation by Deepa Agashe's group; developing a new method of Quantitative fluorescence emission anisotropy microscopy for homo-fluorescence resonance energy transfer measurements in living cells by Satyajit Mayor's group; unravelling the mechanism of regulated calcium entry into neuronal cells, which has implications to understand calcium imbalance in neurons in patients with certain brain disorders by Gaiti Hasan and her colleagues; discovering how certain plant viruses subvert defence mechanism of the host and cause necrosis by Shivaprasad's group etc.

While S&T community is facing far too many changes in administration and finance rules/procedures in the past few years, I am confident that NCBS will continue to excel and (i) contribute new knowledge to the world, (ii) develop/ adopt new technology platforms (experimental/computational) to accelerate discovery, and (ii) catalyses mission-mode projects in fundamental science connected to climate change, food, nutrition, health, environment and biodiversity.

NCBS Awards 2022-2023

INTERNATIONAL AWARDS

- **Prof. Vinothkumar K. R.,** EMBO Global Investigator, Dec 2022.
- **Prof. Uma Ramakrishnan,** Molecular Ecology Prize by Molecular Ecology Journal, May 2023.
- **Prof. Mukund Thattai,** Infosys Prize in Physical Sciences, 2023.
- **Prof. Satyajit Mayor,** Philip Leverhulme International Professorship, 2023.

NATIONAL AWARDS

- **Prof. Upinder S. Bhalla,** Sir M. Visvesvaraya Senior Scientist State Award for 2021, March 2023.
- **Prof. Uma Ramakrishnan,** Dr. Kalpana Chawla Young Women Scientist Award for 2021, March 2023.
- **Prof. Uma Ramakrishnan,** Senior Fellowship, Wellcome Trust – India Alliance (renewal), Sept 2023.
- **Prof. Hiyaa Ghosh,** Senior Fellowship, Wellcome Trust – India Alliance, Sept 2023.
- **Prof. Sandeep Krishna,** elected fellow, Indian National Science Academy, Sept 2023.
- **Prof. P.V. Shivaprasad,** elected fellow, Indian National Science Academy, Sept 2023.
- **Dr. Arjun Srivathsa,** elected Associate Member, Indian National Science Academy,Sept 2023.
- **Prof. Vatsala Thirumalai,** ACTECH Distinguished Alumni Award, 2023 by ACTECH, Chennai.
- **Prof. Dimple Notani,** Senior Fellowship, Wellcome Trust – India Alliance, Jan 2024.
- **Prof. Sandeep Krishna,** elected fellow, Indian Academy of Science, Jan 2024.
- **Prof. P.V. Shivaprasad,** elected fellow, Indian Academy of Science, Jan 2024.
- **Prof. Mukund Thattai,** elected fellow, Indian Academy of Science, Jan 2024.

Diversity on Campus

Raj Ladher
Dean, Academics

The graduate student interviews are among the most enjoyable events on the NCBS calendar. Faculty spend four days interviewing around 400 candidates. We ask questions that will allow the students to shine, allowing us to see their best side. Once the interviews are over, all faculty discuss the candidates that we have met. We pour over the records of their interviews, look at what they have achieved in their academic record, and search for that certain something that distinguishes them. That something is not necessarily how well they may have plotted a graph, how eloquently they were able to tell us how they would count the number of fish in a pond, or whether they were able to rebuild a phylogeny of birds based on beak morphology; that something is how they could transform us, while we transform them: the adage that student's learning teaches the teachers is particularly true in a graduate programme. Every offer made is made to a candidate that we see potential in. It is our job as supposedly experienced mentors to make sure that they realise their promise. The easy part is to help students learn how to do science. As well as subject-specific courses, the graduate programme has courses, such as our excellent synthesising literature course, and our research integrity course, that teach the fundamentals of research methodology, giving students an understanding of how science should be done. Courses on science communication such as the critical thinking and writing for scientists course, give them insights on presenting their data to different audiences. The course given by the Obaid Siddiqi chair; last year by Prof GN Devy on the People of India, and this year from Prof Gita Chada on Modernity, Science and Gender provides students with the perspective of where the pursuit of science falls within society. These are our way of ensuring that our academic offerings match the potential of the students we bring in. As an academic programme, we can place signposts and milestones on the road that transforms a young researcher into a well-rounded scientist, and although this can be a tricky road, it is well-trodden, and there are other travellers on it. However, this is not the only journey our early career researchers are on; most students are also hacking their way through the jungle that is early adulthood. This journey is more singular, we ask ourselves if there are ways we can help. Perhaps. We have just established a student support cell, a way that we can increase the pastoral care that we provide for students. This group will set up workshops, seminars and one-on-one meetings that will provide means for students to understand who they are (wellness) and what they may want to do (career guidance). It is a privilege to be able to work with students at NCBS, to be able to watch their growth so that they become mature, well-rounded, and well-grounded individuals, that retain their enthusiasm, their dynamism and their passion for understanding the world around them.

NCBS as a Catalyst: Introduction

Origins of BLiSC
Origins of IndiaBioscience
Origins of Archives

NCBS as a Catalyst: Big, Bold and Unique

LS Shashidhara

What makes NCBS a unique institution? Many of you, like me, have watched NCBS from the outside for many years and have wondered, how do all these things happen there? If you have visited, you will know there is something in the air here, a sense of possibility. Through almost three decades, NCBS has facilitated institutions and spaces (like the Bangalore Life Science Cluster), collectives (like IndiaBioscience) and out-of-the-box efforts (like the NCBS Archives). These initiatives, like honey, attract others adventurous and forward-thinking at heart, amplifying a culture of freedom and boldness, the only true breeding ground for breakthroughs. In this years' annual report, we have put together some of these stories. We look forward to many more such efforts in the years to come.

Join us, and be a part of this journey.

NCBS AS A CATALYST

Origins of **Bangalore Life Science Cluster (BLiSC)**

Satyajit Mayor

The Genesis of the Bangalore Life Science Cluster (BLiSC)

To trace the genesis of the Bangalore Life Science Cluster, it may be necessary to rewind the clock to understand how the ground was being prepared for the creation of BLiSc.

As a young faculty at NCBS in its early years – and with a sense of the excitement of establishing a new Centre for Biological Science in Bangalore as a place to study Biology across all scales- it seemed like anything was possible. We had settled ourselves into a new state of the art building and a campus that was growing into a warm and welcoming space to do great science. Science at NCBS was beginning to gain both National and Global recognition. I recall being asked by Vijay if I would take on the role of the Dean in 2008 and while it took some time and persuasion, (it was going to be a distraction from the exciting science that I was involved in), I accepted this job. Soon I realized that we were embarking on a very different journey. In Obaid, we had had a visionary founder, and in Vijay a clever and generous leader. Vijay was ambitious, and able to steer a steady ship with a happy and motivated crew, even when uncharted waters lay ahead. Obaid cautioned against rapid growth lest we destroy the soul of the little bubble, a short distance from India, that we had created for Science at NCBS. But Vijay had very different ideas. In hindsight I could see Vijay was gunning for change. We had also initiated the building of the Phase II of our laboratory buildings, so spanking new, state-of-the-art space would be available in a few years.

Insert into this picture, Dr. MK Bhan, the dynamic and charismatic, Secretary of the DBT. Bhan was to be a perfect foil for Vijay's ambition.

2009 was an exciting time in biology. Induced pluripotent cells were just being discovered. The DBT enticed an ambitious Centre Director, and developmental biologist to build a new institute for Stem Cells abutting and feeding off the scientific depth offered by NCBS. This new institute of the DBT would be a translational activity and therefore required a different mode of engagement from the fundamental research focus of NCBS-TIFR. With the frequent visits of Jim Spudich who was responsible for the California Stem Cell Initiative at Stanford, the idea of an interdisciplinary research and translational platforms for Stem Cells was initiated, and inStem was born. The DBT and DAE signed a historic MoU to work together to help facilitate this effort in the form of a joint activity. Jyotsna Dhawan from CCMB and Ramaswamy Subramanium from Iowa University were recruited to help put this new institute into place. To facilitate the building up of core facilities that would be necessary for such an activity, and allow its access to the outside world, we envisaged a new structure that could fulfil this need. CCAMP was conceived as a project of NCBS and inStem, and very soon we had the DBT signing on to create a not-for profit unit on the newly identified inStem land that was located abutting NCBS where CCAMP would be built. Not only did CCAMP facilitate the access of Core facilities across the campus, it also saw itself

as an incubator for life science start-ups. Today CCAMP under Taslim's able leadership is India' go-to place for a young start-up.

By 2013, the stage was set, and motivation for setting up of a multi-institutional campus soon acquired a momentum of its own so that three different types of institutions with different paymasters and structures of governance could be brought to work together under the same umbrella. This umbrella was BLiSc, which was established in 2013, again seeded by another visionary device, the Cluster model, a legacy that Dr. Bhan left behind at the DBT as an accelerator for biological research and its translational consequences. BLiSc therefore became a funded program where its core elements received financial support from the DBT, providing the glue for collaborative activity amongst its constituent parts. Our campus was able to build the country's first Life Science Cluster and as a consequence, the National Facility for Cryo-EM was also established. In 2017, with the growing recognition of the excellent ecosystem for the life sciences and its translation, a new institute set up by the Tata Trust to address pressing societal problems using the new tools of genetics, approached us to see if we could partner with this entity. This brought in the Tata Institute for Genetics and Society (TIGS) and expanded the scope of our Cluster. Initially this began as a TIGS Centre at inStem, and today TIGS is a fully minted member of BLiSc.

It is not possible to name and acknowledge all of the wonderful people who have been involved in this incredible journey of building BLiSc, but I will name a few. Sahadevan helped immensely by physically moving the location of inStem from across the GKVK campus to its current location. I thank Upi Bhalla, without whom we would not have had the Southern Laboratory Complex in the functional form it is today; H. Krishnamurthy and Raghu Padinjat who created the template for the extraordinary Core facilities we have available (and growing) on the campus; Rengasamy, ex-Chief Engineer ISRO and Poornima, who were demanding project management and dedicated architect, respectively, ensured that all our buildings were according to our specifications, and Apurva Sarin, whose attention to detail ensured that the Cluster grant was operationalized and that the inStem building was eventually completed and occupied. And last but not the least, the late Mr. K.P. Pandian, who is credited with drafting the DBT-DAE MoUs and subsequently serving as Cluster Coordinator to ensure a smooth function of the cluster institutions.

K VijayRaghavan

The Bangalore Life Sciences Cluster 2034

With looking at the rear-view mirror, important and done well by Jitu, let us ask what the BLiSc should look like in 2034 and what should we do now to achieve that goal.

There are two ways for institutions to survive well for a long, long time. One is through preservation and pickling, and the other is through shedding, renewal and growth. We discarded that option by choosing growth. A 'deletion' test might tell us what we would be like if we did not have the SLC, the sports and dining facilities, housing and students, inStem, C-CAMP and TIGS. Well, we would likely have been a very small, perfectly formed, but nationally and globally borderline-irrelevant institute. We can do a gain-of-function test and ask what has been the consequence of what we have done. Well, we have a chaotic, difficult, but exciting enterprise. Teetering at times, but with the potential of dealing well with a very uncertain global future. Experimenting with a new recipe is risky but makes for a better meal than the certainty of a jar of perfect achar.

So, what then, does the future hold for BLiSc? We are now big, and strong enough, that we can and should take on impactful tasks and put in place internal systems for those willing and enthusiastic. We could speedily form the following national networks where BLiSc could be a hub or share that task with another institution.

One could create a centre for scenario modelling of ecosystems in the contexts of climate change and development. Disparate voices in this sector are active but there are few, if any, who also engage to assist policy makers with data and deep-dive analysis of consequences of decisions. Such a network centre should also raise resource for large-scale experiments on one side and develop in-house computational tools on the other.

The second centre could be a partnership centre with agricultural universities, plant sciences and industry in research on sustainable agriculture of the future. Reducing the use of water, pesticides and fertilisers and yet ensuring yield and nutrition is one of the biggest challenges of the next decade and combines fundamental research with application.

The third could be a centre for research in lifestyle disease, and healthy aging. This sounds like, and is, a big catch all term, like the previous two. But, the campus can show leadership in putting together a national team here, networking with hospitals and data scientists.

The fourth is a national network centre for computational and experimental brain research. Such a centre would generate and collect data on neurons, circuits and behaviour at all scales. This is an exciting area that can involve students and researchers from school to the top reproach labs.

I could go on. There are just placeholders and you can discard them and choose others and add more. More important, what is needed for each centre to take off? One leader from inside or who can be recruited, who develops the plan, in discussion with BLISc. Every aspect can be thoroughly but speedily discussed. The idea and vision is most important, followed by details of how to network nationally and internationally, raise resources, find space etc. If at least half the discussants strongly disagree with an idea, then it is worth pursuing (as Seymour Benzer famously said. BTW, this was the case with the Molecular Biology Unit, NCBS, the SLC inStem, C-CAMP and TIGS. Most people are conservative and love change as long as it does not happen in their house).

Fundamentally, we now can, and should, take on intellectually big challenges that are of broad value. We should do this without diluting, indeed by enhancing, the support for individual, curiosity driven, purpose-free 'useless' science. To paraphrase Mukund Thattai, the former is the well from which society draws, and the later are the streams that feed the well. BLiSc is both well and stream. The well can quench the world's thirst and the streams can renew the well.

NCBS AS A CATALYST

Origins of **IndiaBioscience**

By Ronald Vale, Director, Janelia Research Campus

2008: The seed

Mrinalini Puranik, Uma Ramakrishnan and Sandhya P. Koushika invited Ron Vale *(sabbatical professor at NCBS)* to dinner to discuss career and science advice. The success of early career faculty is critical for the overall success of Indian science.

2008: Sprouting of an idea

After the dinner, Ron tosses and turns during the night grappling with this question—how does one develop and spread a culture of support and mentoring for early career scientists through all institutions, across India? "Aahh Ha" moment—a national level meeting to bring together junior faculty throughout India, postdocs who might return to India to become faculty, outstanding Indian and International senior scientists, and key leaders from government, institutes, and universities.

2009: The idea turns into reality

The first Young Investigator Meeting in India was held in Trivandrum, organized by Mukund Thattai (NCBS), Sandhya Koushika (NCBS, now TIFR Mumbai), Ron Vale (UCSF). The meeting, and its unusual format of talks discussing scientific journeys, mentoring panels, open discussion, and focus on early career scientists, is a success!

2009: The sprouting of another idea – Website

The postdocs at the first YIM, say people in India and internationally would benefit from the valuable information exchanged at the meeting. A limited number of people can attend YIM once a year, so the idea of IndiaBioscience website emerges.
Website: https://indiabioscience.org

2010: IndiaBioscience.org

The initial web content is organized by Ron, Shubha Tole and Aurnab Ghose and the web infrastructure is built by NCBS. The web initiative launched in mid-2010 to disseminate information about the bioscience landscape of India, including blogs, videos from leaders in government, jobs, grant information, etc. The second YIM meeting is held near Kolkata, adding a satellite meeting for postdocs and institute directors.

2011-2012: IndiaBioscience launches as an organization

IndiaBioscience has become more than a website and now has employees whose mission is outreach and community building in the Indian life science community. Swetha Suresh and Athulaprabha Murthi are IndiaBioscience's first full-time employees. With Director Jitu Mayor's support, IndiaBioscience's office is on the NCBS campus and has begun applying for grant support.

2013-2016: 1st phase of funding

IndiaBioscience applies for and receives the first phase of funding from the Department of Biotechnology, Government of India.

2017: 2nd phase of funding

IndiaBioscience receives the second phase of funding from the Department of Biotechnology, Government of India.

2018: IndiaBioscience hosts the 10th annual YIM at Thiruvananthapuram.

Ideas for the Regional YIMs and IndiaBioscience Outreach Grants emerge at the 10th meeting.

2021-2022: The YIMs are held in virtual mode.

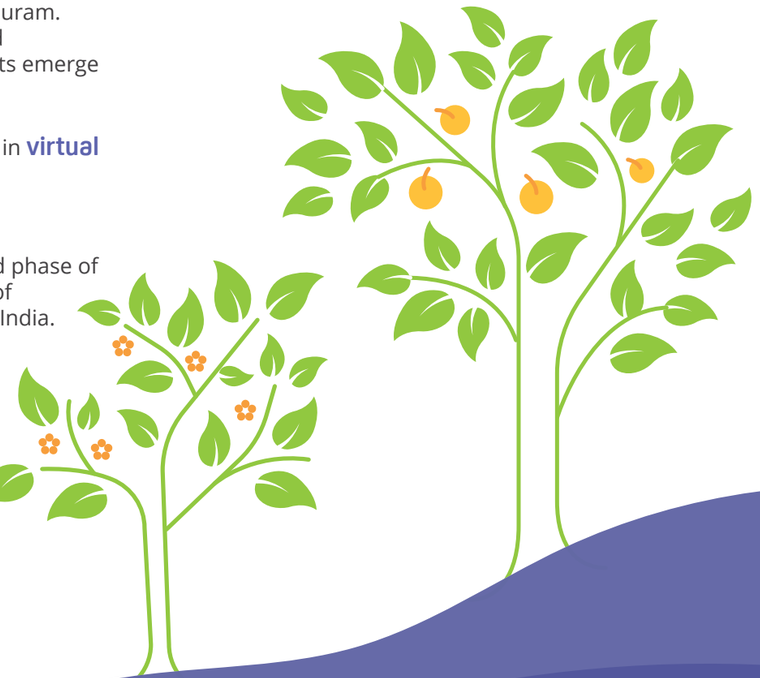
2022: 3rd phase of funding

IndiaBioscience enters the third phase of funding from the Department of Biotechnology, Government of India.

2023: YIM is now planning for its 16th annual meeting

Current team members:
Ankita Rathore, Arushi Batra, Karishma S Kaushik, Manjula Harikrishna, Rohini Karandikar, Shwetha C and Vijeta Raghuram.

Current board members:
LS Shashidhara, Rashna Bhandari, Ron Vale, Roop Mallik and Satyajit Mayor.



Verticals of IndiaBioscience

1. Networking & Mentorship
2. Skill Building
3. Science Communication
4. Digital Initiatives
5. Education
6. Community Building
7. Data & Policy

The IndiaBioscience website has **over 2000000 views per year** (2023), newsletters have **over 50000 subscribers**, and the program has an expanding and substantial **social media presence** (*Twitter, Facebook, LinkedIn, Instagram, YouTube).*

Key Reference:

IndiaBioscience: knitting together the life sciences community. N Ramakrishnan (2021)
https://indiabioscience.org/columns/indiabioscience-blog/indiabioscience-knitting-together-the-life-sciences-community

NCBS AS A CATALYST

Origins of NCBS Archives

By Satyajit Mayor

Preparing the ground

The science and society activity and the archival activity associated with this effort began in **early 2000's** with **Anna** and **Indira** and the TIFR Archives including efforts by **Aparna Uppaluri** who built one of the initial bridges for the archival effort from 2015-17.

Setting up Archives

Announcement by Director- NCBS, Satyajit Mayor, of the creation of an archive for science and history of science at NCBS.

May 2016

Recruitment of an archivist, **Venkat Srinivasan**

2017

The **engagement of interns** *(more than 70 now)* at Archives.

Initiation of Public Lecture Series

March 2018: Initiation of Public Lecture Series *(https://www.ncbs.res.in/events/apls)*
1st Public Lecture by **Seema Mundoli**
September 2022: 50th Public Lecture by **Ramchandra Guha**

February 2019

Establishment of the Archives in Obaid Siddiqui's lab space.
Archives opened to the public in 2019.

Obaid Siddiqi Chairs

The establishment of the **TNQ Chair** and expansion of activities associated with the Archives, Obaid Siddiqi Chairs.
Announcement of Obaid Siddiqi Chair in January 2021
MD Madhusudhan: August 2021-Jul 2022
GN Devy: October 2022 - September 2023
Gita Chadha: August 2023 - Jul 2024

December 2022

Archives receives **The Arcadia Grant** for "*Documenting the Contemporary History of Science in India*".

Major acquisitions at Archives

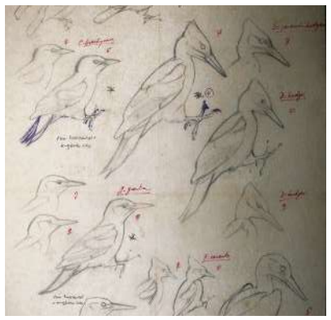
- Obaid Siddiqi
- KS Krishnan
- MS Swaminathan
- Leslie Coleman
- TSG Sastry
- BV Sreekantan

Archives as an open source

Archives is a partner with **Milli Archives Foundation** set up in 2023. Milli is an open access digital platform that Milli intends to build will allow the public to find, connect, describe and share archival material and stories. *https://milli.link/*

The Future

Archives as a space with four objectives: **collections, research, education, engagement.**



Our Research Interests

Biophysics, Biochemistry, and Bioinformatics

- Aswin Seshasayee
- R Sowdhamini
- Vinothkumar K R
- Ranabir Das
- Arati Ramesh
- Sabarinathan R
- Tapomoy Bhattacharjee

Genetics and Development

- K VijayRaghavan
- P V Shivaprasad
- Raj Ladher
- Dimple Notani
- Soumyashree Das
- Gaiti Hasan

Cellular Organisation and Signalling

- Satyajit Mayor
- Raghu Padinjat
- Varadharajan Sundaramurthy
- Anjana Badrinarayanan
- Swadhin Jana
- Amey Redkar

Theory, Simulation, and Modelling of Biological Systems

- Shachi Gosavi
- Mukund Thattai
- Sandeep Krishna
- Madan Rao
- Shashi Thutupalli
- Shruthi Viswanath
- Shaon Chakrabarti
- Archishman Raju

Neurobiology

- Upinder Bhalla
- Sanjay P Sane
- Sumantra Chattarji
- Vatsala Thirumalai
- Hiyaa Ghosh
- Abhishek Bhattacharya
- Sufyan Ashhad

Ecology and Evolution

- Mahesh Sankaran
- Uma Ramakrishnan
- Krushnamegh Kunte
- Deepa Agashe

1 Biophysics, Biochemistry, and Bioinformatics

Arati Ramesh

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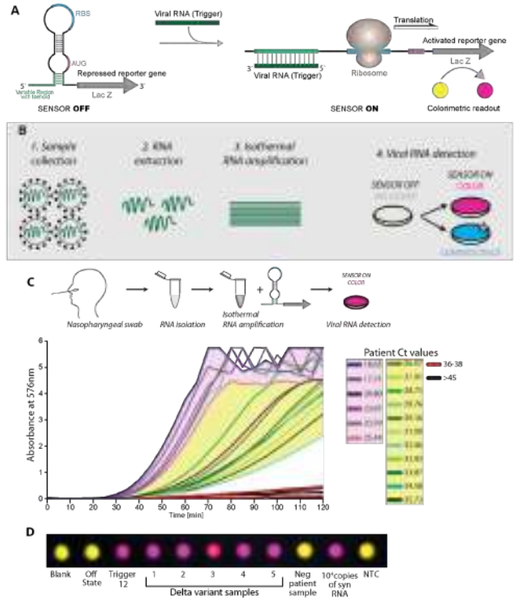
BIOPHYSICS, BIOCHEMISTRY, AND BIOINFORMATICS

Structure to Signalling: Insights into Biology through Natural and Engineered RNA Structures

We use biochemical/ structural approaches to investigate how RNAs create the chemical complexity for sensing metabolites/ proteins, how natural signal-sensing RNAs function, and how they may be exploited to develop RNA-based biosensors.

India faces challenges in the prevention/diagnostics/treatment of infectious diseases. We have established a robust pipeline for design and development of RNA-biosensors for ultrasensitive detection of infectious microbes including SARS-CoV-2 and Dengue viruses *(Figure).* Isothermal-amplification of a viral-RNA fragment coupled with activation of our biosensors leads to a conformational switch in the sensor, leading to translation of a reporter that is detected using color/luminescence. This assay is remarkably sensitive (attomolar RNA) and specific, producing a color easily visualized by the eye. Our RNA biosensors detect viral RNA in patients, are comparable with RT-qPCR tests, and are deployable in low-resource settings, making them potentially important for many parts of our country.

We are investigating mechanisms of RNA-mediated regulation that confer pesticide resistance in soil organisms. Organophosphate hydrolases (OPH), are enzymes from soil bacteria, that hydrolyze pesticides. Our findings establish a novel, multi-layered, iron-responsive regulation that occurs via structured RNA elements and is crucial for OPH expression. Our work implies links between the transport of siderophore-mediated iron uptake and pesticide break-down vi OPH.



A-B) Toehold RNA based biosensors are designed to specifically sense SARS-CoV-2 RNA. Coupled RNA amplification and biosensor detection results in attomolar sensitivity.
C-D) Sensors report on COVID (and the prominent DELTA variant) in patient nasopharyngeal samples, with easily detectable color.

PUBLICATIONS

- Anirudh Chakravarthy, Anirudh K N, Geen George, Shyamsundar Ranganathan, Nishan Shettigar, Suchitta U, Dasaradhi Palakodeti, Akash Gulyani, Arati Ramesh. “Engineered RNA sensors for ultrasensitive SARSCoV2 detection in a simple color or luminescence assay” Life Science Alliance. 2021 Sep; 4 (12) e202101213; DOI: 10.26508/lsa.202101213.
- Dolly Mehta and Arati Ramesh. “Diversity and prevalence of ANTAR RNAs across actinobacteria” BMC Microbiology. 21, 159 (2021). DOI: 10.1186/s12866-021-02234-x.

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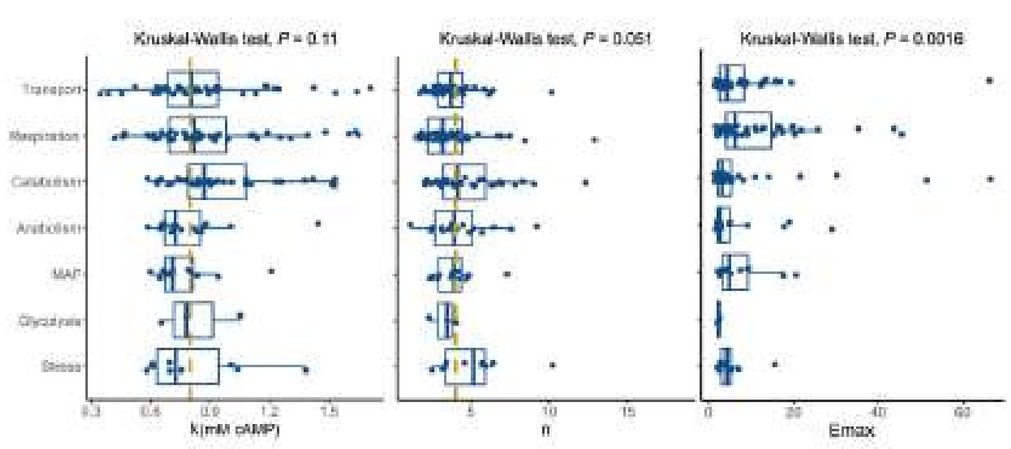
BIOPHYSICS, BIOCHEMISTRY, AND BIOINFORMATICS

Adaptation, the Bacterial Way!

Bacterial adaptation is multipronged. Not only do bacteria regulate what molecules are produced when, they also adapt by changing their genotype. We ask how these phenomena operate using computation.

Regulation of transcription is a critical component of bacterial adaptation to their environments. We are interested in the structure and evolution of these networks. An example is that mediated by the molecule cyclic AMP, which binds to a transcription regulatory protein CRP and affects the expression of hundreds of genes in the bacterium *E. coli.* Much work has gone into comparing gene expression states in the presence and absence of cAMP; however, cAMP levels in the cell are a continuum. We sought to investigate how the expression state of *E. coli* changes with changing concentration of cAMP using RNA-seq and by modelling the resulting data with the biochemical Hill’s equation. We showed that most genes regulated by cAMP are activated at a narrow range of cAMP concentrations. The affinity of the regulator CRP to the DNA does not imply a change at the cAMP level at which the target gene is activated, but instead the maximal expression level it reaches. We argue that biochemical / phenomenological models are a better alternative to standard clustering for analysing this kind of genome-scale gene expression data.



Distribution of Hill’s equation parameters - k, n and Emax - for various gene functions. This figure is from Chakraborty et al. 2023.

PUBLICATIONS

- Chakraborty S, Singh P, Seshasayee ASN. Understanding the Genome-Wide Transcription Response To Various cAMP Levels in Bacteria Using Phenomenological Models. mSystems. 2022 Dec 20;7(6):e0090022. doi: 10.1128/msystems.00900-22. Epub 2022 Nov 21. PMID: 36409084; PMCID: PMC9765429
- Malhotra N, Seshasayee ASN. Replication-Dependent Organization Constrains Positioning of Long DNA Repeats in Bacterial Genomes. Genome Biol Evol. 2022 Jul 2;14(7):evac102. doi: 10.1093/gbe/evac102. Erratum in: Genome Biol Evol. 2023 Jan 4;15(1): PMID: 35776426; PMCID: PMC9297083

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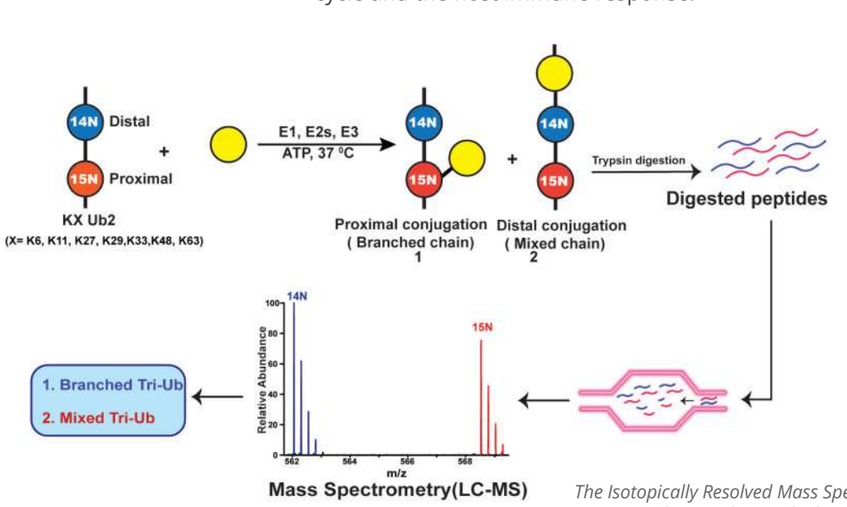
BIOPHYSICS, BIOCHEMISTRY, AND BIOINFORMATICS

Protein Modifications in Host-Pathogen Interactions

Protein post-translational modifications (PTM) regulate their function and lifetime. By careful analyses of the molecular interactions we study how PTM signaling is exploited to suppress the host immune response.

We study the role of PTMs in host-pathogen interactions. Our results provided the first structural insights into a collective action of Ubiquitination, SUMOylation, and phosphorylation that enhances the activity of the herpes simplex virus protein ICP0 to deplete the host immune responses *(Hembram et al. 2020).* Baculoviruses use a variant of ubiquitin, the central player in ubiquitin signaling, to produce unique ubiquitin chains on the substrate that the host cannot regulate *(Negi et al. 2020).*

We also investigate the role of ubiquitin signaling in interactions between hosts and bacteria. The enteric bacteria take advantage of the host's ubiquitin signaling to regulate the host's immune responses. Interestingly, the bacterial ubiquitin ligases produce branched ubiquitin chains on their host substrate. To decipher the mechanism of branched ubiquitin chains, we recently developed a new method based on isotopic labeling and mass spectrometry called Isotopically Resolved Mass Spectrometry of Peptides (IRMSP). Using this technique, it is feasible to monitor how and with what rate branched ubiquitin chains grow in different directions in a single experiment *(Singh et al, 2023).* We have begun to scratch the surface regarding the repertoire of PTM crosstalk in host-pathogen interactions. It is interesting to explore how they modulate the pathogen's life cycle and the host immune response.



The Isotopically Resolved Mass Spectrometry of Peptides (IRMSP) technique detects the branching point and distinguishes between mixed and branched heterotypic ubiquitin chains. Isotopically labeled ubiquitin chains are provided as substrate, and the branching point is detected by trypsin digestion followed by mass spectrometry.

PUBLICATIONS

- Singh G, Kumar S, Das R*, (2023), "Decoding the Assembly of Mixed and Branched Heterotypic Ubiquitin Chains," Analytical Chemistry, 95(26):10061-10067

HONORS AND AWARDS

- Fulbright-Nehru Professional Excellence Fellowship from the US-India Educational Foundation.

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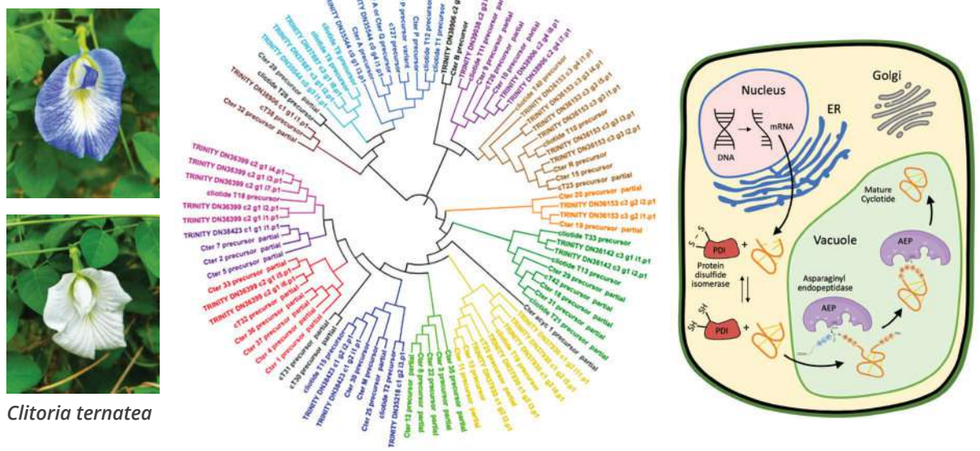
BIOPHYSICS, BIOCHEMISTRY, AND BIOINFORMATICS

Computational Approaches to Protein Science

We employ computational algorithms to enable efficient annotation of functions to unknown gene products. Our future projects are geared towards modelling protein/ligand interactions and plant genomics, aided collaborative ventures.

Genome sequencing projects have enormous potential to benefit human endeavours. However, just as acquiring a language's vocabulary does not enable one to speak it, databases that list the amino acid compositions of proteins do not directly tell us much about the higher-level structures and functions of these proteins. Proteins with very similar amino acid sequences are 'no-brainers', but the real test—is to detect the "essential" similarities in proteins whose non-critical sections have experienced random rearrangements during evolution.

Functionally similar proteins may have <25% sequence overlap. We seek to provide a structural rationale for disease-causing mutations. Explicit computational pipelines have been devised to recognise parts of the genome that retain genic regions and applied in DNA or RNA assemblies of select medicinal plants like the drumstick and Shankhapushpi. Finally, we have identified families of enzymes in herbal plant genomes to ascertain their roles in the biosynthesis of medicinally relevant secondary metabolites.



Transcriptome studies of different tissues of the herbal plant "Shankhapushpi" – work done in collaboration with Radhika Venkatesan (currently in IISER Kolkata) and P Balaram (Kalmankar et al., 2020). Flowers are shown to the left. Middle: Sequence-based phylogeny of around 70 disulphide-rich cyclotides secreted by the plant. Cyclotide sequences were identified by computational approaches. Different clusters are shown in different colours. Right: shows different enzymes which are involved in the biosynthesis of cyclotides. Sequence searches were performed within the transcriptome assembly for these enzymes as well.

PUBLICATIONS

- Tiwari, V., & Sowdhamini, R. (2023). Structural modelling and dynamics of full-length of TLR10 sheds light on possible modes of dimerization, ligand binding and mechanism of action. Current research in structural biology, 5, 100097. https://doi.org/10.1016/j.crstbi.2023.100097
- Pankaj Kumar Chauhan, Ramanathan Sowdhamini (2023) Transcriptome Data Analysis of Primary Cardiomyopathies Reveals Perturbations in Arachidonic Acid Metabolism. Front. Cardiovasc. Med., 10, 1-14. https://doi.org/10.3389/fcvm.2023.1110119.

HONORS AND AWARDS

- Professor Darshan Ranganathan Memorial Lecture Award (2022) from the Indian National Science Academy (INSA).

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BIOPHYSICS, BIOCHEMISTRY, AND BIOINFORMATICS

Deciphering Genetic and Molecular Alterations in Cancers

We are interested in understanding the genetic and molecular alterations responsible for cancer development and resistance to treatments, using computational and functional genomics approaches.

The specific research areas of interest are:

i) Understanding the impact of chromatin architecture on somatic mutational processes and gene regulation in cancer.

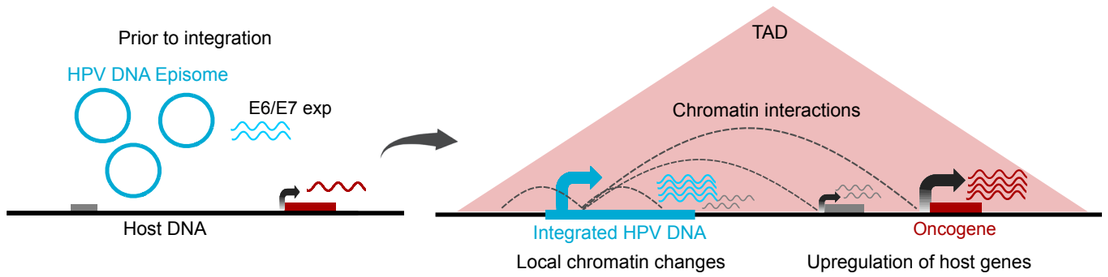
ii) Identification of cancer driver mutations and their mechanism of action.

iii) Understanding intra-tumoral heterogeneity and tumor-immune cell interactions.

Key findings from our recent studies:

i) We identified immunoproteasome *(a type of proteasome complex involved in the degradation of proteins to aid in antigen-presentation)* expression as a prognostic biomarker to predict overall survival and response to immune checkpoint blockade (ICB) therapies in multiple solid tumours such as skin-melanoma, non-small-cell lung, breast, bladder and thymus *(Kumar and Dhaka, 2023).*

ii) Integration of Human papillomavirus (HPV) in the nuclear genome is often detected in cervical cancers; however, the oncogene role of this integration is not yet fully understood. We identified that HPV integration affects host chromatin structure and gene expression both locally and long-range to drive the expression of oncogenes such as MYC/PVT1 *(Figure) (Singh et al., 2023).*



Model summarising the oncogenic role of HPV integration in cervical cancer. HPV integration can lead to local chromatin changes resulting in transcriptional upregulation of host genes (also in fusion with viral genes) in its vicinity. Moreover, it can mediate long-range chromatin interactions resulting in the upregulation of oncogenes at a distance.

PUBLICATIONS

- Kumar R, Dhaka B, Sahoo S, Jolly MK, Sabarinathan R. Prognostic association of immunoproteasome expression in solid tumours is governed by the immediate immune environment. Molecular Oncology, 17: 1041-1059, 2023.
- Singh AK, Walavalkar K, Tavernari D, Ciriello G, Notani D, Sabarinathan R. Cis-regulatory effect of HPV integration is constrained by host chromatin architecture in cervical cancers. Molecular Oncology, 2023.

HONORS AND AWARDS

- DBT/Wellcome-Trust IA Intermediate Fellowship (2021-25).

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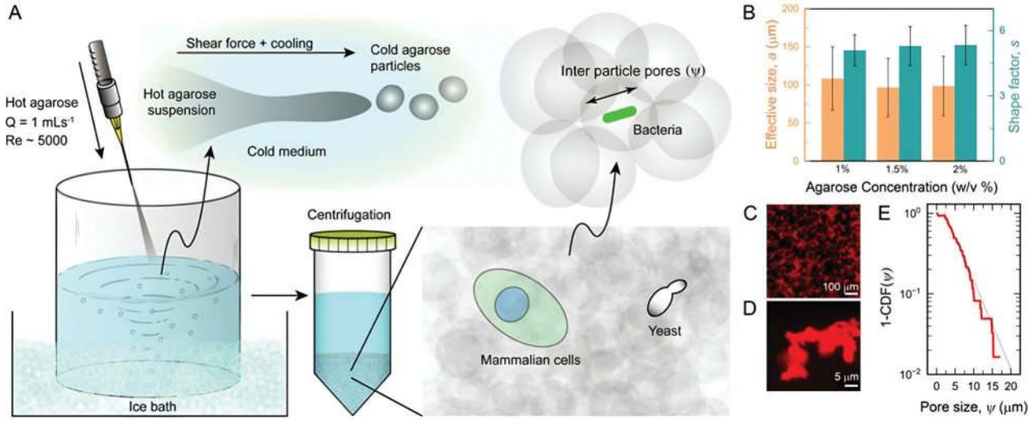
BIOPHYSICS, BIOCHEMISTRY, AND BIOINFORMATICS

Active Living Material in Complex Environment

We aim to discover new physical and biological principles emerging from the interactions between living organisms and their complex, three-dimensional microenvironments.

Our lab works in the broad area of active living matter in complex environments and aims to discover new physical and biological principles emerging from the interactions between mammalian cells, bacteria, and their microenvironments. We design and fabricate biomimetic 3D media to mimic the natural habitat of mammalian cells, bacteria and even worms. We fine-tune the material properties of the media to explore how living organisms respond to the change in their microenvironment. The lab uses bioprinting and a variety of microscopy techniques to probe multicellular systems at three-dimensional biological interfaces. More specifically, the lab is exploring a spectrum of areas that include characterizing the properties of biomimetic gels, understanding worm behavior in 3D environment, exploring bacterial growth and response to antibiotics in 3D, designing long-term cultures of 3D-printed tissues, studying the interaction between microbes and mammalian tissues in 3D, and investigating mechanically assisted maturation of tissues.



PUBLICATIONS

- Sreepadmanabh, M., Ganesh, M., Bhat, R., and Bhattacharjee, T.*, Jammed microgel growth medium prepared by flash-solidification of agarose for 3D cell culture and 3D bioprinting. Biomedical Materials (2023).
- Theeyancheri, L., Chaki, S., Bhattacharjee, T.* & Chakrabarti, R*. Active Dynamics of Linear Chains and Rings in Porous Media. Journal of Chemical Physics (2023).

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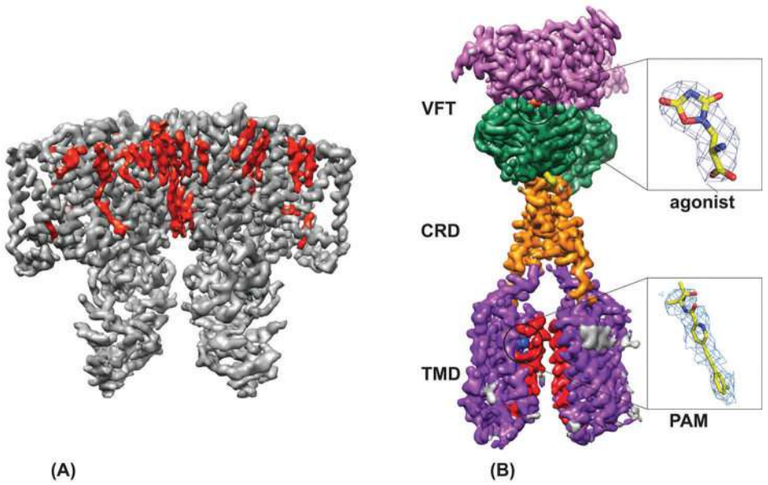
BIOPHYSICS, BIOCHEMISTRY, AND BIOINFORMATICS

Structures of Macromolecules and Dynamics

Our research is driven by the curiosity of how macromolecules function in the cell. We study macromolecules that function in the membrane, those that regulate translation and interesting microbial enzymes.

The lab's theme is 'Macromolecular Structure and Dynamics' and the research areas that we work on can be divided into membrane proteins, microbial enzymes and large macromolecules such as ribosomes. Within the broad area of membrane proteins, we are working towards understanding the mechanism of peptide and antibiotic resistance in bacteria, cleavage of transmembrane proteins by intramembrane proteases and membrane receptors *(Figure).* We also work on select microbial enzymes with interesting catalytic mechanisms and for their use as test samples for cryoEM *(to understand the behaviour of specimens during freezing and also to optimize data collection)*. One of the projects that we have been working on is the metabotropic glutamate receptor, $mGlu_5$, a class C G-protein coupled receptor. We are interested in understanding how different ligands bind in the transmembrane domain to inhibit or promote signalling as shown for a PAM bound structure in figure 1B.



CryoEM maps of a membrane enzyme and receptor. (A) The map of the dual membrane enzyme, MprF (multiple peptide resistance factor from P.aeuroginosa) is shown with the density for lipid molecules highlighted in red and protein in grey. The lipid molecules are lined up to illustrate the path that they might take to exit and enter the enzyme. (B) The map of $mGlu_5$ with domains coloured individually. The density for agonist (QUS) bound in the extracellular domain and the PAM in the TMD domain are highlighted. The grey density is for the cholesterol hemisuccinate molecule that is co-purified.

PUBLICATIONS

- Yadav, S and Vinothkumar, K.R., Factors affecting macromolecule orientations in thin films formed in cryo-EM. bioRxiv 2023. DOI:10.1101/2023.11.06.565913.
- Cannone et al., Conformational diversity in class C GPCR positive allosteric modulation. bioRxiv 2023. DOI:10.1101/2023.11.07.565819

HONORS AND AWARDS

- EMBO Global Investigator Network (2023-2026).

2

Genetics and Development

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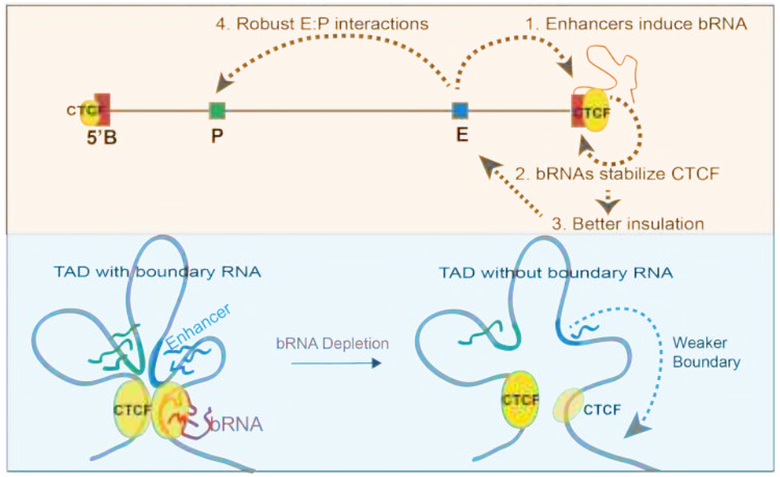
GENETICS AND DEVELOPMENT

Chromatin Dynamics in Gene Regulation

My group is interested in understanding the dynamic interplay between regulatory elements, non-coding RNAs, and chromatin-architecture in gene regulation.

Expression of genes is controlled by DNA sequences that are distal from the promoters known as enhancers. They regulate target genes by establishing looping with the promoter in a cell-type specific manner. Although discovered over forty years ago, how enhancers regulate their promoters remains poorly understood. Further, the enhancers that drive cyclic signaling response, are reversibly dynamic as opposed to developmental enhancers, adding another layer of complexity to this conundrum.

Using genomic techniques that quantify the alterations in TF binding, nascent transcription, three-dimensional architecture during the course of estrogen signaling, our work has revealed that chromatin state under basal signaling is the key to signaling response. Further, these and other enhancer clusters do not function as sum-of-all but they rely on complex hierarchies that cannot be predicted. Furthermore, promiscuous transcription and mutations in these enhancers lead to patho-physiologies including cancer.



Islam and Saravanan et al. Genome Research

The active enhancers loop with chromatin domain borders to induce RNA transcription. The RNA then recruits CTCF for successful stalling of loop extrusion. Therefore, the enhancers have a direct role in genome organization.

PUBLICATIONS

- Mann R, Notani D*. Transcription factor condensates and signaling driven transcription. Nucleus. 2023 Dec;14(1):2205758. doi: 10.1080/19491034.2023.2205758.
- Islam Z, Saravanan B, Walavalkar K, Farooq U, Singh AK, Radhakrishnan S, Thakur J, Pandit A, Henikoff S, Notani D*. Active enhancers strengthen insulation by RNA-mediated CTCF binding at chromatin domain boundaries. Genome Research. 2023 Jan;33(1):1-17. doi: 10.1101/gr.276643.122.

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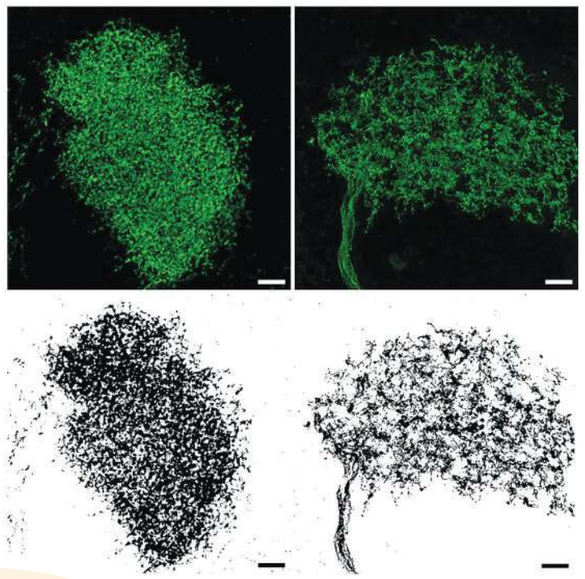
GENETICS AND DEVELOPMENT

Intracellular Ca^{2+} Signaling and the Regulation of Neuronal Function

Neuromodulator stimulated ER-Ca^{2+} release and Ca^{2+} entry through STIM and Orai determines the development of activity of central dopaminergic neurons required for feeding and flight.

My group studies how intracellular Ca^{2+} signaling, through the IP3R and the store-operated Ca^{2+} channel (STIM/Orai) impacts neuronal function. Ca^{2+} release through the intracellular ER-membrane localised IP3R activates STIM and leads to extracellular Ca^{2+} entry through Orai referred to as SOCE.

Recent work by our group in human neuronal cells **(i)** demonstrates a new role for the IP3R in regulating SOCE. Ligand-bound IP3Rs enhance the association of STIM1 and Orai1 in neuronal cells even in the absence of Ca^{2+} release from the ER. Convergent regulation of SOCE by IP_3Rs may tune neuronal SOCE to respond selectively to membrane receptors that generate IP3. An understanding of how such membrane receptors impact neuronal function comes from our recent work in Drosophila. IP_3-mediated intracellular Ca^{2+} signals and SOCE in a subset of larval dopaminergic neurons, normally generated upon stimulation of the muscarinic acetylcholine receptor, are attenuated by loss of STIM. STIM mutant larvae stop feeding leading to developmental arrest and death, thus identifying an essential requirement for dopamine in larval feeding **(ii)** Adult viable mutants of the IP_3R, STIM and Orai, all exhibit flight deficits. Loss of SOCE in flight circuit dopamine neurons during circuit maturation impacts neuronal gene expression including genes encoding ion channels **(iii)** The functional significance of SOCE across specific neuronal subtypes and in the context of neurodegenerative syndromes is under further investigation in Drosophila, a human neuronal cell line and human stem cell-derived neurons.



The complexity of presynaptic axonal arbors is severely compromised upon loss of Store-operated Ca^{2+} entry by expression of a dominant negative Orai transgene (panels on the right). PPL1 dopaminergic neurons that innervate the mushroom body were marked by membrane GFP. Image courtesy Rishav Mitra and Nandashree Kasturacharya.

PUBLICATIONS

- Chakraborty, P., Deb, B. K., Arige, V., Musthafa, T., Mullick, S., Yule, D.I., Taylor, C.W. and Hasan, G. (2022). Regulation of Store-Operated Ca^{2+} entry by IP3 receptors independent of their ability to release Ca^{2+}. eLife, https://doi.org/10.7554/eLife.80447
- Kasturacharya, N., Dhall, J.K. and Hasan, G. (2023). A STIM dependent dopamine-neuropeptide axis maintains the larval drive to feed and grow in Drosophila. PLOS Genetics https://doi.org/10.1371/journal.pgen.1010435.

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GENETICS AND DEVELOPMENT

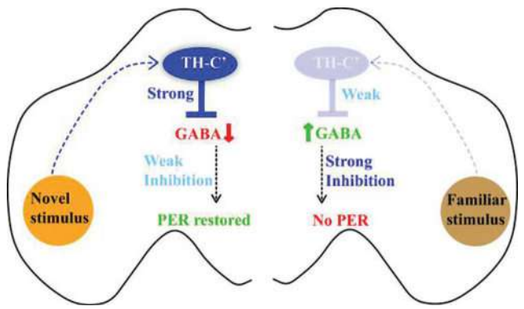
Development of Neural Circuits, Muscles, and the Emergence of Behaviour

Our laboratory studies how the birth, morphogenesis, and connectivity of neurons and muscles translate into behaviour. We approach this complex problem by focussing on the olfactory, gustatory and motor system of *Drosophila melanogaster*.

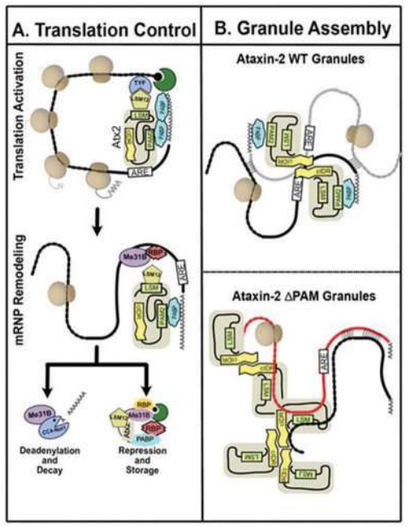
We endeavour to understand the principles of development culminating in behaviour, using Drosophila. Muscles, the nervous system and their interplay at cellular and molecular resolution, remain our focus. In our recent work on deciphering the neural correlates of habituation override when presented with a novel stimulus, we have identified a subset of dopaminergic neurons necessary for it. We also show that these dopaminergic neurons may form direct synapse with the sensory neurons (a).

Our work with Mani Ramaswami's group at Trinity, Ireland, has provided insights into regulation of mRNP granules of both human and Drosophila Ataxin-2. Ataxin2 is an intrinsically disordered ubiquitous RNA binding protein implicated in translational activation/repression, mRNA stability and mRNP granule assembly. *In vivo* experiments show that while both PAM2 and IDR-interactions promote Ataxin2-mediated cytotoxicity, LSm domain acts as an antagonist.

In collaboration with Maneesha Inamdar's group at JNCASR, we have uncovered challenge specific functions and heterogeneity in immune cell progenitor pools of Drosophila larvae (b).



a) Model for habituation override in the Drosophila gustatory system.



b) A model for Ataxin2 RNP dynamics and the role of PAM2 domain in determining its RNP composition and mRNA selection.

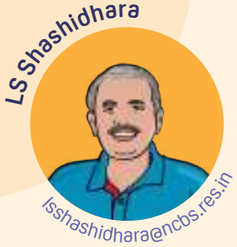
PUBLICATIONS

- Trisal S, Aranha M, Chodankar A, VijayRaghavan K, Ramaswami M. A Drosophila Circuit for Habituation Override. J Neurosci. 2022 Apr 6;42(14):2930-2941. doi: 10.1523/JNEUROSCI.1842-21.2022. Epub 2022 Mar 1. PMID: 35232763; PMCID: PMC8985855.
- Rodrigues D, Renaud Y, VijayRaghavan K, Waltzer L, Inamdar MS. Differential activation of JAK-STAT signaling reveals functional compartmentalization in Drosophila blood progenitors. Elife. 2021 Feb 17;10:e61409. doi: 10.7554/eLife.61409. PMID: 33594977; PMCID: PMC7920551.

HONORS AND AWARDS

- Elected to the American Philosophical Society in May 2021.

LS Shashidhara



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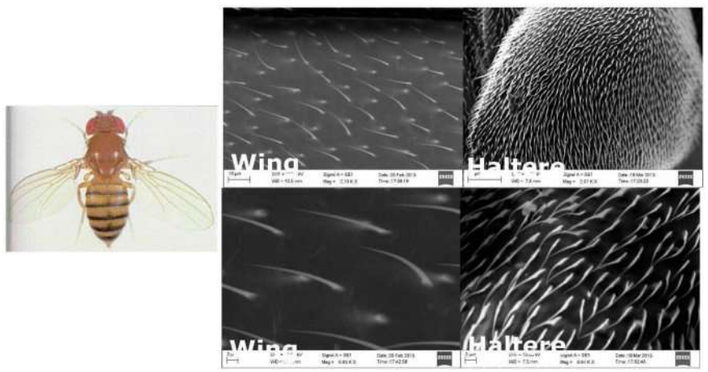
GENETICS AND DEVELOPMENT

Control of Organ Size and Shape During the Differential Development of Drosophila Wing and Haltere

We study (i) how biomechanical properties of cellular components such as membrane, actin-myosin and microtubular complexes determine cell size and shape of individual cells (ii) and their collective behaviour shaped by extracellular matrix and forces exerted on individual cells in specifying organ shape.

How genes and mechanical properties of individual cells combine and determine an organ's shape and size remains a mystery. Drosophila wing-a flat structure and the globular haltere are two homologous flight appendages emerging from a similar group of progenitor cells. The differential development of wing and haltere, which differ in cell size, number, and morphology, is dependent on the function of Hox gene Ultrabithorax (Ubx), which is only expressed in developing halteres and not the wings. Ubx modulates multiple growth regulatory and patterning gene pathways to fine-tune the specification of haltere shape. However, for determining the final shape of an organ, various signalling networks and cues from the external environment have to converge at the level of altering the individual cell behaviours such as cell shape, size and mechanical properties- thus dictating the overall tissue geometry. Our studies on differential development of wing and haltere shapes suggest that the localization and abundance of actomyosin complexes, apical cell contractility, properties of extracellular matrix, cell size and shape, which is a result of various cell intrinsic and extrinsic forces, can influence the flat vs globular geometry of these two organs. Some of the mutants of major growth regulatory pathways *(such as Hippo, IIS/Akt signalling)* showing partial homeotic haltere to wing transformation also exhibit respective cellular level transformation. Interestingly, we observe deformations in the three-dimensional architecture of the mutant haltere epithelium during early pupal morphogenesis, indicating the role of the above-mentioned factors in force generation and driving differential morphogenesis, leading to different organ shapes. This links growth regulatory pathways and cellular biophysical properties in determining tissue and organ morphology.



Differential development of wing and haltere is a good system to study how organ size, shape and, thereby, function are specified and how these features evolve.

PUBLICATIONS

- Khan, S., Pradhan, S.J., Giraud, G., Bleicher, F., Paul, R., Merabet, S. and Shashidhara, L.S. (2023). A micro-evolutionary change in target binding sites as a key determinant of Ultrabithorax function in Drosophila. J Mol Evol. doi: 10.1007/s00239-023-10123-2.
- Vaid et al. (2022). Evaluation of tumor-infiltrating lymphocytes (TILs) in molecular subtypes of an Indian cohort of breast cancer patients. Diagnostics Pathology. https://doi.org/10.1186/s13000-022-01271-y.

HONORS AND AWARDS

- Joining as Director, NCBS-TIFR in January 2023.

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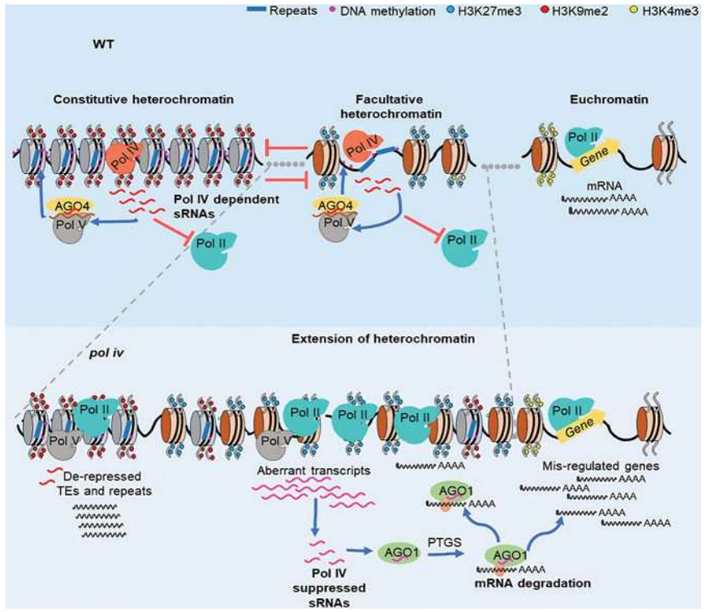
GENETICS AND DEVELOPMENT

Epigenetics and Small Silencing RNAs

A number of epigenetic regulatory layers are superimposed on the genome. We study mechanisms of small (s)RNA biogenesis, induction and maintenance of epigenetic changes, and functional significance of these regulatory layers.

sRNAs are a group of key molecules resulting from RNA silencing pathways. They regulate transcription and translation of their target RNAs by associating with Argonaute protein effectors. sRNAs are also important factors in initiating and maintaining heritable changes in gene expression without changes in DNA sequence ('epigenetics'). sRNAs and epigenome modifications impact every aspect of eukaryotic development and disease. Our laboratory is interested in understanding the pathways and mechanisms that generate sRNAs and epigenome modifications in plants. We use various biochemical, genetic, bioinformatic and whole-genome approaches in a wide variety of model organisms. During the reporting period, we have discovered two important regulatory modules, one on the new role of plant-specific Polymerase IV *(Vivek Hari Sundar et al., 2023),* and the other on the ability of a viral protein to destabilize chloroplasts, a hub of plant defense against pathogens to induce vein-clearing symptoms by inducing a chloroplast-specific nuclease *(Nair et al., 2023).*



Plant-specific polymerase IV (PolIV) maintains chromatin boundaries, in addition to its well known roles in RNA-directed DNA methylation. PolIV prevents facultative heterochromatin formation in protein coding genes. This is a very surprising discovery since it shows PolIV can act directly on the chromatin without sRNAs. From Vivek Sundar et al., Genome Res. 2023.

PUBLICATIONS

- Vivek Hari Sundar, Swetha Chenna, Debjani Basu, Kannan Pachamuthu, Tania Chakraborty, Rebecca Mosher, P.V. Shivaprasad (2023). Plant Polymerase IV sensitizes chromatin through histone modifications to preclude the spread of silencing into protein-coding domains. Genome Res. 33:715-728.
- Ashwin Nair, C.Y. Harshith, Anushree N. and P. V. Shivaprasad (2023). Geminiviral βC1 orchestrates organellar genomic instability to augment viral infection by hijacking host RecA. Plant J. 114:934-950.

HONORS AND AWARDS

- Elected fellow of the National Academy of Sciences India, 2022.

Raj Ladher
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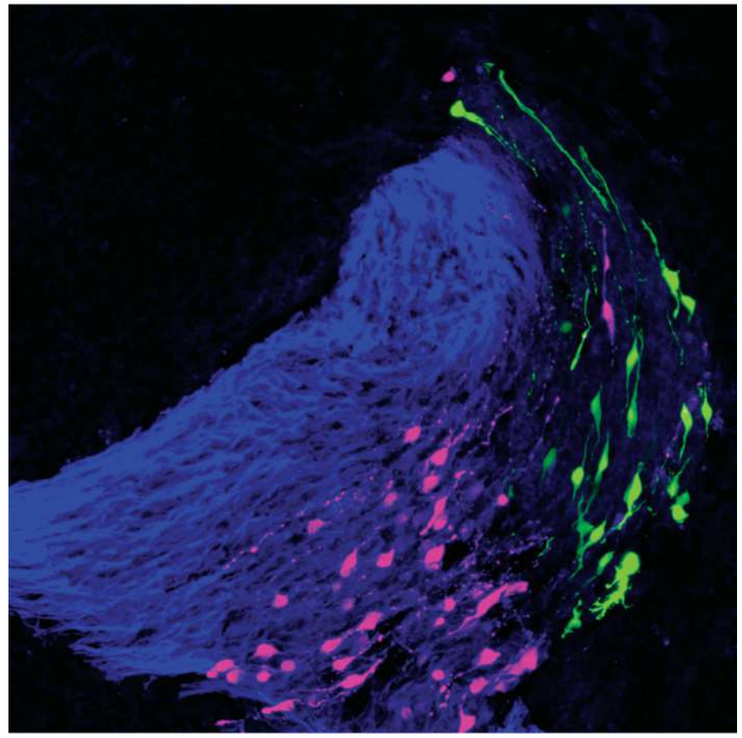
GENETICS AND DEVELOPMENT

Development and Morphogenesis of the Inner Ear

We explore the mechanisms through which developmentally encoded genes coordinate the changes in cell biology that drive cell and tissue specialisation during the formation of the inner ear.

The inner ear is a complex structure that is generated from a relatively simple group of cells. These cells should have become skin, yet receive a series of instructions that change their potential and their shape. A subset of these cells form inner ear hair cells that convert the mechanical vibrations associated with sound into electrochemical impulses that are sent to the brain. How do development programmes instruct these changes to the cell? Using a variety of molecular, cellular, imaging, and computational approaches, our aim is to understand the morphogenesis of the inner ear.



Section through the auditory ganglion of the chick. Plasmids encoding mCherry and GFP are electroporated into the inner ear at 2 and 3 days respectively. The location of the neurons depends on the time of electroporation.

PUBLICATIONS

- Prakash A, Weninger J, Singh N, R. Sukanya, Kruse K, Rao M, Ladher RK (2023) Junctional Force Patterning drives both Positional and Orientational Order in the Auditory Epithelia. Research Square doi: 10.21203/rs.3.rs-2508957/v1
- Singh N, Prakash A, Chakravarthy SR, Kaushik R, Ladher RK (2022) In Ovo and Ex Ovo Methods to Study Avian Inner Ear Development. J Vis Exp). doi: 10.3791/64172.

Soumyashree Das

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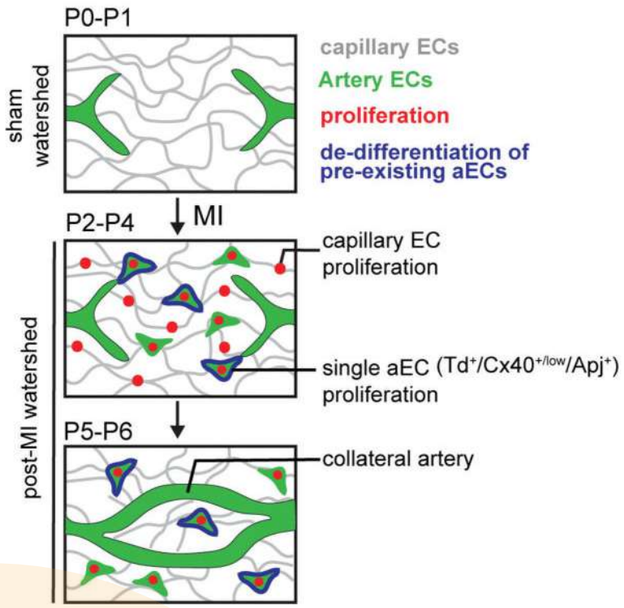
GENETICS AND DEVELOPMENT

Investigating the Role of Endothelial Cells in Cardiovascular Regeneration

We investigate mechanisms by which arteries are built, maintained and remodeled in response to biological cues. We also study how the formation of new arteries contributes to tissue regeneration.

Symptoms of occlusive diseases could be combated by growing new arteries called collateral arteries. These are special artery-subtype that connect occluded vessels with healthy vessels and create an alternate route for blood flow. Collateral arteries are associated with better survival in heart and stroke patients. Despite the high clinical significance, it is unclear how collaterals form. We showed that coronary collaterals are built via a process called Artery Reassembly (migration, proliferation, de-differentiation and coalescence of pre-existing coronary artery ECs); which drives cardiac regeneration in mice. We showed that VEGF and CXCL12 facilitate Artery Reassembly. Interestingly, this process is age-dependent and is not observed in adult mice.

Why do adult ECs fail to build collateral arteries? How do collaterals attain maturity? Is Artery Reassembly observed in other ischemia-prone critical organs (brain)? These are some questions we are currently pursuing. These studies will help us gain insights into the poorly understood collateral biology and elucidate ways for their induction.



Artery ECs de-differentiate and re-enter cell cycle upon MI.
The presumed terminally differentiated artery ECs (green) can undergo de-differentiation (in blue) and re-enter the cell cycle (in red) upon activation of cardiac ischemic conditions. This allows expansion of the artery cell pool within an injured cardiac region. The newly formed artery cells reorganize to build connections between two arteries. These connecting arterial segments are called collateral arteries, which are responsible for driving complete cardiac regeneration in mice. The image is adapted from Arolkar et al., ATVB, 2023.

PUBLICATIONS

- Arolkar G*, Krishna Kumar S*, Wang H, Gonzalez KM, Kumar S, Bishnoi B, Rios Coronado PE, Woo YJ, Red-Horse K, Das S. (2023). Dedifferentiation and Proliferation of Artery Endothelial Cells Drive Coronary Collateral Development in Mice. Arterioscler Thromb Vasc Biol. doi: 10.1161/ATVBAHA.123.319319. (* equal contribution)•

3

Cellular Organisation and Signalling

Anjana Badrinarayanan
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CELLULAR ORGANISATION AND SIGNALLING

Microbial Genome Plasticity: Molecular Mechanisms and Regulation

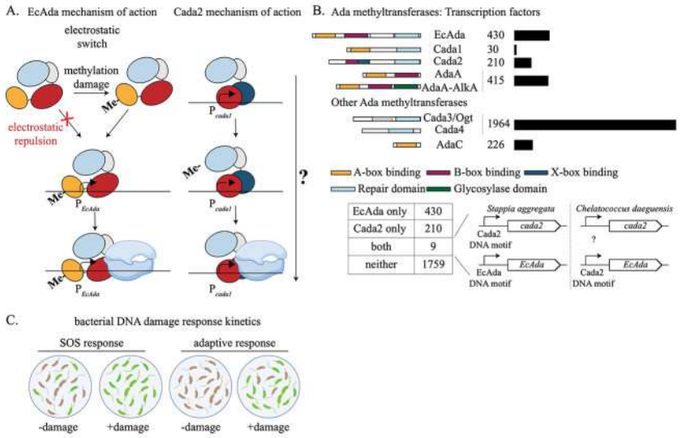
The overall objective of our work is to understand fundamental regulatory mechanisms that govern the activity of genomic error-correction pathways and how this can drive genome evolution under genotoxic stress.

While DNA damage repair is important for faithful propagation of life, pathways of repair can also be sources for mutagenesis. Mutations during repair most often arise due to error-prone repair or tolerance mechanisms. For example, repair can sometimes be inaccurate due to the participation of stress-induced error-prone DNA polymerases (translesion polymerases). Apart from their impact on evolution, such inducible mutagenesis can lead to genetic defects and cancer in human cells, as well as antibiotic and stress resistance in bacteria. Thus, the modulation of these pathways can have a significant impact on cellular adaptation and survival. This becomes particularly relevant in organisms such as microbes, that live in constantly fluctuating environments.

We primarily use imaging approaches, in combination with other interdisciplinary tools, to understand how DNA damage response repair is regulated in microbial systems. Presently, we have focused our efforts on understanding how specific steps of response and repair are regulated in vivo, under the following themes:

i) To change or not to change: regulation of mutagenic and non-mutagenic mechanisms of DNA repair.

ii) Co-evolution of genomes and their error-correction mechanisms.



A conserved non-electrostatic switch mechanism drives a bacterial adaptive response to methylation damage: The central regulator of the bacterial adaptive response appears to undergo domain shuffling across the bacterial kingdom; although highly conserved, it has several distinct domain architectures in bacterial genomes. However, despite diverse organizations and mechanisms of regulation, widespread occurrence of adaptive response regulators such as Ada (E. coli-like) and Cada2 (Caulobacter-like) underscores the importance of a methylation-specific bacterial DNA damage response (Kamat et al., 2023)

PUBLICATIONS

- Kamat A and Badrinarayanan A*. SOS-independent bacterial DNA damage responses: diverse mechanisms, unifying function. Current Opinion in Microbiology, 2023, 73:102323. doi: 10.1016/j.mib.2023.102323
- Joseph A, Daw S, Rahman KR and Badrinarayanan A*. Mechanistic insight into the repair of C8-linked Pyrrolobenzodiazepine(PBD) monomer-mediated DNA damage. RSC Medicinal Chemistry, 2022, doi: 10.1039/d2md00194b

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CELLULAR ORGANISATION AND SIGNALLING

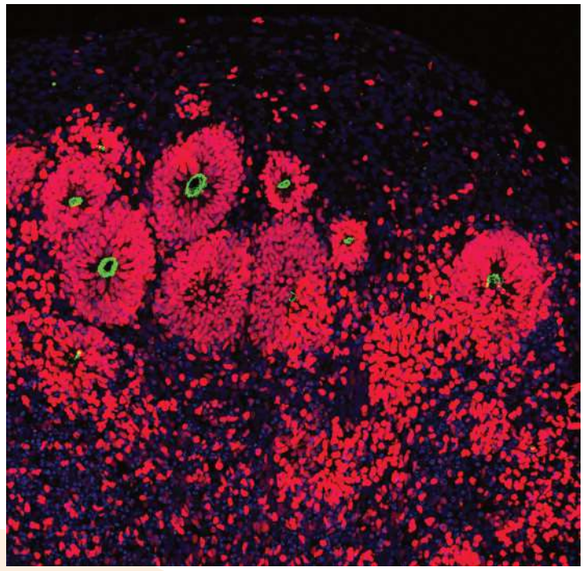
Phosphoinositide Signalling in Cell Biology

Chemical messengers derived from phosphatidylinositol are an evolutionarily conserved mechanism of signalling. They regulate key cellular and biological processes. We study the logic underlying lipid signalling and its relevance to biomedical science.

Our long-term scientific interest is to understand cellular communication mediated by lipid molecules generated by the metabolism of phosphatidylinositol. Phosphoinositide signals provide molecular control for key subcellular processes such as membrane remodelling, cytoskeletal function, transcription, and translation. Through these processes, this signalling pathway orchestrates basic cellular behaviours such as cell division, shape changes, polarised movement, and cell death; and these behaviours play key roles in a number of physiological processes including early embryogenesis, lymphocyte development and function, as well as neuronal activity.

The overall goal of our work is to understand how the architecture in this signalling cascade is designed to optimally deliver physiological outputs. The work is multidisciplinary and done using a combination of Drosophila and human disease models. Over the last year, we have uncovered the function of key enzymes that regulate lipid signalling and provided a molecular mechanism by which they control cellular processes. These include the mechanism by which lipid molecules are exchanged between cellular compartments, the control of membrane turnover and receptor activity by lipids, and a quantitative model of the turnover of lipids during critical cell signalling reactions important for brain function.

We also study the function of phosphoinositides in neuronal cell biology and brain disorders using human iPSC-derived neural cells in cell culture. The goal of this work is to uncover the function of altered phosphoinositide signalling in brain disorders.



Immunohistochemistry of 60 days old iPSC-derived spheroids showing Protein Kinase C (PKC-gamma, green) indicative of neural rosettes and Sox-2 (red) representing Neural Stem Cells (NSCs).

PUBLICATIONS

- Ghosh A, Venugopal A, Shinde D, Sharma S, Krishnan M, Mathre S, Krishnan H, Saha S, Raghu P*. PI3P-dependent regulation of cell size and autophagy by phosphatidylinositol 5-phosphate 4-kinase. Life Sci Alliance. 2023 Jun 14;6(9):e202301920. doi: 10.26508/lsa.202301920. PMID: 37316298
- Akhtar BM, Bhatia P, Acharya S, Sharma S, Sharma Y, Aswathy BS, Ganapathy K, Vasudevan A & Raghu P*. A human stem cell resource to decipher the biochemical and cellular basis of neurodevelopmental defects in Lowe Syndrome. Biology Open 2022 15;11(1):bio059066. doi:10.1242/bio.059066

Satyajit Mayor

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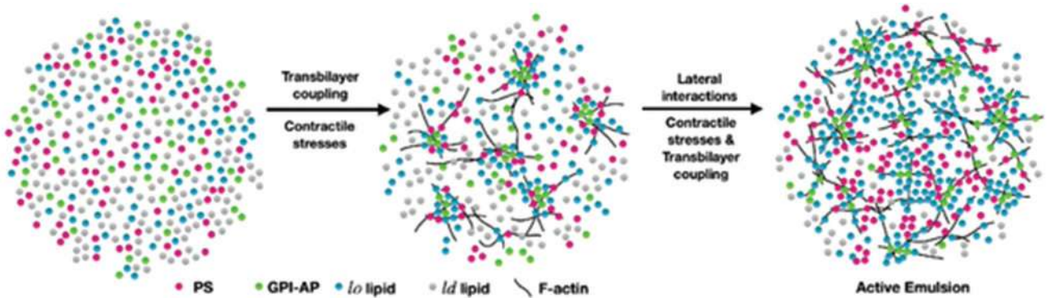
CELLULAR ORGANISATION AND SIGNALLING

Mechanisms of Membrane Organization and Endocytosis

Our laboratory studies physico-chemical rules that govern the local organisation of cell membrane components in a living cell and connects this to cellular and organismal physiology. In this context, we explore how functional signalling complexes and responsive endocytic platforms are built.

The plasma membrane that demarcates the boundary of a cell is a macromolecular assembly teeming with activity and local heterogeneities. It is the site where information transfer and endocytic activities take place modulated by the local organization and structure of the membrane. Our laboratory has provided a new understanding of the membrane as an active composite of a lipid bilayer in conjunction with a dynamic cytoplasmic cortical actin scaffold [1]. This is mediated by generating nanoscopic clusters which in turn organize as mesoscopic domains of liquid-ordered lipid species, resulting in active emulsions in the cell membranes. This provides control over the local composition of the membrane creating sites necessary for cell migration and signalling. In parallel, we have discovered that a specific clathin and dynamin-independent endocytic process that is involved in regulating global composition and tension in the membrane is also involved in developmental patterning. It is responsible for robust inference of the Wingless morphogen position during morphogenesis in Drosophila wing imaginal discs [2]. This endocytic process serves to create multiple-tiered gradients by promoting the internalizing of the Wingless morphogen via a non-signalling receptor.



Active emulsions in living cell membranes driven by contractile stresses and trans-bilayer coupling – membrane 'rafts' in living cells

PUBLICATIONS

- A Survey of Models of Cell Membranes: Toward a New Understanding of Membrane Organization S Mayor, A Bhat, A Kusumi. Cold Spring Harbor Perspectives in Biology 15 (10), a041394.
- Cellular compartmentalisation and receptor promiscuity as a strategy for accurate and robust inference of position during morphogenesis. KS Iyer, C Prabhakara, S Mayor, M Rao. Elife 12, e79257.

HONORS AND AWARDS

- Leverhulme International Professorships, 2023, UK.

Swadhin C Jana

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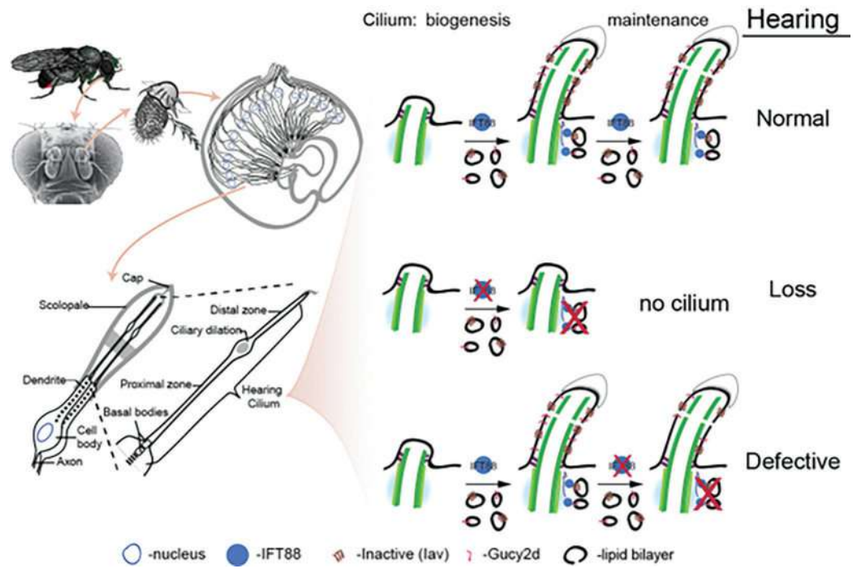
CELLULAR ORGANISATION AND SIGNALLING

Organelle Biology: in Physiology and Diseases

The Organelle Biology Laboratory (OBL) investigates mechanisms for building, diversity, evolution and maintaining organelles, primarily Cytoskeleton, Centrosome, and Cilium (i.e., 3Cs), in various organisms using a multifaceted approach.

Essential eukaryotic structures, the cytoskeleton, centrosome, cilium, mitochondria and lysosome, are implicated in numerous human diseases, including degenerative diseases, cancer and ciliopathies *(combined affect 1 in every 3 individuals).* Despite these organelles' importance to human health, our knowledge of their roles in pathologies is limited.

The OBL primarily focuses on the Cytoskeleton, Centrosome and Cilium (3Cs) and their involvement in numerous signalling processes, which are vital for organism development and homeostasis. We, for example, ask 1) What controls the organisation of several critical building blocks of 3Cs? 2) How are different portions of these structures assembled? 3) How are these vital structures maintained and go wary with pathological conditions? And, last year, we applied a combination of approaches/ techniques/tools *(including bio-physics, -chemistry and -informatics, genetics, transcriptomics, proteomics, advanced imaging, electrophysiology and animal behaviour).*



Summary of our findings reported in Wernet et al, 2023. LSA (in press).

PUBLICATIONS

- IFT88 maintains sensory function by localising signalling proteins along Drosophila cilia. Sascha Werner, Pilar Okenve-Ramos, Philip Hehlert, Sihem Zitouni, Pranjali Priya, Susana Mendonça, Anje Sporbert, Christian Spalthoff, Martin C. Göpfert, Swadhin Chandra Jana*, Mónica Bettencourt-Dias*. Life Science Alliance (in press) *- shared lead and corresponding authors.

HONORS AND AWARDS

- Principal Investigator, FCT Research Grant, FCG-IGC, Portugal (2018-2022).
- Principal Investigator, CEFIPRA (Indo-French) Project Grant (2023-2026).

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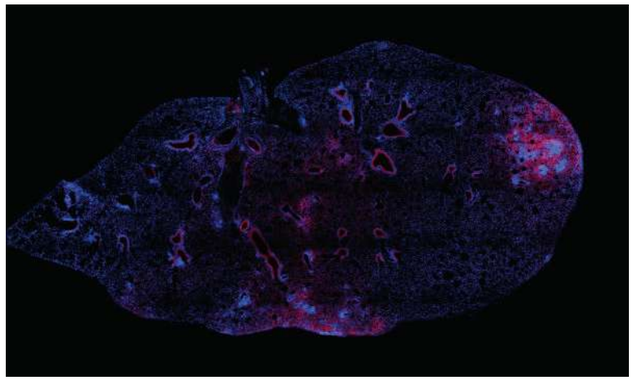
CELLULAR ORGANISATION AND SIGNALLING

Cell Biology of Host-Pathogen Interactions

The broad goal of our lab is to understand the interactions between the intracellular pathogens and host cells, with particular interest in the modulation of host cellular pathways, and exploit this knowledge for host-directed therapeutics against infectious diseases.

My lab works on host-pathogens interactions, specifically on how fundamental host cellular processes such as trafficking *(endocytosis, autophagy, and lysosomes)* are modulated by intracellular infections. We combine cell biological methods, high content imaging and computational approaches with conventional cell and molecular biology tools. We address distinct aspects of these interactions at molecular, cellular and tissue scales during *M. tuberculosis* infections. Simultaneously, we aim to exploit this knowledge for drug discovery to identify small molecules that can be used as adjuncts in host directed therapeutics.

When an intracellular bacteria encounters host cell, variety of outcomes are possible. The cell can get infected, or not; once inside the cell, the bacteria can proliferate, or remain dormant, or escape the cell, or succumb to the immune pressures and die; the host cell can undergo cell death due to bacterial proliferation. These events are not mutually exclusive, and often occur in the same non-perturbed cell population, underlining the cellular heterogeneity in responses to infection. Yet population level responses are largely robust. Ongoing projects in the lab aim to understand the cause and consequences of such heterogeneity in host-pathogen encounters, and relate them to phenotypic diversity often seen in bacterial physiological states. We study this in the context of *M. tuberculosis* infection in cells and tissues.



Section from M. tuberculosis infected mouse lung. Mtb (red), nucleus (blue)

PUBLICATIONS

- Lahree A, et al. Active APPL1 sequestration by Plasmodium favors liver-stage development. Cell Rep. 2022 May 31;39(9):110886.
- Anand K, Sundaramurthy V. Mycobacterial lipids in the host-pathogen interface: roles in pathogenesis and host immune response. Biology of Mycobacterial Lipids, Page 52-82. Academic Press, Elsevier Inc. ISBN: 978-0-323-91948-7.

4

Theory, Simulation, and Modelling of Biological Systems

Archishman Raju

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THEORY, SIMULATION, AND MODELLING OF BIOLOGICAL SYSTEMS

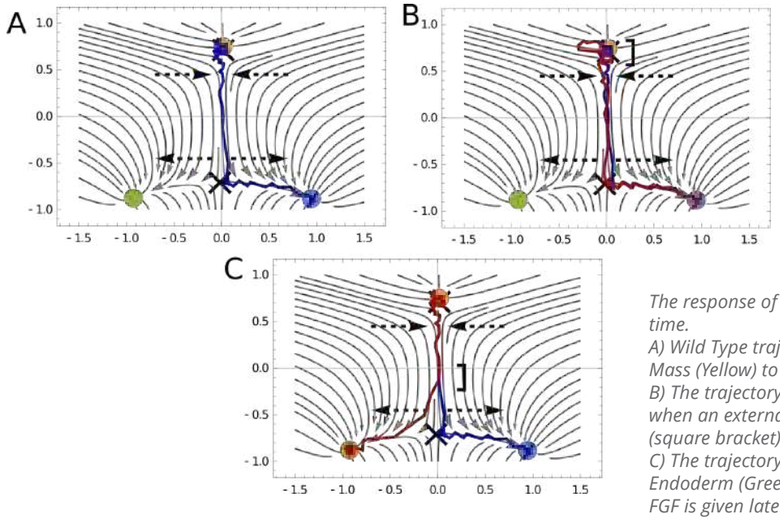
Emergence and Control in Development and Evolution

I am interested in the theoretical modeling of cell fate specification during development, both to make more parsimonious representations of data as well as to clarify broader concepts.

We are proposing a novel mathematical model of how cell fate specification proceeds in the mouse blastocyst based on our analysis of recent measurements of a live ERK reporter. We have shown that our model is consistent with previous experiments and suggests new experimental directions. This work is near completion.

We have also organized years of available experimental work on the phenomenon of "genetic assimilation" i.e. environmentally induced characters that are expressed without the inducing perturbation after a few generations of selection. We have also constructed a model qualitative consistent with the results. This work has been submitted for publication and is under review.

We are also working on a way to theoretically combine two big ideas in developmental biology: Positional Information and Self-Organized Patterns while continuing our work on modeling digit specification in mice. Other work includes relating gene motifs to developmental landscapes, understanding the basis and transmission of cellular "memory" *(i.e. heritable phenotypic states).*



The response of cells to signals is plastic in time.
A) Wild Type trajectory going from Inner Cell Mass (Yellow) to Epiblast (Blue).
B) The trajectory (red) still goes to Epiblast when an external pulse of FGF is given early (square bracket).
C) The trajectory (red) goes to Primitive Endoderm (Green) when the same pulse of FGF is given later.

PUBLICATIONS

- Raju, A., & Siggia, E. D (2023). A geometrical perspective on development. Development, Growth and Differentation, 65(5):245-254
- Sethna, J. P., Hathcock, D., Kent-Dobias, J., & Raju, A. (2023). Normal forms, universal scaling functions, and extending the validity of the RG. arXiv: 2304.00105.

Madan Rao

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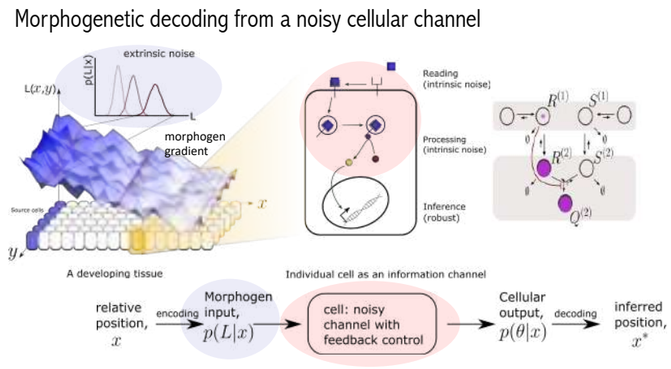
THEORY, SIMULATION, AND MODELLING OF BIOLOGICAL SYSTEMS

Theoretical Approaches in Cell Biology: Physics of Active, Evolving Systems

We look for new physical principles underlying the nonequilibrium organisation of the living state, arising from the interplay between active mechanics, molecular organisation, geometry, information processing and control in diverse cellular contexts such as the cell surface, cytoskeletal patterning, chromatin organisation, organelle biogenesis, and tissue morphogenesis.

How do living systems, driven far from equilibrium, self-organise (evolve) to perform, "engineering tasks", such as information processing, computation, and control? We explore new physical principles underlying biological organisation across scales, from functional biomolecules, to subcellular, cellular and tissue scale organisation. We study the mesoscale organisation at the cell membrane driven by active stresses arising from the actomyosin cortex, leading to active segregation and active emulsions. We are interested in the emergence and inheritance of intracellular patterning, e.g., the nonequilibrium assembly and morphodynamics of a system of organelles, such as the Golgi. We work on the dynamics of the active cytoskeleton and cellular force patterning. We have been studying the morphogenesis, patterning, excitability, and homeostatic control in epithelial tissues, driven by an interplay between active mechanics and geometry. A recent focus has been cellular inference and control in the context of tissue development. In addition, we study the unusual mechanical response, segregation and pattern formation in active soft matter, that exhibit non-reciprocity, enhanced memory and fragile elasticity. Our theoretical studies are often supported by collaborations with experimental groups.



We approach the problem of morphogenetic decoding in a developing tissue by combining Information processing and Systems Biology and eventually Mechanics. The relative position of cells in a tissue is encoded in the morphogen input received by cells. Production and transport from the producing cells to the rest adds extrinsic noise to this input, the distribution P(L|x). Receiving cells then read and process this input to generate a developmentally meaningful signaling output, the distribution P(θ|x). The cellular processes involved in decoding contribute to intrinsic chemical noise. The question we address is how to design the cellular channel to get accurate and robust inference of cellular position.

PUBLICATIONS

- Suvrajit Saha, Amit Das, Chandrima Patra, Anupama Ambika Anilkumar, Parijat Sil, Satyajit Mayor and Madan Rao, Active emulsions in living cell membranes driven by contractile stresses and transbilayer coupling, PNAS 119, e2123056119 (2022).
- Krishnan S Iyer, Chaitra Prabhakara, Satyajit Mayor and Madan Rao, Cellular compartmentalisation and receptor promiscuity as a strategy for accurate and robust inference of position during morphogenesis, eLife 12:e79257 (2023).

HONORS AND AWARDS

- IUPAB sponsored speaker at the Biophysical Society Meeting, San Diego, Feb. 18-23, 2023.

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THEORY, SIMULATION, AND MODELLING OF BIOLOGICAL SYSTEMS

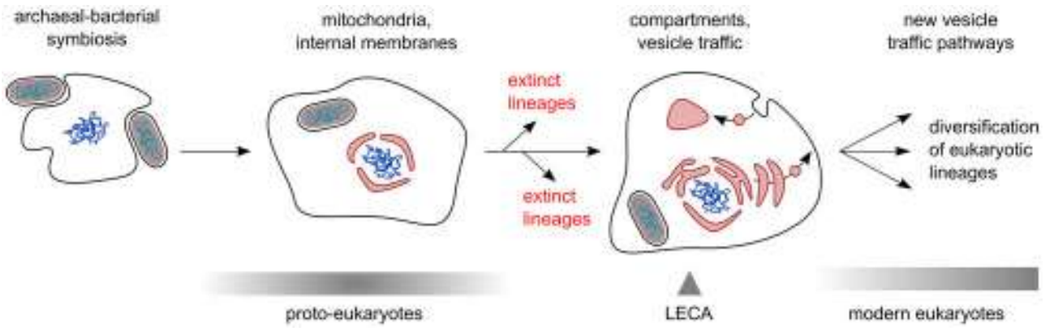
The Whats, Hows and Whys of the Eukaryotic Cell Plan

As a physicist practising biology, I am interested in how cellular complexity emerges from molecular rules. My group is based within the Simons Centre for the Study of Living Machines at NCBS. We use biophysical, mathematical and computational principles to understand how cells work. We have been deeply involved in developing evolutionary cell biology as a rigorous field of study.

We use the membrane traffic system as a window to study the mechanistic and evolutionary origins of the eukaryotic cell plan, using tools from mathematics, physics, and computer science.

We ask:

- **What?** We study the evolution of proteins involved in membrane traffic, to shed light on the natural history and diversity of this system across species and time.
- **How?** We use mathematical and computational methods to understand how the global structure of the membrane traffic system emerges from local molecular interactions.
- **Why?** We explore the selective advantage of having intracellular organelles and intra-organellar transport, with particular focus on the structure and function of the Golgi apparatus.



The architecture of eukaryotic cells was established over billions of years of evolution. We are interested in the period since the last eukaryotic common ancestor (LECA) during which the membrane traffic apparatus expanded and diversified. Figure adapted from: Thattai, Current Opinion in Cell Biology, 2023.

PUBLICATIONS

- Thattai, M. (2023). Molecular and cellular constraints on vesicle traffic evolution. Curr Opin Cell Biol 80: 102151.
- Purkanti, R., & Thattai, M. (2022). Genome doubling enabled the expansion of yeast vesicle traffic pathways. Sci Rep 12: 11213.

Sandeep Krishna

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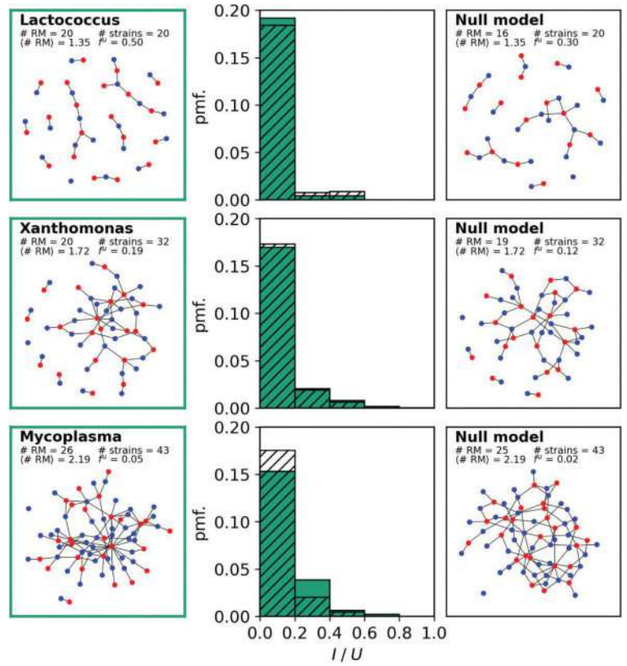
THEORY, SIMULATION, AND MODELLING OF BIOLOGICAL SYSTEMS

Non-equilibrium Dynamics of Living Systems across Scales

At the molecular level, I am interested in using a combination of experimental data and mathematical models to study the dynamics of different mechanisms of protein regulation and their roles in feedback loops. At the cellular level, I have been interested in oscillatory behaviour, synchronisation, and entrainment in signalling pathways. Finally, at an ecosystem level, I have been studying infectious diseases, bacteriophage and microbial communities to understand phenomena related to cooperation, communication and symmetry breaking in populations.

I study the complex, far-from-equilibrium dynamics of biological systems, ranging from molecules to cells to populations.



Restriction-modification (RM) systems are the most ubiquitous bacterial defense system against bacteriophages and an important part of controlling phage predation. Using genomic sequence data, we show that RM systems are often shared among bacterial strains in a structured way. The figure shows bipartite network representations of the distribution of the RM systems among the bacterial strains for three different genera (blue: bacterial strains; red: RM systems) along with the distribution of the RM system overlap in real (solid green bars) and random networks (hatched bars). Examining the network of interconnections between bacterial strains within each genus, we find that in many genera strains share more RM systems than expected from a random network. We also find that many genera have a larger than expected number of bacterial strains with unique RM systems. Figure adapted from ref. 2.

PUBLICATIONS

- Mozaffer, F., Cherian, P., Krishna, S., Wahl, B. & Menon, G. I. (2022) Effect of hybrid immunity, school reopening, and the omicron variant on the trajectory of the covid-19 epidemic in India: A modelling study The Lancet Regional Health – Southeast Asia, p. 100095.
- Eriksen, R. S., Malhotra, N., Narain Seshasayee, A. S., Sneppen, K. & Krishna, S. (2022) Emergence of networks of shared restriction-modification systems in phage-bacteria ecosystems J. Biosci. 47, 38.

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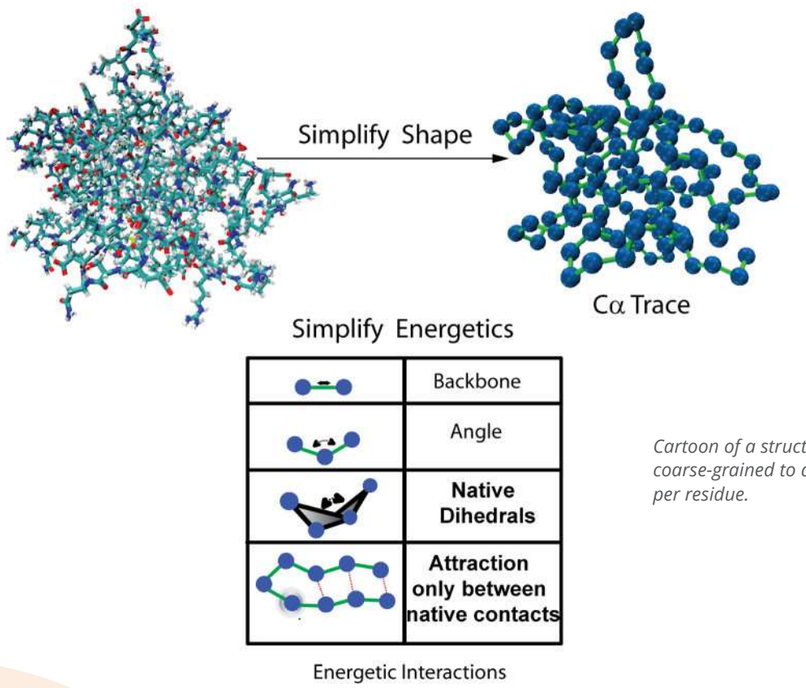
THEORY, SIMULATION, AND MODELLING OF BIOLOGICAL SYSTEMS

Computational Dynamics of Biomolecular Self-Assembly

My group uses computational methods, specifically molecular dynamics simulations of coarse-grained and structure-based models, to understand the dynamics of protein folding and self-assembly.

Natural proteins fold robustly because of a funnel-shaped energy landscape. This funnel shape arises because native interactions dominate the folding landscape, while interactions not present in the native state (i.e. non-native interactions) contribute only in an average way. Structure-based models (SBMs) of proteins ignore non-native interactions by encoding only the folded structure of the protein into the energy function. This energy function can then be used to perform molecular dynamics (MD) simulations. The advantage of using SBMs is that they simplify the energy function such that long time-scale biomolecular motions such as protein folding, large conformational transitions and protein self-assembly can be easily sampled. We have been using and developing SBMs to understand mechanisms of biomolecular self-assembly, including those of multimerization and domain-swapping in viral proteins and how pieces of a protein (self-peptides) interact with the whole protein.



Cartoon of a structure-based model coarse-grained to a single Cα bead per residue.

PUBLICATIONS

- DL Prakash, S Gosavi, "The diversity of protein-protein interaction interfaces within T= 3 icosahedral viral capsids", Frontiers in Molecular Biosciences 9, 967877, 2022.
- S Yadahalli, LP Jayanthi, S Gosavi, "A Method for Assessing the Robustness of Protein Structures by Randomizing Packing Interactions", Frontiers in Molecular Biosciences 9, 849272, 2022.

Shaon Chakrabarti
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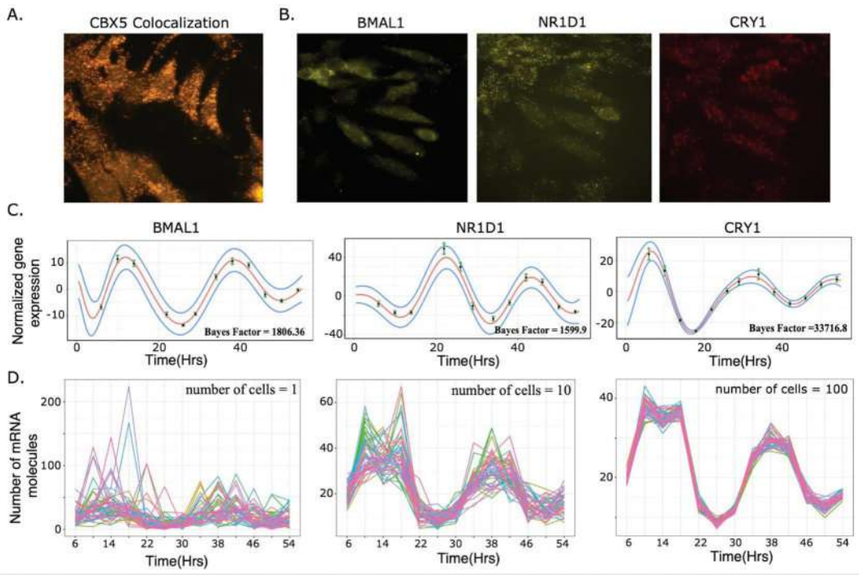
THEORY, SIMULATION, AND MODELLING OF BIOLOGICAL SYSTEMS

Quantitative Cell Biology: Cellular Proliferation in Development and Disease

My research combines theory and experiments to study cellular proliferation at the single-cell level: its underlying physical principles, control mechanisms, and consequences in development and disease.

My lab continues to explore a variety of research directions with cell proliferation forming the unifying element within somewhat disparate cell-biology questions.

We have established a simple theoretical framework for understanding how population growth laws emerge in cancer cells during treatment with anti-cancer therapies, from fluctuations (non-genetic heterogeneity) at the single cell level. These fluctuations induce a variety of lineage correlation patterns which we are using as probes to understand how the circadian clock drives cell proliferation and also to infer the phase of the circadian clock in single cells. Along with developing these theoretical frameworks, we have also successfully established single molecule FISH protocols to quantify and utilise information hidden in the lineage correlations. We have imaged multiple circadian clock genes and demonstrated how circadian phase inference can be made from as low as 10 cells *(see Figure below).*



smFISH to infer circadian phase. (a) Colocxalization experiment showing 95% specificity. (b) Example smFISH images. (c) Trajectories of 3 genes. (d) Oscillations emerge upon averaging over as few as 10 cells.

PUBLICATIONS

- "An improved rhythmicity analysis method using Gaussian Processes detects cell-density dependent circadian oscillations in stem cells", Shabnam Sahay, Shishir Adhikari, Sahand Hormoz, Shaon Chakrabarti*, Bioinformatics, Volume 39, Issue 10, October 2023.

Shashi Thutupalli

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THEORY, SIMULATION, AND MODELLING OF BIOLOGICAL SYSTEMS

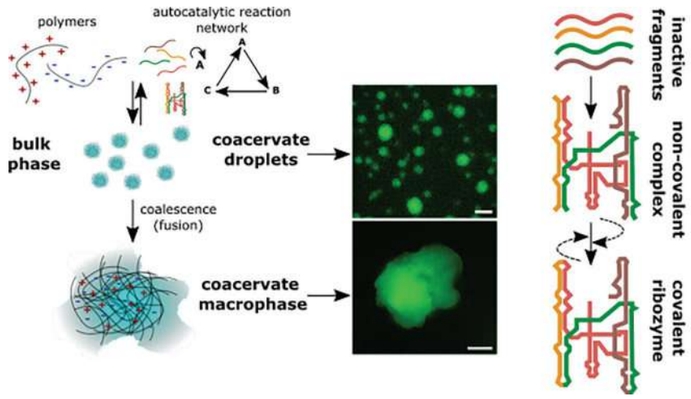
Living Metamaterials: Towards a Synthetic Biology from a Physical Perspective

We are interested in the underlying principles of emergence and organization in living systems. Towards this goal, we develop quantitative experiments combined with conceptual frameworks.

As part of our long-term research program, jointly with the group of Sandeep Krishna, in creating synthetic "Darwinian-like protocells", we created and studied pre-biotic chemistries within the confines of complex coacervates. We also reported a new class of molecular motors that play a key role in vesicle trafficking inside cells. This was in collaboration with the groups of Marino Zerial and Stephan Grill at the MPI in Dresden.

Our HFSP grant, together with Geert van den Bogaart and Stefano Sacanna draws to a close this year and has resulted in 3 publications overall, in addition to exchange research visits for the postdocs working on this project.

In terms of personnel, we have some happy news: Anupam Singh has moved on to do his postdoc at the MPI, Dresden. Sandeep Ameta, a Simons postdoc in my group, has started an independent faculty position at Ashoka University. Yoshiya Matsubara, a joint Simons postdoc, has moved to a new postdoctoral position at the University of Chicago with Arvind Murugan and Jack Szostak.



(Left) Schematic representation of phase separated compartments formed by interactions between oppositely charged polymers (PAA and spermine). These phase-separated compartments can exist as spatially isolated, micron-sized "coacervate droplets" in solution or can coalesce into a single consolidated "coacervate macrophase". Both these coacervate environments support autocatalytic RNA self-assembly and reaction network formation. (Middle) Microscopy images (green fluorescence channel) of PAA-spermine coacervate droplets (top right, scale bar 5 μm) and coacervate macrophase (bottom right, scale bar 10 μm). The fluorescence is due to 30-nt long oligonucleotides labeled with Alexa-488 added during the coacervation step.
(Right) Schematic showing the self-assembly of Azoarcus covalent ribozyme (WXYZ, ~200 nt) from its inactive substrate RNA fragments (red:W~ 65 nt, yellow: X ~ 43 nt, green: Y ~ 52 nt, brown: Z ~ 55 nt)33,36. The 5'-end of W and 3'-end of W, X, and Y contain 3-nt long recognition elements annotated as "IGS" and "tag", respectively. When mixed together, the substrate RNA fragments rapidly self-assemble to form a non-covalent complex (catalytically active) which is converted to a covalent ribozyme (catalytically active, WXYZ). The dashed arrow denotes catalytic feedback from the non-covalent as well as covalent catalysts.

PUBLICATIONS

- Multispecies autocatalytic RNA reaction networks in coacervates. S Ameta, M Kumar, N Chakraborty, YJ Matsubara, D Gandavadi, S Thutupalli. Communications Chemistry 6 (1), 91, 2023.
- Two-component molecular motor driven by a GTPase cycle. A Singh, JA Soler, J Lauer, SW Grill, M Jahnel, M Zerial, S Thutupalli. Nature Physics, 1-8, 2023.

Shruthi Viswanath

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THEORY, SIMULATION, AND MODELLING OF BIOLOGICAL SYSTEMS

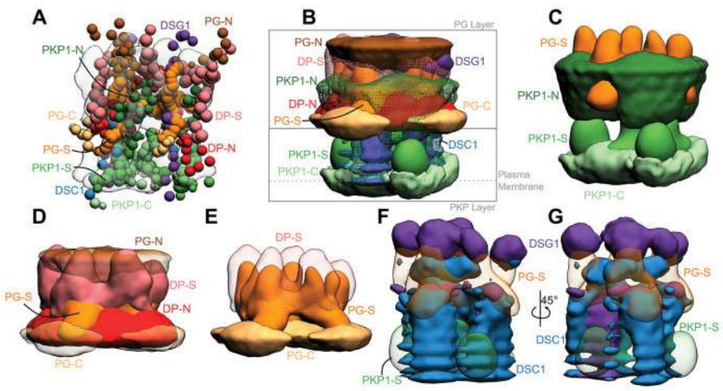
Integrative Structural Biology of Large Macromolecular Assemblies

Using an integrative approach, we develop and apply methods to determine protein organization in cells by characterizing their structures in binary complexes, macromolecular assemblies, and nanoscale architectures.

Large molecular machines, such as the ribosome or proteasome, contain tens to hundreds of proteins, and are molecular machines. The structures of these assemblies are key to understanding mechanistic details of biological function. We seek to understand: How did these machines evolve? How are they assembled and regulated in the cell?

Determining the structures of these assemblies using a single experimental method is challenging. Therefore, we use an integrative approach, combining data from biophysical, biochemical, genetics, and cell biology experiments, along with statistical inference, physical principles, and prior models. We are currently characterizing assemblies in three broad areas: assemblies involved in chromatin remodeling, assemblies at cell-cell junctions, and mitochondrial assemblies.

Our other focus is developing rigorous methods and software for computational modeling of protein organization. Our methods are used by the PDB (Protein Data Bank). We use statistical inference including machine learning and deep learning, along with graph theory and methods from computer vision.



Integrative structure of the desmosomal ODP A) The cluster center bead model for the major structural cluster with the cryo-tomogram (EMD-1703) superimposed in translucent gray. B) Localization densities of the major cluster. The densities are at a cutoff of approximately 15% for PKP1-C, PKP1-S, PG-S, DP-S, Dsc1, Dsg1 and around 30% for disordered termini regions (PKP1-N, PG-N, DP-N, PG-C). C) Localization densities for PKP1 layer (PG-S density is shown for reference). D) Localization densities for PG-layer. E) The densities for PG-S and DP-S with PG-C as a reference. F-G) Localization densities for the cadherins. Panel G is a rotated view of Panel F. See also Fig. S2-S4.

PUBLICATIONS

- Satwik Pasani, Kavya S Menon, Shruthi Viswanath, The molecular architecture of the desmosomal outer dense plaque by integrative structural modeling, bioRxiv 2023.06.13.544884; doi: https://doi.org/10.1101/2023.06.13.544884.
- Arvindekar, S, Jackman, MJ, Low, JKK, Landsberg, MJ, Mackay, JP, Viswanath, S. Molecular architecture of nucleosome remodeling and deacetylase sub-complexes by integrative structure determination. Protein Science. 2022; 31(9):e4387. https://doi.org/10.1002/pro.4387

HONORS AND AWARDS

- Cover image on Protein Science, "Molecular architecture of nucleosome remodeling and deacetylase sub-complexes by integrative structure determination." Arvindekar et al, Protein Science 2023.

5

Neurobiology

Regulation of Electrical Synapse Formation
Abhishek Bhattacharya

Brain Homeostasis and Neuroinflammation
Hiyaa Ghosh

Physics, Neurobiology, and Ecophysiology of Insect Flight and Insect Architecture
Sanjay P Sane

Adios and a Pivot to Translational Neuroscience
Sumantra Chattarji

Brain Computation and Memory: from Molecules to Behavior
Upinder Bhalla

Development, Modulation, and Function of Motor Systems
Vatsala Thirumalai

Abhishek Bhattacharya
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NEUROBIOLOGY

Regulation of Electrical Synapse Formation

We are investigating the fundamental principles regulating formation and function of electrical synapses, a conserved, critical, yet much understudied feature of the nervous system.

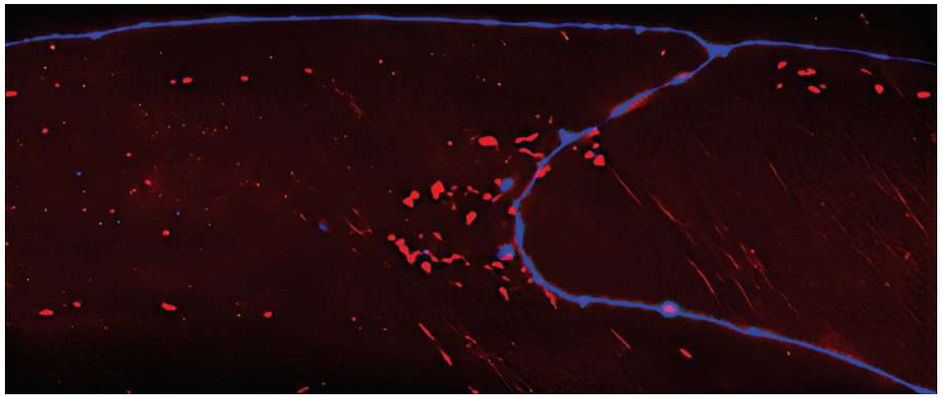
Understanding how an individual neuron finds specific synaptic partner (synaptic specificity) and connects with different partners using synapses that bear distinct properties (functional diversity), have remained pivotal questions in neuroscience. While the complex biology of chemical synapses has been widely studied, electrical synapses remained much understudied, despite playing conserved and critical roles in the establishment and functioning of the neural circuit. The overall research goal of our lab is to understand the fundamental molecular principles regulating the diversity, assembly and functioning of the electrical synapse connectome, areas that are still very poorly understood.

We are working to understand:

a) how individual neurons form molecularly and functionally distinct synapses with different synaptic partners

b) electrical synapse accessory proteins that regulate trafficking of synaptic components and synapse formation

c) how plastic changes in the electrical synapse network is achieved in response to intrinsic and extrinsic cues and b) function of gap junctions on glial cells.



Subset of electrical synapses in C. elegans head is visualized using a CRISPR/Cas9-mediaded GFP-tagged allele of Innexin-18 (pseudo colored in red). Two of the touch receptor neurons, ALM and AVM, are marked with blue axonal reporter.

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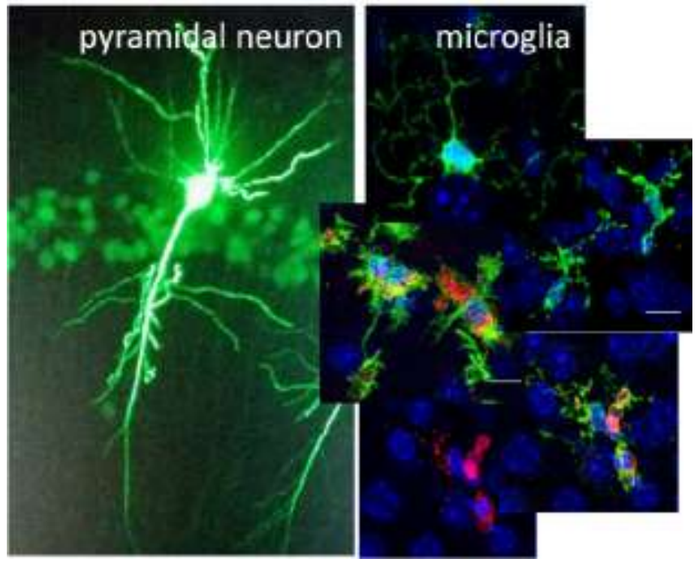
NEUROBIOLOGY

Brain Homeostasis and Neuroinflammation

Research in my laboratory seeks to understand genetic regulations that underlie homeostatic functioning of the brain, and deregulations that cause neuroinflammation.

Our goal is to uncover genetic programs in neuron and glial cells in the adult brain that enable adaptive changes under conditions of physiological perturbations, in order to maintain homeostasis. For this, we study neurons, microglia and adult neural stem cells (NSC) using mouse-models for stress, injury, neurodegeneration and infection. We try to understand how neuronal and glial functions adapt to regain homeostasis after physiological insults. We investigate cell-specific responses as well as interaction between neurons and glia at the level of molecules and cells to circuit, behavior and cognition. For this, we use a suite of high-throughput and high-resolution tools to interrogate genes, cells and circuits in the adult mouse brain. Our recent studies have revealed that adult brain cells, including neurons, retain the flexibility to change their form and function. To examine if this is potentially to confer adaptive advantage for cellular homeostasis under conditions of physiological disturbance, we also investigate functional diversity and cellular heterogeneity within neuronal and glial cells, to integrate these concepts into the larger context of cellular homeostasis in the adult brain.



Left panel: dye-filled projection neuron in mouse brain hippocampus showing the dendritic arborization. Right panel: Resting microglia (top) and varied versions of activated microglia (lower four images, showing phagocytic cups (red) with engulfed DNA (blue) in lower two microglia images.

PUBLICATIONS

- Sahasrabuddhe V, Ghosh HS. Cx3Cr1-Cre induction leads to microglial activation and IFN-1 signaling caused by DNA damage in early postnatal brain. Cell Rep. 2022;38(3):110252. doi:10.1016/j.celrep.2021.110252
- Sarkar, D., Shariq, M., Dwivedi, D. et al. Adult brain neurons require continual expression of the schizophrenia-risk gene Tcf4 for structural and functional integrity. Transl Psychiatry 11, 494 (2021). https://doi.org/10.1038/s41398-021-01618-x

HONORS AND AWARDS

- Recently Recommended Fellowship for Clinical and Public Health Research Fellowship and Basic Biomedical Research Fellowship 2022 by DBT/Wellcome Trust India Alliance
- EMBO Global Investigator.

Sanjay P Sane

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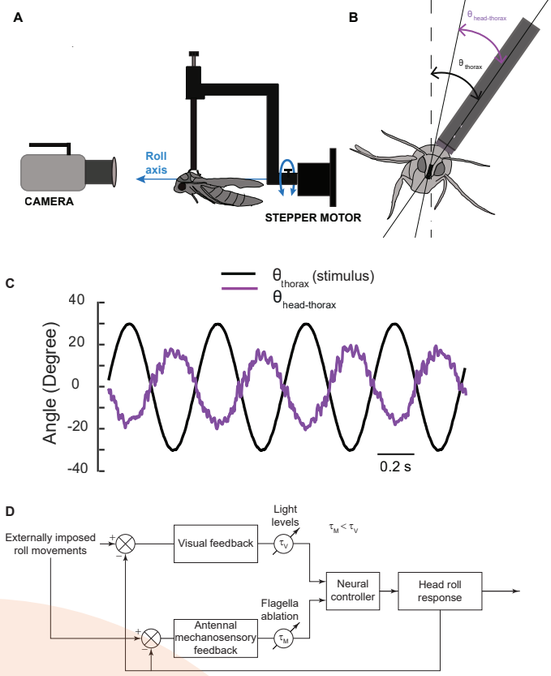
NEUROBIOLOGY

Physics, Neurobiology, and Ecophysiology of Insect Flight and Insect Architecture

We study the physics, neurobiology, and ecophysiology of insect flight and insect architecture, including flight-related behaviours such as aerial manoeuvers, territorial chases, short/long-distance navigation, and individual or collective nest-building.

Insect flight is an extraordinary feat of evolution. Insects were the first animals to evolve flight and have maintained their mastery over the aerial habitat. Across various scales of size and neural complexity, insects fly with exquisite speed, control, and maneuverability. Their wings can flap at several hundred beats per second—each wingstroke finely controlled by a sensorimotor system that acquires and processes information at similarly rapid rates. Sensory information acquired by visual, olfactory, mechanosensory, hygro-, and thermo-sensory organs is communicated to the central nervous system, which generates motor responses in the form of head, leg, and wing movements. To understand the mechanistic details of even mundane observations about flying insects *(e.g. flies chasing other flies, moths hovering on flowers, dragonflies or hoverflies guarding territories, etc.),* we must conduct a multi-disciplinary study of the entire chain of events from sensory input to motor output and flight force generation.

My laboratory integrates physics, engineering, biomechanics, neurobiology, muscle mechanics, and behavioural biology to address diverse flight-related phenomena and how the flight system of insects adapts to the miniaturisation of their body size. We also study complex nest-building behaviour in insects, which involves intricate coordination of their movements at individual and collective levels.



Head movements in insects are essential for gaze stabilization.
The figure depicts an assay to (A) film and (B) quantify head movements. These experiments allow us to measure the compensatory head movements in hawkmoths (C) By altering the visual and antennal mechanosensory feedback, we showed that both these inputs are integrated by the brain to generate compensatory head movements to stabilize gaze. (D) A conceptual model for the multisensory integration of visual and antennal mechanosensory feedback by the head movement system.

PUBLICATIONS

- Chatterjee, P., Prusty, A.D., Mohan, U, and Sane, S.P. (2022) Integration of visual and antennal mechanosensory feedback during head stabilization in hawkmoths. eLife 2022;11:e78410.
- Sane, S. P., Manjunath, M., & Mukunda, C. L. (2023). Vestibular feedback for flight control in hawkmoths. Trends in Neurosciences.

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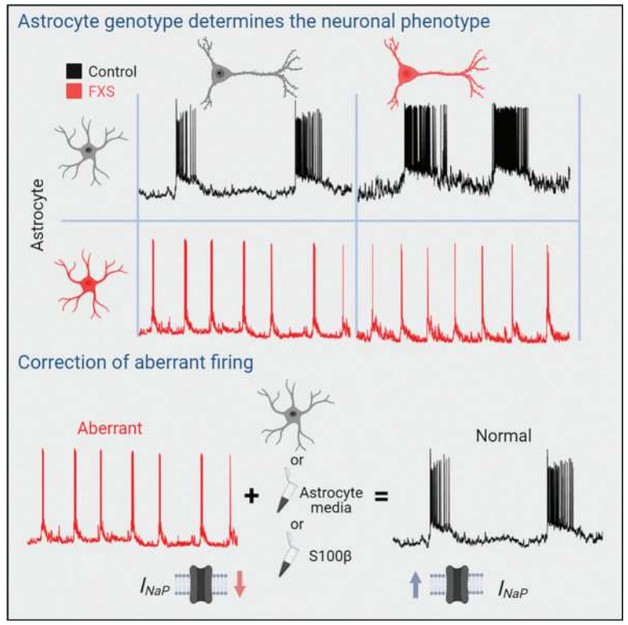
NEUROBIOLOGY

Adios and a Pivot to Translational Neuroscience

After more than 20 years at NCBS, as my laboratory was winding down its work, an entirely new line of research led to some very interesting insights into the pathophysiology of Fragile X Syndrome (FXS), a leading genetic cause of intellectual disability and autism spectrum disorder. Using human pluripotent stem cells *(Figure, adapted from Sharma et al., Cell Reports 2023)*, we found that FXS cortical neurons fire aberrant spontaneous bursts of action potentials. In a co-culture system, the astrocyte genotype determines the neuronal phenotype. Strikingly, astrocyte-conditioned media, alone, is enough to determine neuronal firing patterns. Addition of S100β, which is lower in FXS astrocyte media, restores normal firing by enhancing a persistent sodium current (I_{NaP}) in FXS neurons. These results identify an important cell non-autonomous contribution of human astrocytes in correcting aberrant electrical activity in human FXS neurons, thereby suggesting a framework for exploring new therapeutic strategies aimed at human neuron-glia interactions.



The example described above underscores the need for new interdisciplinary approaches in discovery neuroscience that can be translated into effective therapeutic interventions. Hence, I am now setting up a new translational neuroscience institute in Kolkata, called CHINTA, to meet these challenges by harnessing India's strengths in the physical, computational, engineering, and biomedical sciences.

1. Astrocyte genotype determines the neuronal phenotype.
2. Correction of aberrant firing.

PUBLICATIONS

- Datta S, Rashid Z, Naskar S, and Chattarji S (2023) Administration of the glutamate-modulating drug, riluzole, after stress prevents its delayed effects on the amygdala in male rats. Proc. Natl. Acad. Sci. USA Nexus DOI: 10.1093/pnasnexus/pgad166.
- Sharma SD, Reddy BK, Pal R, Ritakari TE, Cooper JD, Selvaraj BT, Kind PC, Chandran S, Wyllie DJA and Chattarji S (2023) Astrocytes mediate cell non-autonomous correction of aberrant firing in human FXS neurons. Cell Reports DOI: 10.1016/j.celrep.2023.112344.

Upinder Bhalla

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NEUROBIOLOGY

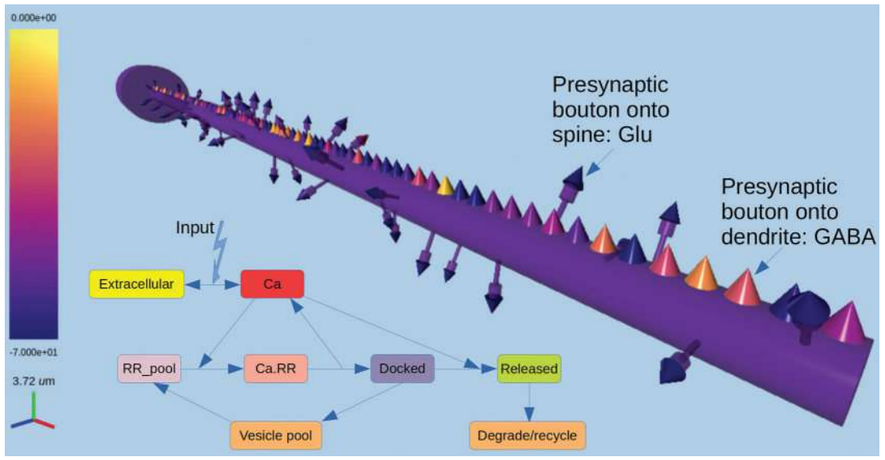
Brain Computation and Memory: from Molecules to Behavior

We study how pattern recognition and memory formation emerge from molecular, electrical and mechanical signaling in neurons. We use computer models and experiments including optical recordings, optogenetics, and electrophysiology.

In vivo, 2-photon imaging of hippocampal activity in mice shows us that while stimulus responses remain the same during learning, time-selectivity may spike before new associations are formed.

In vitro, we use optogenetics in mouse brain slice to deliver precise patterned stimuli to the hippocampal network while monitoring responses. Different sets of synapses on the same cell may show different plasticity profiles, yet retain exquisite balance between excitatory and inhibitory inputs over complex pulse trains.

In silico, we have developed an array of tools for building data-driven models of brain function in health and disease *(https://findsimweb.ncbs.res.in).* We use these tools to develop multiscale models of synaptic plasticity, subcellular sequence recognition, and activity-triggered protein synthesis in synapses with particular relevance to autism. Our in-vitro data feed into these models, which suggest that single cells perform pattern recognition in space and time. We also model the mechano-chemical basis for dendritic spine formation.



Multiscale model of CA3 excitatory inputs and CA1 inhibitory interneurons projecting onto a single conductance-based model of a CA1 neuron (purple). Excitatory presynaptic inputs are conical caps on dendritic spines, and inhibitory synapses are conical caps on the dendrite. Activity is indicated by the color of the conical caps. All synapses have a chemical signaling model (below) for presynaptic vesicle release.

PUBLICATIONS

- Asopa A, Bhalla US. A computational view of short-term plasticity and its implications for E-I balance. Curr Opin Neurobiol. 2023;81:102729. doi:10.1016/j.conb.2023.102729
- Ananthamurthy KG, Bhalla US. Synthetic Data Resource and Benchmarks for Time Cell Analysis and Detection Algorithms. eNeuro. 2023;10(3):ENEURO.0007-22.2023. Published 2023 Mar 17. doi:10.1523/ENEURO.0007-22.2023

HONORS AND AWARDS

- Sir M. Visvesvaraya Senior Scientist State Award, Karnataka.
- CEFIPRA 68T08-3 Automated generation and analysis of signaling networks models for quantitative biology and precision medicine. (Co-PI Dr. Ovidiu Radulescu, U. Montpellier).

Vatsala Thirumalai

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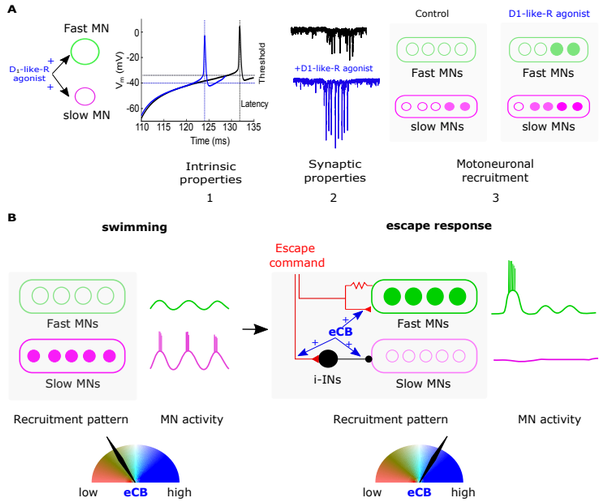
NEUROBIOLOGY

Development, Modulation, and Function of Motor Systems

In vertebrates, locomotion is generated by multiple circuits in the brain and spinal cord acting in a coordinated fashion. We study how these circuits assemble and how they function at all stages of life.

My lab focuses on the function and development of brain circuits that control locomotion using the small freshwater fish zebrafish as our model system. Our work aims to understand how disparate circuits in the optic tectum, cerebellum, hindbrain, and spinal cord work together to generate appropriate locomotor behaviour. We also examine how locomotory circuits are assembled de novo, quite early in development when much of the nervous system is immature.

We use a range of techniques to probe how single neurons compute, how such computations are integrated circuit-wide and how behavior is generated. Some of the tools we use include genome editing, whole cell patch clamping, calcium imaging and high speed videography of larval swim kinematics. Lately, we have also forayed into building models of neurons to ask how their activity patterns are generated.



Neuromodulation of synaptic and intrinsic properties of motoneurons alters motoneuronal recruitment pattern.
A. D1-like-R activation modulates both intrinsic properties (1) and excitatory synaptic drive (2) in fast and slow motoneurons in larval zebrafish during optomotor response. These changes result in enhanced activation of slow motoneurons as well as additional recruitment of fast motorneurons that are typically silent during this behavior.
Figure adapted from (Jha and Thirumalai, 2020).

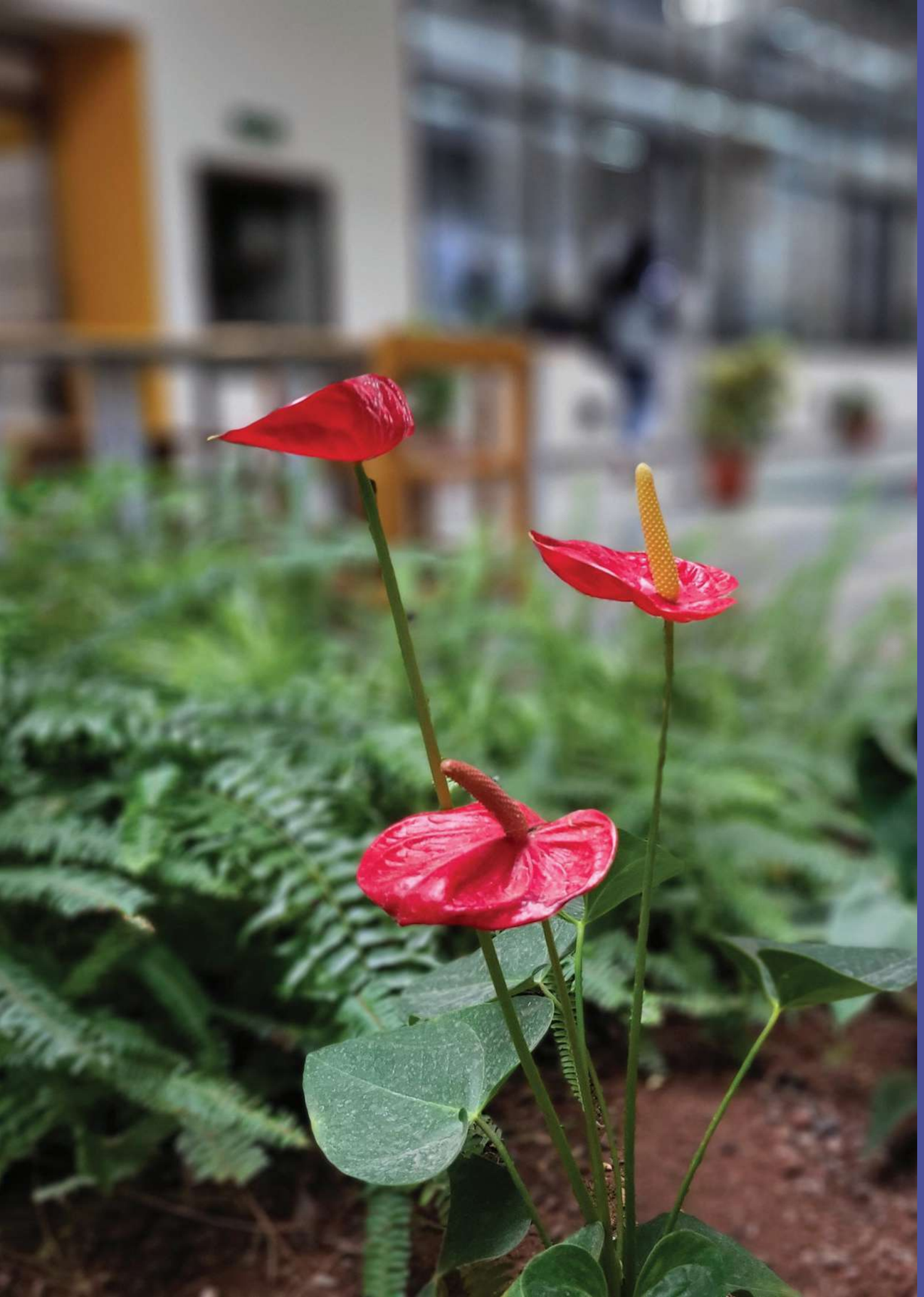
B. Left: Slow motoneurons in adult zebrafish are recruited during slow swimming while fast motoneurons only receive sub-threshold synaptic inputs. Right: During escape response, the Mauthner system indirectly inhibits slow motoneurons via inhibitory interneurons (i-INs) while fast motoneurons are activated via mixed synapses. This selection of fast motoneurons over slow motoneurons during escape is positively modulated by endocannabinoids (eCB, blue arrows). Based on (Song et al., 2015).
(Thirumalai and Jha, 2022)

PUBLICATIONS

- Thirumalai V, Jha U. Recruitment of Motoneurons. Adv Neurobiol. 2022;28:169-190. doi:10.1007/978-3-031-07167-6_8
- Narayanan S, Varma A and Thirumalai V*, Predictive neural computations in the cerebellum contribute to motor planning and faster behavioral responses in larval zebrafish. Sci. Adv., 2024.

HONORS AND AWARDS

- Featured as one of 75 women scientists of India in the book Vigyan Vidushi, book released by the Minister of Science and Technology on the occasion of 75th year of independence.
- Distinguished Alumni Award-2023, Alagappa College of Technology, Anna University, Chennai.



6 Ecology and Evolution

Deepa Agashe
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ECOLOGY AND EVOLUTION

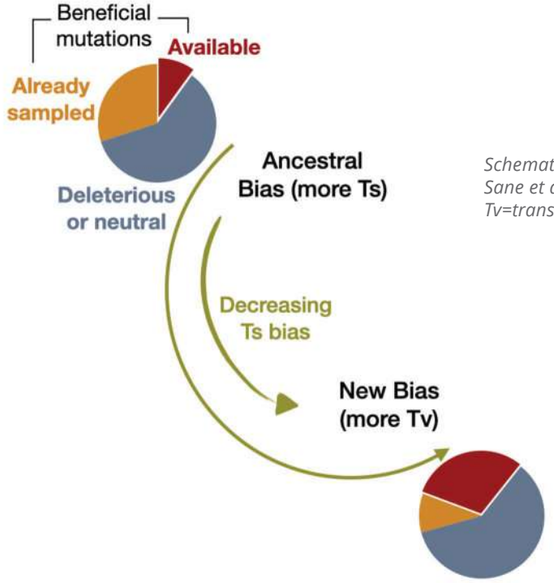
Genetic and Ecological Factors Underlying Adaptive Evolution

We aim to understand evolutionary processes, focusing on the genetic and ecological drivers and consequences of adaptation to new niches.

Mutations are important because they provide the raw material for evolutionary change and drive adaptation. Interestingly, mutational processes are inherently biased in most species, such that some types of mutations occur more often than others. Recent studies have suggested that such mutational bias could significantly alter the course of evolution. Combining experimental evolution, theory, and phylogenetic analyses, we now find direct evidence for these predicted effects.

We changed the transition mutation bias of wild type *Escherichia coli* towards a transversion bias, and found that the bacterium could now access many more beneficial mutations. Simulations showed that such bias reversals are beneficial because they allow a population to explore types of mutations that were previously rarely encountered (Figure). Analysis of over a thousand bacterial genomes suggested that historically, bacteria may have often experienced such beneficial bias switches.

Our work has opened up an exciting new perspective – the role of mutational bias – on the fundamental question of what drives evolutionary change.



Schematic showing a summary of key findings from Sane et al 2023, PNAS. Ts=transition mutations, Tv=transversion mutations.

PUBLICATIONS

- Sane M, Diwan GD, Bhat BA, Wahl LM and Agashe D (2023). Shifts in mutation spectra enhance access to beneficial mutations. Proceedings of the National Academy of Science 120:e2207355120.
- Raval PK, Ngan WY, Gallie J and Agashe D (2023). The layered costs and benefits of translational redundancy. eLife 12:e81005.

HONORS AND AWARDS

- 2023: Invited speaker, Gordon Research Conference on Animal-microbe symbioses-Recent Advances in Evolutionary and Functional Analyses of Symbiotic Interactions, Lucca, Italy.
- 2022 – present: Co-chair, Committee for the Global Evolutionary Biology Initiative of the European Society for Evolutionary Biology.

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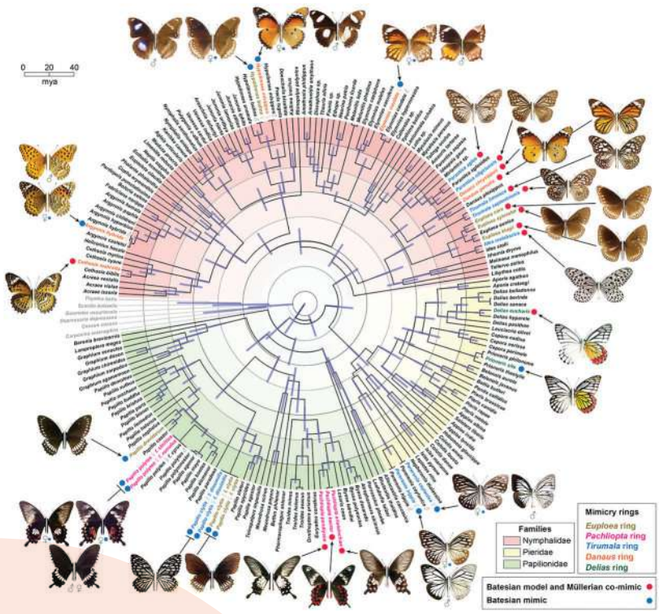
ECOLOGY AND EVOLUTION

Speciation, Adaptation, and Morphological Diversification in the Tropics

Diversity is the cornerstone of life on earth. We are evolutionary biologists who study the origins and mechanisms that underlie the proliferation of biodiversity in tropical regions such as India.

Our Biodiversity Lab has a broad interest in evolutionary biology, ecology and genetics, encompassing the fields of natural selection theory, evolutionary genetics, population and community ecology, and conservation biology. Specifically, we study ecological, sexual and population genetic underpinnings of why populations and traits diverge, and why they often result in new species or sexually dimorphic and polymorphic adaptations. This provides a larger perspective on the evolution of biodiversity.

Our main study system is Batesian mimicry, which is a phenomenon in which unprotected prey species (called 'mimics') gain protection from predators by mimicking toxic or otherwise protected species (called 'models'). Predators learn to avoid models based on prior experience, and subsequently avoid eating mimics due to misidentification. Hundreds of mimetic insects (especially butterflies) are known from tropical forests. There is tremendous variation in Batesian mimicry: mimicry can be sexually monomorphic, polymorphic, or sex-limited within and across species. Our research aims to understand selective pressures that favour such variations in mimetic colour patterns, and uncover its genetic basis.



A time-calibrated Bayesian phylogeny showing relationships of species and memberships of each mimetic community in the Western Ghats. The aposematic Batesian models and Müllerian co-mimics are marked by a red dot, and edible Batesian mimics by a blue dot next to the species names. Species names are colour-coded by their membership in mimetic communities. Males and females are shown separately only for species in which the sexes are distinctly dichromatic; all the other species are largely monochromatic. The left sides of butterflies illustrate dorsal colouration, right sides illustrate ventral colouration. (From Basu et al. 2023, PNAS).

PUBLICATIONS

- Basu, D. N., V. Bhaumik, and K. Kunte. 2023. The tempo and mode of character evolution in the assembly of mimetic communities. Proceedings of the National Academy of Sciences, USA, 120:e2203724120.
- Deshmukh, R., S. Baral, M. Kuwalekar, A. G. Kizhakke, and K. Kunte. 2022. Reproductive barriers and genomic hotspots of adaptation during allopatric species divergence. Preprint on bioRxiv. DOI: https://doi.org/10.1101/2022.03.11.483945.

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ECOLOGY AND EVOLUTION

Terrestrial Ecosystems and Community Ecology

Can our ecosystems cope with the challenges of ever-expanding human activities? We work on understanding the dynamics of mixed tree-grass ecosystems, their responses to changes in climate—particularly drought—and what this means for their future distribution and functioning.

Current research in the lab is grouped around the following broad themes that examine:

(a) how interactions and feedbacks between climate, biogeochemistry, fires, and herbivory influence the structure, composition, and stability of ecosystems and the cycling and sequestration of nutrients.

(b) how projected changes in climate, such as increasing variability of rainfall, frequency of droughts, aridity in the tropics, nitrogen and phosphorus deposition, and rising CO_2 levels will impact ecosystem function, stability, and services.

Most of our research is carried out across a range of systems, from savannas and grasslands to tropical forests, in India and Africa. Our current and planned future work will employ both long and short-term experiments, as well as targeted field surveys to address the above questions across the gamut of natural ecosystem types of the Indian subcontinent, with the goal of bringing a comprehensive understanding of biome-scale vegetation and nutrient dynamics in the Indian subcontinent.

PUBLICATIONS

- Pörtner, H. O et al. (including Sankaran, M.)(2023). Overcoming the coupled climate and biodiversity crises and their societal impacts. Science, 380(6642), eabl4881.
- Srivathsa, A. et al. (including Sankaran, M) (2023). Prioritizing India's landscapes for biodiversity, ecosystem services and human well-being. Nature Sustainability, 1-10.

HONORS AND AWARDS

- R. M. Tulpule Chair Professorship for Global Change.

uramakri@ncbs.res.in

ECOLOGY AND EVOLUTION

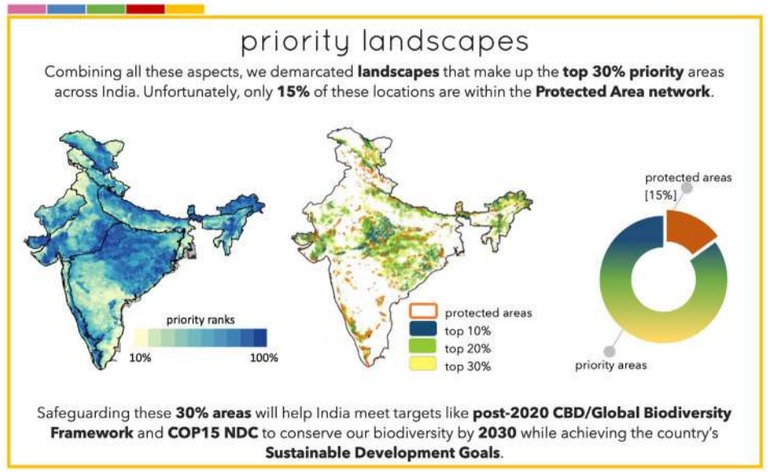
Understanding Human Impacts on Biodiversity and Facilitating Future Survival through a Genetic Lens

India has over a billion people, yet harbours incredible biodiversity. How are we impacting this diversity, and can we facilitate its survival? My research attempts to address this question.

Indian biodiversity: tracking its history, conserving its future.
In my group, we use genetic information to better understand wild populations. We aim to use these insights to suggest strategies for the conservation of threatened species, or to minimize zoonotic spillover in the Indian subcontinent.

How isolated are populations of endangered species today? What determines connectivity? Are individuals in isolated populations inbred? How has human-induced fragmentation impacted the probability of zoonoses? We use field-collected samples (invasive at times, but mostly non-invasive), generate genomic (or genome-wide) data, and use computational tools to analyze this data to answer these questions. One of the highlights of our research this year has been the genetic identification of hybridization between Indian wolf populations and feral dogs in the wild, a first of its kind.

This last year, we have worked with a large team of conservation scientists from all across India, to prioritize landscape for conservation in India. These prioritizations were based on overlapping various measures of biodiversity and ecosystem services, while being cognizant of current and future threats.



Prioritizing landscapes for conservation in India: biodiversity, ecosystem services and threats. From Srivathsa et al., 2023.
Illustration by Arjun Srivathsa.

PUBLICATIONS

- Tyagi, A, Godbole, M, Vanak, A and Ramakrishnan, U (2023) Citizen science facilitates first ever genetic detection of wolf-dog hybridization in Indian savannahs. Ecology and Evolution, https://doi.org/10.1002/ece3.10100
- Srivathsa, A, Vasudev, D, Nair, T, Chakrabarti, S, Chanchani, P, DeFries, R, Deomurari, A, Dutta, S, Ghose, D, Goswami, V R, Nayak, R, Neelakantan, A, Thatte, P, Vaidyanathan, S, Verma, M, Krishnaswamy, J, Sankaran, M, Ramakrishnan, U (2023) Prioritizing landscapes to reconcile biodiversity conservation, ecosystem services, and human well-being in India, Nature Sustainability. 1-10.

HONORS AND AWARDS

- 2023: DBT Wellcome Trust India Alliance, Senior Investigator Award Renewal.
- 2023: Featured in book 'Women in the Wild: stories of India's most brilliant women wildlife biologists', edited by Anita Mani, Juggernaut, September, 2023

New Faculty

Deciphering the Molecular Battleground in Plant-Microbial Interactions
Amey Redkar

Neural Mechanisms Underlying Breathing Rhythms
Sufyan Ashhad

Amey Redkar

aredkar@ncbs.res.in

CELLULAR ORGANISATION AND SIGNALLING

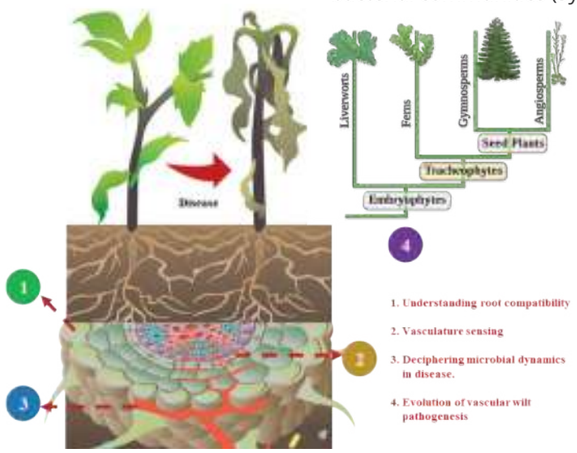
Deciphering the Molecular Battleground in Plant-Microbial Interactions

Our research aims to identify the genetic and molecular determinants of plant diseases. We study the regulatory mechanisms during fungal pathogenesis in plant roots and the microbial crosstalk in the rhizosphere.

Our long-term interest is to understand how fungi establish compatibility with plant roots. Specifically, we investigate the crosstalk in a destructive group of root-infecting fungi called vascular-wilts. Using the fungal root pathogen *Fusarium oxysporum* (Fo), a species complex that collectively infects diverse crops such as legumes, melons, sweet potatoes, tomatoes and bananas, our work dissects the pathogenic dialogue in the root intercellular space (apoplast) using pathogenicity genes (effectors) as probes, to elucidate compatibility processes.

We aim to decipher the signal transduction during the fungal invasion, the host re-programming that occurs across different lifestyles and the host-derived signals that the fungus senses to reach the vasculature (*its ultimate destination).* We also investigate the processes that determine the transition to either pathogenic/endophytic lifestyle which likely occurs in specific cell-type such as endodermis.

On an ecological scale, we understand the modulation of the rhizosphere microbiome by vascular-wilt fungi and dissect the interaction dialogue these fungi have with native plant microbiota to elucidate how these interactions shape the disease outcome. Using synthetic microbiology approaches, we engineer and reconstitute plant microbiota using the formulations of synthetic bacterial communities (SynComs) to test as a means of biological control.



Moreover, we are keen to understand the evolution of pathogenicity in vascular-wilts to address how these fungi have adapted to vasculature (xylem) in angiosperms. For this, we investigate the widely conserved and lineage-specific pathogenicity and host mechanisms that have shaped the interactions of vascular-wilt fungi across diverse lineages of land plants. Using insightful crop and non-vascular evolutionary distant land-plant models (Tomato, Banana, *Arabidopsis, Marchantia polymorpha* and *Adiantum capillus-veneris*), we are gaining a holistic understanding of the evolution of microbial pathogenicity as well as the evolution of plant root immunity.

Schematic representation of the different objectives that our research group investigates to get a holistic understanding of fungal interactions below ground.

PUBLICATIONS

- Redkar A*, Sabale M, Schudoma C, Zechmann B, Gupta YK, López-Berges MS, Venturini G, Gimenez-Ibanez S, Turra D, Solano R, Di Pietro A* (2022b). Conserved secreted effectors contribute to endophytic growth and multi-host plant compatibility in a vascular wilt fungus. The Plant Cell (Breakthrough Report) 34(9), pp: 3214-3232. (Selected for Cover Image Vol34, Issue9, Sep22).
- Redkar A*, Gimenes-Ibanez S, Sabale M, Zechmann B, Solano R, Di Pietro A* (2022a). Marchantia polymorpha model reveals conserved infection mechanisms in the vascular wilt fungal pathogen Fusarium oxysporum. New Phytologist 234, pp: 227-24. (Selected for Cover Image Vol234, Issue1, April 22) *corresponding author

HONORS AND AWARDS

- Ramalingaswami Re-entry Fellowship, DBT, India.
- Ko-Shimamoto Travel Award to attend XIX IS-MPMI Congress, USA.

Sufyan Ashhad

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NEUROBIOLOGY

Neural Mechanisms Underlying Breathing Rhythms

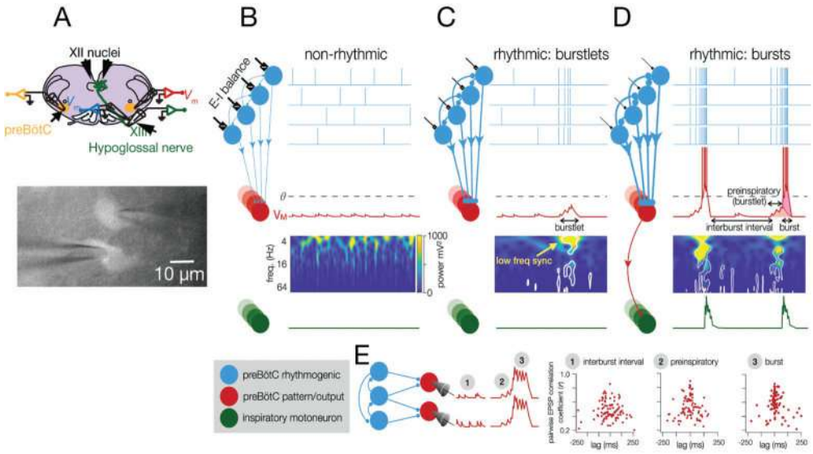
We investigate the neuronal mechanisms underlying breathing rhythm generation and its control, employing an integrative and interdisciplinary approach spanning computational and experimental neuroscience.

Breathing is a rhythmic motor behavior generated by neural circuits in the brainstem, the breathing central pattern generator (bCPG). preBötzinger Complex (preBötC)–the kernel of bCPG–generates the inspiratory rhythm. Breathing rhythms impact the brain and the body in several ways, by binding activity in different brain regions and regulating several behaviors. Our laboratory aims to elucidate the computational logic of the preBötC rhythm generation and its regulation by asking:

i. What features of network organizations and dynamics allow preBötC rhythm to be robust yet flexible?

ii. How does preBötC modulate activity in other brain regions?

We employ *in vitro* and *in vivo* electrophysiological recordings and computational modeling to understand the mechanism of breathing rhythm generation, regulation, and breathing-modulated behaviors in rodents.



preBötC synchronization, gated by background excitation-inhibition (E-I) balance, drives rhythmicity. A top: experimental configuration to study preBötC rhythm in brainstem slices. (B-D) Connection scheme with firing pattern of rhythmogenic neurons, membrane potential (Vm), and Vm time-frequency decomposition from an output neuron recorded in vitro. (B) Background E-I balance is tilted toward I (C) When E-I balance tilts toward E, recurrently connected rhythmogenic neurons begin to synchronize, (D) Further shift E-I balance enhances the ability of rhythmogenic neurons to synchronize strongly, leading to an inspiratory burst. (E) Simultaneous recordings from pairs of output neurons illustrate the synchronization of their synaptic inputs via their pairwise excitatory postsynaptic potential (EPSP) correlograms as the cycle evolves from the interburst interval (1) to preinspiratory (2) to inspiratory burst (3) phases.

PUBLICATIONS

- Ashhad, S*., Kam, K*., Del Negro*, C.A., Feldman, J.L., 2022. Breathing Rhythm and Pattern and Their Influence on Emotion. Annu. Rev. Neurosci. 45, 223–247. https://doi.org/10.1146/annurev-neuro-090121-014424
- Ashhad, S.*, Slepukhin, V.M*., Feldman, J.L., Levine, A.J., 2023. Microcircuit Synchronization and Heavy-Tailed Synaptic Weight Distribution Augment preBötzinger Complex Bursting Dynamics. J. Neurosci. 43, 240–260. https://doi.org/10.1523/JNEUROSCI.1195-22.2022

* Equal Contributions

Administration, Academics and Facilities

Administration, Procurement and Finance
Research Facilities
RDO
Library

Administration, Procurement and Finance

G. Ravi Shankar

Established in 1991 as a Centre of NCBS-TIFR has flourished over the last three decades, evolving into a distinguished Centre of Excellence within the realm of biological sciences. The administrative arm of NCBS plays a pivotal role in facilitating the institution's research endeavors and representing its interests amid the dynamic landscape of economic conditions and societal needs. This administrative team is actively engaged in coordinating the dissemination and implementation of policies, processes, and guidelines, fostering both inter and intra-departmental coordination within NCBS.

Comprising three integral divisions - **Establishment, Procurement,** and **Finance** - the NCBS administration boasts a workforce of 45 employees, encompassing both permanent and temporary staff. Each division undertakes specific operational responsibilities, contributing to the comprehensive functioning of the institution. The hallmark of the NCBS-TIFR administration lies in its commitment to hard work, punctual performance, and the delivery of a diverse range of services throughout the campus.

Over the past year, the Administration division has demonstrated a commendable team effort, showcasing an outstanding service attitude and a proactive approach to enhancing services. The team's creativity and resourcefulness have played a pivotal role in improving overall administrative functions. Notably, their positive attitude and collaborative spirit in working with students, faculty, and staff have further solidified the Administration division's contribution to the thriving academic environment at NCBS-TIFR.

The **details of personnel** at NCBS as on March 2023 are as follows:

Particulars	Sanctioned positions	Filled in positions	No. of Vacancies	Deputation	Pachmarhi Field station
Academics	42	38	4	1	0
Scientific & Technical	49	37	12	0	0
Administrative	33	21	12	0	1
Auxiliary	5	3	2	0	5
TOTAL	**129**	**99**	**30**	**1**	**6**

Contract & outsourced staff:

S. No.	Particulars	No.
1	Contract	55
2	Outsourced	320

Procurement

In the chronicles of the NCBS, a captivating tale unfolds — a remarkable model of cooperative effort within the procurement support system. This narrative traces the evolution of NCBS's procurement responsibilities, an intricate web encompassing lab consumables, equipment, furniture, and cutting-edge laboratory apparatus. The team's purview extends beyond acquisitions, delving into the management of diverse contracts, from canteen and security services to the maintenance of labs, animal houses, and buildings.

The saga deepens as NCBS takes on the mantle of mentoring the procurement and contract procedural systems for prestigious entities like the Institute for Stem Cell Biology & Regenerative Medicine (inStem) and the Centre for Cellular and Molecular Platforms, integral components of the Bangalore Life Sciences Cluster (C-CAMP). This responsibility is a testament to the institution's commitment to shaping the broader landscape of life sciences.

At the heart of this narrative lies the NCBS procurement division, a small yet formidable force, single-handedly managing a substantial 40% to 50% of the institution's annual expenditure. As the campus undergoes a transformative expansion in infrastructure and facilities, the Purchase division confronts novel challenges. The team, led by the indomitable Unit Head, strategically aligns resources, particularly emphasizing the critical role of human resources, to sustain the growth trajectory.

Amidst the challenges posed by the COVID-19 pandemic, the procurement division emerged as a hero, orchestrating the timely mobilization of materials crucial for testing and sequencing. The division's role in supporting RTPCR (Swab), sequencing, and saliva testing during this critical period underscores its indispensable contribution to scientific endeavors.

This compelling tale transcends routine procurements, delving into the nuanced realm of specialized acquisitions, including expensive capital equipment for biological and scientific research. The division's expertise extends beyond transactional matters to the meticulous finalization of contracts and agreements, showcasing an unparalleled understanding of rules and procedures.

In the discharge of multifarious and complex functions, the NCBS procurement division emerges not just as a custodian of transactions but as a guardian of knowledge, initiative, and unwavering commitment. This is a story of how a dedicated team navigates the unexpected, ensuring effective services that propel NCBS researchers toward the pinnacle of scientific excellence.

Finance

During this year, 35 new grants were added to the ever-growing list of extramural support. The Department of Biotechnology, Science and Engineering Research Board, Department of Science and Technology, Department of Health Research (GoI), Wellcome Trust-DBT India Alliance, Wipro Foundation, Simons Foundation, The Human Frontier Science Program, University of Edinburgh, Action on Hearing Loss, UK, and The Open University, London were the major contributors in the extramural category. Smt. Sudha Murty, has been financially and morally supporting the Dengue Vaccine Development Programme through her generous contributions. Shri.Gopalakrishnan and Smt. Sudha Gopalakrishnan, Trustees of Pratiksha Trust, continued their generous support this year in helping the cause of world-class research in neurobiology.

CCMB-Hyd for supporting SARS-CoV-2 Coronavirus Genomic surveillance. Also, our special thanks to M/s TNQ Technologies Pvt. Ltd., Hindustan Unilever Limited, Azim Premji Philanthropic Initiatives Pvt. Ltd., Standard Chartered Global Business Services Pvt. Ltd., and IQVIA RDS (India) Pvt. Ltd., for their extraordinary support and generous contributions to COVID-19 research.

The Centre for Brain and Mind (CBM) is an outcome of a 100 crore grant to NCBS and NIMHANS by Rohini Nilekani Philanthropies Foundation (RNPF) for long-term research, and to build capacity for both research and practice in the mental health field.

We take this opportunity to express our deepest gratitude and appreciation to all our supporters (financial, moral, and intellectual) for their continued support and generosity, and for the faith and confidence they place in NCBS.

Expenditure

Rupees in Millions

S.No.	Particulars	2020-21	2021-22	2022-23
1	Research & Development	183.40	328.10	393.86
2	Extra Mural Grants	374.62	445.93	447.88
3	Salaries & Fellowships	268.43	292.92	352.91
4	Operational Expenditure	261.86	253.84	305.01
5	Construction	0.19	0.01	6.53
	Total	**1088.50**	**1320.80**	**1506.19**

Research Facilities

Research facilities at NCBS are essential catalysts for bringing our researchers' innovative ideas to fruition. In addition to offering cutting-edge equipment and technology, the facilities offer invaluable experience and expertise and have trained a large number of scientists aiding in generating a pool of well-trained scientists in India and worldwide. These facilities foster collaboration among researchers from diverse fields, encouraging the cross-pollination of ideas and innovative problem-solving. Research facilities also facilitate access to funding sources, especially by providing the credibility associated with reputable facilities providing the services to facilitate proposed research. Currently, there are **20 facilities** helping researchers with their various needs, including sophisticated biological manipulations at tissue and organismal levels and in-depth knowledge in operating and using new technology at atomic and molecular levels.

Facilities Coordination Committee: Raghu Padinjat, Arvind Ramanathan, Deepti Trivedi, Latha Chukki, Dimple Notani, Shivaprasad PV, Taslimarif Saiyed, Vinothkumar Kutti Ragunath, Arjun Guha.

Animal Care and Resource Centre

Animal Care and Resource Centre (ACRC) is a unique state-of-the-art high barrier Specific Pathogen Free (SPF) health status laboratory animal facility which provides services and resources to accomplish animal research objectives while ensuring optimal animal welfare conditions and animal ethics regulations.

Achievements in 2022-23

- Maintained **360** strains of mice, **22** lines of rats and **40** lines of zebrafish.
- Used by **28 labs** and handled over **70 projects**.
- Trained **117 scientists** in various aspects of lab animal management.
- Acknowledged in **11 publications**.
- Implemented many cost saving measures at ACRC and enhanced ACRC **outreach activities** - training workshops & customized trainings for external scientists.

Crew: Mohan G H, Yogesh C, Latha Chukki, Abhishek, Sreenivasulu T, Manjuntha AM, Sharath DP, Lalitha KS, Unnikrishnan M, Gamyashree, Abhirup Datta, Jagdish PT, Padmavathi GV, Himakar T, Laxmankumar NA, Akash R, Aravind N, Mahesh M, Babu P, Gopi P, Kumar R, Muthana Shekara, Amarnath, Manjunath A, Nagaraju V, Nagaraju MC, Rohina, Srikanth R, Madhu H and Mahesh MV.

Faculty Advisory Committee: Raj Ladher, Colin Jamora, Vatsala Thirumalai, Soumyashree Das, Dhandapani P.

Biosafety Facility

Biosafety Facility at NCBS comprises dedicated BSL-2 and BSL-3 laboratories. The BSL-3 facility is certified for the regulatory biosafety guidelines by the Review Committee on Genetic Manipulation (RCGM), DBT-GOI in 2022. It has two independent workspaces for viral and bacterial work. The BSL-2 facilities are equipped with class-2 biosafety cabinets and essential equipment to perform studies involving risk group-2 agents.

Achievements in 2022-23

- 77 users were trained for BSL2 and BSL-3 facilities.
- 64 users used these facilities.

Crew: Akshay Tharali, Chaitra Jagannathrao.

Faculty Advisory Committee: Varadha Sundarmurthy, Colin Jamora, Dimple Notani, Sabari Radhakrishnan, Diya Binoy Joseph, Sudarshan Gadadhar, Tapomoy Bhattacharjee.

C Elegans Facility

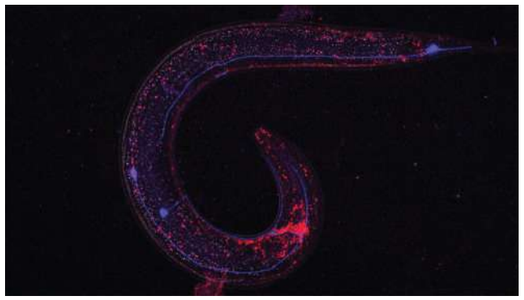
C elegans facility trains new users in regular C. elegans work, maintains C. elegans strains in frozen and growing conditions and supply C. elegans culture plates, media, worm-specific buffers etc. The facility provides services in making new transgenic C. elegans strains through germline microinjection, CRISPR/Cas-9 based knock-out and knock-in alleles.

Achievements in 2022-23

- 11 users were trained in microinjection.
- 13 users used the facility.
- Generated > 100 transgenics and ~10 CRISPR C elegans lines.

Crew: Selvanayaki E.

Faculty Advisory Committee: Abhishek Bhattacharya, Raghu Padinjat.



UNC-7__tagRFP, A heavily expressed gap junction protein in C. elegans (Blue_ Touch-receptor neurons, Red_ UNC-7__tagRFP)

Central Imaging and Flow Cytometry

Central Imaging and Flow Cytometry Facility (CIFF) is equipped with 20 state-of-the-art high-end microscopes and 11 flow cytometers.

Achievements in 2022-23

- Used for 16364 hours by 1357 users.
- Trained 221 students/researchers on microscopy and flow cytometry.
- Acknowledged in 29 papers in peer-reviewed journals.
- Record number of 18362 plant ploidy samples analyzed.

Crew: Venkatesan Iyer, Raksha K, Anil Kumar HV, Chandana S, Shraddha Sharma, Apoorva Shetty, and H. Krishnamurthy.

Faculty Advisory Committee: Anjana Badarinarayan, Minhaj Sirajuddin, Satyajit Mayor, Sudarshan Gadadhar, Shaon Chakrabarti.

Cryoelectron Microscopy

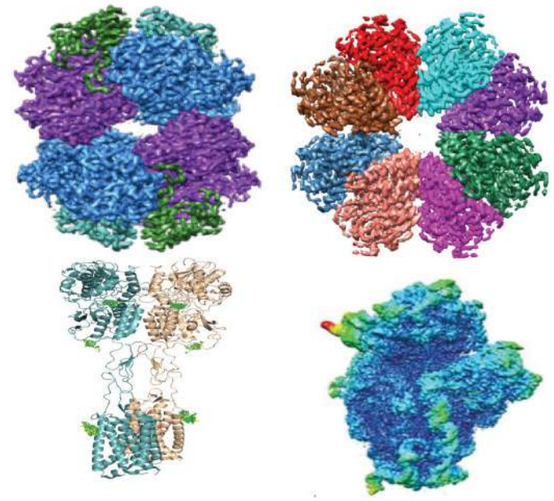
The National **Electron Cryo Microscopy Facility** houses Titan Krios (Thermo Fisher Scientific) - a 300 kV FEG Transmission Electron Microscope equipped with an autoloader. On the pre-GIF position, a general purpose CETA (CMOS) camera and a CMOS direct electron detector, Falcon 3 are housed. The instrument also has a Volta Phase plate. In addition, the microscope is also equipped with a Quantum energy filter and a K2 direct detector. Thus, the instrument is equipped for high-resolution single-particle data collection as well as tomography.

Achievements in 2022-23

- 2 users trained and 27 users used the facility.
- Acknowledged in 4 publications.
- The facility's prominent achievement is its capacity to generate high-resolution macromolecular structures, serving a diverse user community nationwide, and fostering collaborative partnerships spanning academia and industry.

Crew: Sucharita Bose.

Faculty Advisory Committee: Vinothkumar Kutti Ragunath, Minhaj Sirajuddin, Ranabir Das.



Electron Microscopy

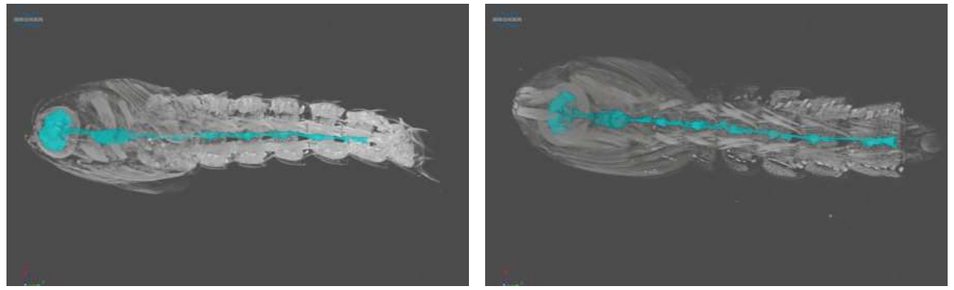
Electron Microscopy Facility is equipped with high-end electron microscopes and an X-ray Source Micro-Computed Tomography (micro-CT) scanner machine. For high-resolution imaging, the facility has a Transmission Electron Microscope (Talos F 200 C G2 and Techni T12 G2 Spirit) and Field Emission Scanning Electron Microscope (Merlin Compact VP).

Achievements in 2022-23

- 29 users trained.
- Acknowledged in 9 publications.

Crew: Priti Bhardwaj, Sunil Prabhakar, and Anjana MU.

Faculty Advisory Committee: Vinothkumar Kutti Ragunath, Swadhin Chandra Jana and Sanjay P Sane.



Neural tissue organization in Anopheles stephensi pupal stage

Fly Facility

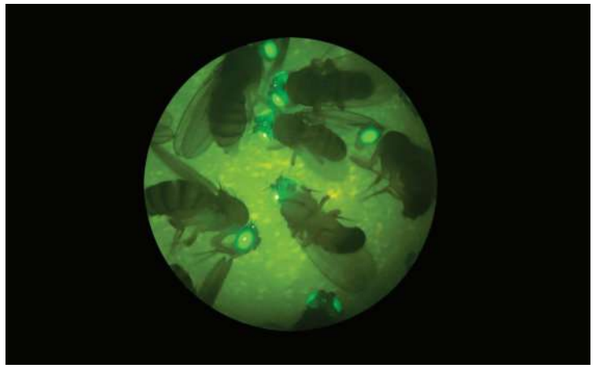
Fly Facility provides services in Drosophila stock maintenance, and genomic manipulations in Drosophila melanogaster including molecular cloning of DNA constructs, generation of transgenic and CRISPR-based mutants. It is the only facility worldwide that provides a complete CRISPR service in Drosophila melanogaster.

Achievements in 2022-23

- Generated 100 transgenic flies and 15 CRISPR flies.
- Maintained ~7000 fly stocks.
- Catered to projects from 224 internal and external users.
- Acknowledged for contribution in 11 publications.

Crew: Deepti Trivedi, Anitha V A, Hemavathy C, Kishore V, Nataraj N, Nishi Singh, Usha K, Yashwantha K.

Faculty Advisory Committee: Tina Mukherjee and Swadhin Jana.



Fly facility provides services in generation of transgenic Drosophila to internal and external users. Shown here are flies generated in the facility that expresses green fluorescence specifically in the eyes.

Genomics Facility

Genomics Facility includes Sanger sequencing and Next Generation Genomics Facility (NGGF). The Sanger Sequencing facility is equipped with a state-of-the-art 48-capillary Sanger sequencing machine. The NGGF is equipped with two state-of-the-art high-throughput next-generation sequencing platforms (NovaSeq 6000 and Hiseq2500), one bench-top next-generation sequencing platform (Miseq) and one Single Cell Genomics platform (10x Genomics).

Achievements in 2022-23

- 37 users trained.
- Acknowledged in 17 published papers.
- 26500 samples sequenced for Sanger Sequencing
- Sequenced 24325 libraries for different applications of NGS i.e. Covid, 16s metegenomics, PCR amplicon, exome, mRNA and whole genome DNA, ddRAD, ATAC, small RNA etc.
- Developed a method which can transform the single amplicon sequencing on Illumina platforms.

Crew: Awadhesh Pandit, Lakshminarayanan C P, Suresraj Y.

Faculty Advisory Committee: Dimple Notani, Dasaradhi P, Sabarinathan Radhakrishnan, Diya Binoy Joseph.

Greenhouse Facility

Greenhouse Facility has 7 greenhouses that allow researchers to maintain pure/transgenic strains of plants and insects and study plant-animal interactions. The greenhouses are equipped with adjustable and fully automated climatic control systems to control light, temperature, and humidity levels using special lights, shading screens, evaporative pads, fan cooling systems, heaters, humidifiers, and dehumidifiers. Several model plants (Arabidopsis, tobacco, rice, Nerium) are grown in the greenhouses.

Achievements in 2022-23

- 28 users used the facility.
- Acknowledged in 7 publications.

Crew: Ranjith PP, SK Munegowda, Narasimha Raju, and Parvathamma.

Faculty Advisory Committee: Shivaprasad PV, Mahesh Sankaran, Amey Redkar.

High-Performance Computing Facility

High-Performance Computing Facility caters to the ever-increasing demands from our scientific community. The facility at NCBS is a symbiosis of computing, network, graphics, and visualization. The facility is a functionally distributed super-computing environment and shared memory systems with state-of-the-art computing systems and open-source software packages all of which are inter-connected via an Infiniband network.

Achievements in 2022-23

- 243 users used the facility.
- Rebuilt the Master node of a crashed Cluster using a compute node.

Crew: Rajshekar KS.

Faculty Advisory Committee: US Bhalla, Shruthi V, Sabarinathan R, Dasaradhi P, Sunil Laxman, Vinothkumar KR.

High Throughput Screening

High throughput screening facility is equipped with state-of-art automated liquid handlers, multimode plate readers, automated imaging platforms, and multiplexing systems to quantify multiple analytes from a single sample while housing collection of RNAi libraries, small molecules and cell lines. The facility assists users in adaptation of both biochemical and cell-based assays in HTS/HCI formats through miniaturization and automation.

Crew: Latha Chukki.

Faculty Advisory Committee: Varadharajan Sundarmurthy, Arjun Guha, Dimple Notani.

Insectary

Insectary supports contemporary research on insecticides, repellents, attractants, vector development and physiology, disease transmission, host-parasite/pathogen interactions, life history studies, population dynamics, behavioural genetics, ecological interactions, and related subjects. There are three major components (a) mosquito rearing facility (b) parasite culture facility and (c) transformation facility.

Achievements in 2022-23

- Acknowledged in 2 publications.
- Successfully trained 35 users.
- Active engagement in outreach programs.

Crew: Sunita Swain, Chaitali Ghosh, Naveen Kumar, Soumya M, Soumya Gopal Joshi, Chethan Kumar R, Joydeep Roy.

Faculty Advisory Committee: Sanjay Sane, Varadharajan Sundaramurthy, Tina Mukherjee, Sonia Sen.

Mass Spectrometry Facility

Mass Spectrometry Facility is equipped with advanced Mass spec (MS) technologies and established workflows to characterize biological and chemical molecules such as Metabolites, Glycans, Lipids, Proteins, Biosimilars, Antibodies and synthetic lab molecules. It also provides post-translation identification and quantitation of biomolecules using labelled and label-free workflow.

Achievements in 2022-23

- Trained ~60 researchers in different LC-MS/MS technologies, such as lipidomics, proteomics, metabolomics, and glycomics.
- Contribution of the facility is acknowledged in several publications.

Crew: Nirpendra Singh, Alifia Jaffer, Sohail Khan, Jyothi Prabha, Theja PP.

Faculty Advisory Committee: Arvind Ramanathan, Ranabir Das, and Raghu Padinjat.

Mouse Genome Engineering Facility

Mouse genome engineering facility is a well-equipped state-of-the-art functional facility for the generation of transgenic and gene-edited mouse models. The main operational domains of the MGEF Facility are 1) using the latest gene-editing tools and technologies to generate customized new mouse models; 2) mouse sperm and embryo cryo-banking services; 3) access to the latest mouse-assisted reproductive technologies to maintain and recover complicated mouse lines; 4) training & workshops.

Achievements in 2022-23

- Catered to 246 projects related to genome editing and assisted reproductive technologies.
- 34 users trained.

Crew: Mahesh Sahare, Shilpakumari B. A, Reena V, Mahima N, Vaishak Nair, Salil Hangekar, Priya P, Akash Aswini, Abhishek Anand, Latha Chukki.

Faculty Advisory Committee: Raj Ladher, Colin Jamora, Vatsala Thirumalai, Soumyashree Das, Dhandapani P.

Microfluidics and Microfabrication

Microfluidics and Microfabrication Facility has a Class 10000 (ISO 7) cleanroom that is equipped with state-of-the-art fabrication and characterization tools to design, manufacture, and test PDMS and other polymer-based microfluidic devices and microstructures. The facility supports research activities in the campus by offering services in designing, fabricating and optimization of experiments that require micron-scale precision.

Achievements in 2022-23

- 52 researchers, students, and innovators were trained in various aspects of microfluidics.

Crew: Karthik Mahesh.

Faculty Advisory Committee: Shashi Thutupalli, Tapomoy Bhattacharjee, Praveen Vemula.

Field Station Facility

Field Station Facility provides support for field research in frontier areas of ecology, evolution and conservation genetics. It hosts long-term monitoring programs of diverse natural habitats, flora and fauna and supports science education and public outreach.

Achievements in 2022-23

- 168 citizens were trained in the field station.
- 12 users used the facility.
- 2 publications acknowledged the facility's contribution to their work.
- Pachmarhi field station was actively involved in the outreach events, participated in moth–week and butterfly month documenting moths and butterflies on the campus and was engaged with a larger audience through social media and citizen science.

Crew: Yeshwanth HM, Savitha Chib.

Faculty Advisory Committee: Uma Ramakrishnan, Sanjay Sane, Mahesh Sankaran and Shivaprasad PV.

Collection Facility

Collection Facility is a state-of-the-art facility for biodiversity-related work and serves as a national repository of type specimens and other specimens of research importance to NCBS and the broader global community of biologists. It facilitates networking with museums worldwide, and museum-based collaborations with taxonomists and biodiversity experts. Provides science education and public outreach through the museum and collections facility.

Achievements in 2022-23

- An insect taxonomy and vertebrate workshop was organized for students.
- Organised outreach programmes, showcasing research collections to strike conversations on various attributes of insects for the school and college students.

- 60 people were trained in various workshops and 22 users used the facility.
- The facility was acknowledged in 11 publications.

Crew: Yeshwanth H M, Tarun Karmakar, and Aswathanarayana G.

Faculty Advisory Committee: Uma Ramakrishnan, Sanjay Sane, Mahesh Sankaran, and Shivaprasad PV.

Insect taxonomy training at Collections and Museum Facility

Nuclear Magnetic Resonance Facility

Nuclear Magnetic Resonance (NMR) Facility is equipped with two machines (800 MHz and 600 MHz) with cryo-probes. The facility aids in studies focusing on de novo structure determination of macromolecules such as proteins and nucleic acids, and their dynamics in the picosecond to millisecond time scales.

Achievements in 2022-23

- Trained 10 researchers.
- 5 users used the facility.
- Total facility usage time increases significantly compared to the previous years.

Crew: Arnab Dey.

Faculty Advisory Committee: Ranabir Das, Minhaj Sirajuddin, and Praveen V.

Radioactivity Facility

Radioactivity Facility has been classified as a Type-2 radioactive laboratory. The facility is equipped to handle ^{32}P, ^{55}Fe, ^{125}I, ^{3}H, and ^{14}C isotopes, and operates strictly within the guidelines set by the Atomic Energy Regulatory Board (AERB). The facility also has a cobalt-based Gamma Irradiation Chamber (GIC) to irradiate animal cells.

Achievements in 2022-23

- 24 users used the facility.
- 4 new users trained in using the facility under the supervision of the campus Radiological Safety Officer (RSO).
- 4 publications acknowledged the contribution of the facility.

Crew: Akshay Tharali.

Faculty Advisory Committee: Shivaprasad P V (RSO) and Sunil Laxman.

Stem Cell Facility

Stem Cell Facility (SCF) provides services and training for research using human pluripotent stem cells (hiPSC/hESC) in addition to a high-end BSL-2 shared space needed to culture, edit and image stem cells.

Achievements in 2022-23

- 10 users used the facility.
- Acknowledged in 1 peer-reviewed publication.

Faculty Advisory Committee: Maneesha Inamdar, Raghu Padinjat and Bhavana M.

Research Development Office

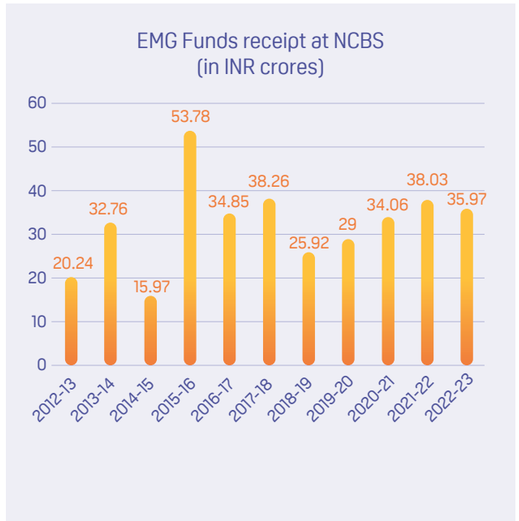
Vineetha Raghavan

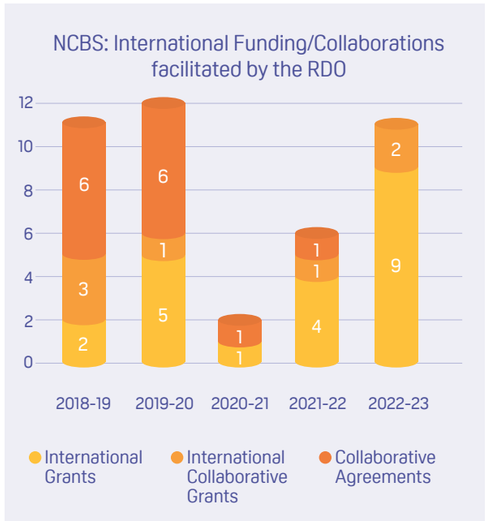
The Research Development Office (RDO) facilitates research and training on campus via research funding and collaborations. The RDO offers several key services at the boundaries of science, management, resource development and outreach.

A few key highlights of research funding at NCBS between 2022-23 include the award of the prestigious Team Science grant by the DBT-Wellcome Trust India Alliance to a multi-institute multi-disciplinary team led by Prof. Upinder S. Bhalla for high-resolution brain imaging through skull using ultrasound. Dr. Hiyaa Ghosh and Prof. Uma Ramakrishnan secured the Senior Research Fellowship and the Senior Renewal Fellowship, respectively, by India Alliance. In addition, Prof. Sowdhamini Ramanathan was awarded the National Network Project from Department of Biotechnology (DBT) for establishing genome informatics networks to understand plant stress management. The Indian SARS-CoV-2 Genomics Consortium (INSACOG) in which NCBS is a partner institution, continues with renewed support from DBT.

Private and philanthropic funding supports a few specific initiatives at NCBS. A significant funding highlight in this period was the award of a grant of Rs.100 crores to NCBS-TIFR and National Institute of Mental Health and Neurosciences (NIMHANS) by Rohini Nilekani Philanthropies Foundation, to set up a Centre for Brain and Mind, to build capacity for both research and practice in the field of mental health.

The RDO continues to provide support towards establishment of national and international collaborations. Recent highlights include Global Investigator Network Award from European Molecular Biology Organisation (EMBO) to Dr. Vinothkumar Kutti Ragunath. and international collaborations with Universite Claude Bernard-Lyon, France, University of Montpellier, France and Imperial College, London U.K., facilitated by grants from Centre Franco-Indien pour la Promotion de la Recherche Avancée (CEFIPRA) and the Wellcome Trust, UK.





NCBS is also a partner in two initiatives funded under the Indo-French campus initiative sponsored by Ministry of Europe and Foreign Affairs in France;

- A consortium led by with Universite de la ReUnion, ReUnion Islands, for a project on Innovation through pLants and A.I. for InDia and FrancE (acronym: ILIADE).
- A consortium project entitled Biosantexc - Network of excellence for training and research in life sciences through interdisciplinary approaches led by ENS de Lyon.

The membership of NCBS for the Indian Cancer Genome Atlas (ICGA) Foundation, has recently been renewed for a further four years. The RDO also facilitated the execution of Memorandums of Understanding with Indian Council of Forestry Research and Education (ICFRE), Indira Gandhi National Forest Academy (IGNFA), CASFOS, ICFRE - Institute of Forest Genetics and Tree Breeding, Coimbatore (IFGTB) and Forest Survey of India for research, education and training in the fields of forest genomics and functional studies on ecosystem function, services and conservation. The collaborations were formalised in a signing ceremony which was organised at NCBS in August 2023.

RDO recently launched its new website *(https://www.bliscrdo.com/funding-database)* in August 2023. Notable features of this website are a newly revamped, user friendly and expanded funding database as well as a new “Resources” page that comprises of lists of funding resources and various grant writing tools. We hope these new additions will be useful for researchers both within our campus and across India.

As part of its outreach efforts, the RDO organized a workshop on International Funding for campus researchers in June 2022. Earlier, in December 2022, an annual grant funding/writing workshop for postdoctoral fellows was also conducted in coordination with the Academic Office. In addition, the RDO also frequently hosts visits of senior officers from DST and SERB to deliver talks and interactive sessions regarding funding schemes, and on recent developments in the research funding landscape in India. These events have been popular and very well received by researchers and scientists on campus and outside.

RDO Team

ADMINISTRATION, ACADEMICS AND FACILITIES

The NCBS **Library**

Vital resource for research and academic pursuits, the NCBS library stands as a pillar of knowledge for the entire campus community and beyond. This **well-equipped, modern academic research library** offers a wealth of resources and services to support the research needs of its members, visiting scholars, and researchers alike.

Committed to serving the academic programs of the institute, the library actively expands its resources and collections, fostering a collaborative partnership between librarians and users to ensure effective information service delivery. This includes a growing collection of online resources, accessible simultaneously to users across the campus network. Additionally, **all library holdings are systematically cataloged and searchable online.**

Boasting **a comprehensive collection of books, journals, and other materials across the biological sciences and interdisciplinary fields**, the library also provides access to a vast array of electronic journals and e-books. Coupled with its extensive physical collections, the NCBS Library offers a diverse range of resources to fuel academic exploration and discovery.

Beyond its collections, the library provides a **comprehensive suite of services to support research and scholarship.** These include interlibrary loan services, expert reference assistance, and convenient document delivery.

Open 24/7 throughout the year, the NCBS Library welcomes all campus members and fosters a comfortable, conducive atmosphere for learning and collaboration. Independent study carrels, wired and wireless internet access, and other modern amenities ensure **a productive and enriching environment for students and researchers alike.**

Indispensable to the campus research community, the NCBS Library stands as **a core facility, its extensive collections, knowledgeable staff, and comprehensive services** serving as an essential foundation for academic excellence and intellectual growth.


STEPHEN KING
DAN BROWN

Retirement Notes

V. Srinidhi
Written by
Vatsala Thirumalai

NCBS handles to the tune of about 350-400 extramural grants (EMGs) every year to run our various research programs. Mr. V. Srinidhi joined the Finance and Accounts team at NCBS in 2015. Srinidhi helmed the management of EMGs at a time when NCBS was seeing exponential growth in the number of grants received. He enabled our transition into digital management of grants and annual financial reporting to the various funding agencies. He successfully implemented the Tata Institute Information System package (TIIS) for EMGs at NCBS and made us the first Centre of TIFR to do so! At this time, there were other digital initiatives as well such as the CSIR Scholarship Direct Benefit Transfer (DBT), Public Financial Management System (PFMS), Treasury Single Account (TSA) and Srinidhi implemented these efficiently for NCBS. Efficient grants management means submission of SE/UCs on time, taking care of rules compliance etc., so that investigators have more time on their hands for research. Srinidhi understood this and did not spare any effort to help scientists with their EMGs. He was always available with a smile on his face to advise, clarify and issue financial reports on time. Srinidhi took voluntary retirement in January 2022 to spend more time with his family. His smile and warmth will be missed. We wish him the very best!

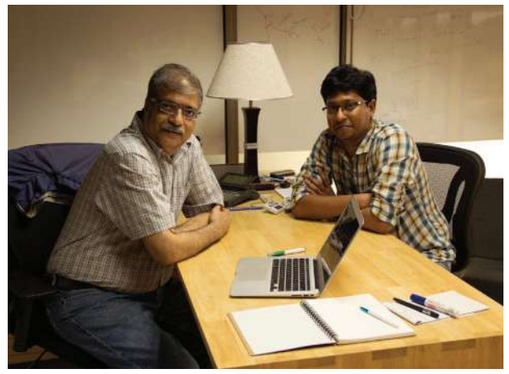
Sumantra Chattarji
Written by
Upinder Bhalla

After over 25 years at NCBS, Sumantra "Shona" Chattarji is riding off into the sunrise. Shona has taken early retirement to work much harder, in Kolkata as Director of CHINTA, TCG CREST. His moving on to parts East marks a new phase of a career in building institutions, supporting neuroscience, and cultivating art interleaved with surpassingly bad jokes.

Shona and I were joined at the hip for much of our careers, with a brief overlap at IIT Kanpur doing Physics, and another overlap as postdocs on the East Coast of the US. We interviewed at NCBS together and started our labs within a few months of each other. For years our labs were next to each other and shared everything, including a telepathic linkage among the students to alert for food treats.

I am proud to have been associated with Shona in having helped to anchor the scaling up of systems neuroscience in India. This field involves overlapping techniques in electrophysiology, in-vivo physiology, and animal behaviour. It is difficult to overstate the importance of having a nucleus of groups working in sync to do this. These are hard techniques, even harder when far from the Western centres of excellence and the associated expertise and commercial support. At NCBS we built at least four incarnations of the animal house set up electronic and mechanical workshops and trained a generation of young colleagues, many of whom are now part of the Indian neuroscience ecosystem. Shona anchored a major grant to upgrade the campus animal facilities to a full-fledged reference centre for mouse genomics and breeding. These contributions to the field and India are enormous and are quite missing from a bare statement of Shona's research accomplishments which are outstanding in their own right.

Shona worked on stress and learning, with enormous basic science as well as medical implications. One of his big-picture contributions is to systematically delineate and contrast the processes of learning between the hippocampus and the amygdala, in health and under stress. The hippocampus is widely associated with memory and the amygdala with emotion. Among many other things, he showed that learning in the amygdala thrives *(for want of a better word)* when there is stress. This is in direct contrast to the hippocampus and has major implications for the overwhelming flashbacks in post-traumatic stress disorder. Shona also anchored the Centre for Brain Development and Repair, a major ever neuroscience collaboration between NCBS, InStem and the University of Edinburgh, to look at neurodevelopmental disorders such as autism spectrum disorder. Among the insights from this work is the finding that fragile X syndrome related deficits in neurons may be due not to their intrinsic deficits, but due to aberrant signals received from the supporting astrocytes.



I would leave out a huge part of Shona's accomplishments if I did not mention his remarkable connections with all things cultural. Whether it was to do with painting, music, cricket, literature, or the fine art of Bengali sweets, it seemed that Shona knew all the masters.

I am sure that Shona and Neuroscience will thrive in Kolkata as he takes on new frontiers.

Obituary

Knight Paul Pandian (1950-2023)

Written by Raghu Padinjat

Knight Paul Pandian, senior administrator and colleague at the Bangalore Life Sciences Cluster passed away after a brief illness in January 2023. He is survived by his wife Gitika and daughter Pallavi.

Following initial training in Geography at the University of Madras, Pandian *(as we addressed him)* specialized in financial management and administration including a stint at the John F Kennedy School of Government, Harvard University. He served continuously in the Government of India until his superannuation in 2010. During this long service, he was associated with various science ministries including the Ministry of Earth Sciences, the Departments of Biotechnology and the Department of Science and Technology. Through his work, he facilitated many important and complex science projects including those related to oceanography, atmospheric science, and polar exploration. Pandian also participated in implementing numerous international science partnerships of the Government of India with nations across the globe. Notable among these was the establishment of the Wellcome Trust - DBT India Alliance, a unique partnership between the Wellcome Trust U.K., the world's largest biomedical charity and the Department of Biotechnology, Government of India. The India Alliance went on to become hugely influential in stimulating modern life sciences research and nurturing a new generation of scientists in India.

Following superannuation from the Government of India service, Pandian moved to Bangalore and brought his enormous experience to bear on the establishment of the Bangalore Life Sciences Cluster (BLiSC). At the time, BLiSC was a unique experiment in India that entailed collective and collaborative working between three administratively distinctive entities, the National Centre for Biological Sciences, the Institute for Stem Cell Science & Regenerative Medicine and the Centre for Cellular and Molecular Platforms. His enormous experience in administration and finance was key to seeking solutions for the many challenges faced by this new venture and he mentored many younger colleagues at BLiSC in this process.

K. P. Pandian at the Indian Research Station in Antarctica-2020.

At a personal level, Pandian was hugely interested in people and places. He was well-read, widely travelled and during his career visited many places on all continents of our planet. Coupled with his travels, he had a keen and abiding interest in the history and culture of the people and places he visited. He was a marvelous storyteller, a raconteur with warm insights into humanity. His travelogues, if published, would be a hugely informative and interesting read. Remarkably, and perhaps fittingly for a life well-travelled, Pandian travelled to Antarctica on his 70th birthday, the only continent he had not visited until then. After an initial failed attempt to land on the icy continent due to inclement weather conditions, he did not give up and finally made it onto Antarctica a few days later and visited the Indian research station. On his return, he narrated the most engaging stories of this trip over a cup of coffee in the academic canteen at NCBS. Pandian will be remembered fondly as a person and with gratitude for his contributions by all those whose lives he touched at the BLiSc campus and beyond.

Partnerships and Flagship Programmes

MSc Wildlife

NCBS Archives

The Simons Centre for the Study of Living Machines at NCBS Bangalore

Science Gallery Bengaluru

India Bioscience

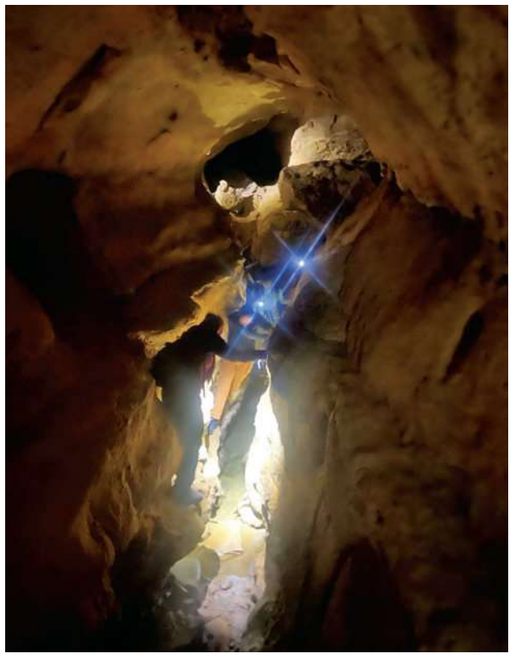
Bengaluru Sustainability Forum

The Master's Programme in Wildlife Biology and Conservation

Vivek Ramachandran

India is host to diverse ecosystems, with globally endangered wildlife as well as the second largest human population. Science-based, socially sensitive research and management of our biodiversity is necessary for safeguarding our natural heritage. In the early 2000s, recognising the lack of trained wildlife biologists, a consortium of institutions joined forces to launch the master's program in Wildlife Biology and Conservation. Based at the National Centre for Biological Sciences- TIFR in Bangalore, this program is a unique collaboration between academia and non-governmental organizations focused on building expertise in Wildlife Biology and Conservation Science.

Our program draws upon a diverse faculty from various disciplines and regions of the country to impart both theoretical and practical skills in ecological, social, and quantitative sciences to our students. Spanning four semesters, the curriculum comprises intensive coursework and field visits to diverse habitats across India, exposing students to different ecosystems and their unique conservation challenges. Students also learn about national laws, regulations, and global agreements relevant to conservation. An essential component of the program involves hands-on experience in effectively communicating their science and conservation messages, through presentations, scientific publications, and various print and visual media.



As of 2022, the program has trained 133 students across nine batches (as of 2022). These students have conducted fieldwork throughout India, working on a wide range of ecosystems and species, resulting in 90 peer-reviewed publications. Our alumni have authored over 600 scientific papers, reports and popular articles.

Our current cohort, comprising 16 students, has completed three semesters of coursework and is now focused on conceptualizing and designing research projects they will execute during the coming months. As always, our dedicated faculty and resource people from various academic and conservation organizations have steadfastly supported the program and students throughout their journey. We are profoundly grateful for this support system and network, which enables us to deliver this program and significantly enhances the development of our students.

Students exploring the subterranean limestone cave ecosystem in Meghalaya

Hoolock Gibbon at Hoologapar Wildlife Sanctuary, Assam

Open water dive training during the Marine Ecology course, Havelock, A&N islands

Archives at NCBS

Venkat Srinivasan

The Archives at NCBS *(https://archives.ncbs.res.in/)* is a public collecting centre for the history of science in contemporary India. Over 200,000 processed objects across over 30 collections are housed at the 2000-square-feet state-of-the-art physical centre. Our objectives are four-fold: to strengthen research collections and public access in our domain, push the frontiers of research in archival sciences in India, build capacity through education, and reimagine the archives as part of the commons through vibrant public engagement. Much of our work is generously supported by TNQ Technologies and Arcadia.

Obaid Siddiqi Chair in the History and Culture of Science

The Obaid Siddiqi Chair in the History and Culture of Science at the Archives at NCBS was founded to bridge gaps in the practice, history, and philosophy of science and the humanities *(https://archives.ncbs.res.in/OS).* Prof Gita Chadha, the renowned sociologist, was chosen as the recipient of the third Obaid Siddiqi Chair, 2023-24. She brings an intersectional feminist perspective to discussions of the study of science India. Beginning with exploring questions of who gets to do science and who does not, she hopes to initiate deeper conversations on its practice, method and on the social construction of scientific knowledge. Using principles of feminist archiving, she hopes to make visible the life and work of women in science. She will also conduct short workshops on the relationship between science and culture.

Prof. GN Devy, concluded his tenure as the Chair in September 2022. Prof Devy is a literary scholar, historian, and social and cultural activist, and is perhaps best known for establishing the People's Linguistic Survey of India (PLSI). Drawing from the work of dozens of scholars, in 2023, he co-edited and published The Indians: Histories of a Civilization. He taught a course, The People of India, and led workshops at NCBS that questioned the process and meaning of doing science in India. In July 2023, he delivered the Obaid Siddiqi lectures (conducted in collaboration with Mount Carmel College), a three-part exposition on India as a linguistic civilisation.

Collections

The Archives at NCBS completed one year of its grant from Arcadia toward "Documenting the Contemporary History of Science in India". During the first year, we have processed more than 100,000 digital objects and 50 interview sessions from across over 30 collections, including the papers of BS Madhava Rao, Zafar Futehally, KS Krishnan, Prakash Gole, AP Krishnaja, Wayanad Prakrithi Samrakshana Samithi, Ranjit Daniels, and Carl D'Silva. These collections, which cover 140 years of science history from various corners of India, and bring together stories from individual lives, environmental movements, socio-cultural and global geopolitical events, will be made public in 2024.

Research and Collaborations

We concluded a three-way partnership between oral historians in India and England [Graham Smith - Newcastle University Oral History Unit and Collective (OHUC), Indira Chowdhury and Siddhi Bhandari - Centre for Public History (CPH) at Srishti Manipal Institute, and Archives at NCBS] toward designing a research pilot to gain a better understanding of intergenerational impact on climate consciousness and activism. About a dozen researchers across India conducted interviews in various native languages, and then came together to discuss this work and the interviews at a workshop at NCBS in September 2023.

The Archives at NCBS was host to dozens of archivists and various online participants as part of the fourth annual Milli Sessions on Jun 9 2023 *(https://milli.link/sessions2023/),* with a focus on archival conservation and preservation. The Milli Archives Foundation, a network of individuals and communities interested in the nurturing of archives *(https://www.milli.link)*, formalized as a Section 8 non-profit company. In collaboration with Milli and the lead writers, Divij Joshi and Farah Yameen, the Archives at NCBS also published "Archives, Ethics and the Law in India: A Guidebook and Training Programme for Archivists in India" in January 2023 *(https://ethics-law.archives.ncbs.res.in/).* This year, the Archives also put into operation the first archival conservation lab in any educational institution in Bangalore, and an open source framework for digital preservation. We were invited to present on archives and education, and on ethics and law, digital annotations and frameworks for oral history description at two conferences of the International Council on Archives in Dublin, Ireland, and Abu Dhabi, UAE.

Education

The Archives at NCBS continued to build capacity in archival training through internships offered to more than a dozen students. In addition, this year, it started a pilot school-outreach programme at Aditi Mallya School, toward school curriculum building to train students to work with historical primary sources.

Public Engagement

The Archives launched the papers of TSG Sastry (Mar 15, 2023) and Leslie Coleman (Jun 16, 2023). It launched its fourth exhibition season, "Ever Met an Ugly Flower?" by Anoushka Mathews, Bhanu Prakash, Komal Jain, Ranjani Prasad and Shafali Jain. Through the anchor of a flower, their exhibition extends the imagination of binaries in the context of gender, sexuality, botany, and labour in society. The Archives also hosted a lecture-performance in April 2023 titled 'For the Archives User' by Anuja Ghosalkar. Meera K, an animator, completed a short animation in mid-2023 on the place of an archive in society. The Archives Public Lecture Series, a monthly public fixture to initiate dialogue and debate on an array of diverse topics and histories of ideas, covered diverse lectures on the media in India, food, the postage stamp, Agyeya, caste and gender, migration and language, forest rights, and the NCBS buildings. The series completed 60 editions in November 2023, with a lecture on the idea of the Constitution.

2023 Team

Abhijith AV, Aditya R, Aiswarya S, Anjali JR, Anjana T, Deepika S, Dhatri S, Divij Joshi, Diya Shah, Gouri A, Hannah James Louwerse, Hari Sridhar, Janani AS, Joseph Jose, Meera K, Megha Ramachandra, Meghal Bansal, Nandita Jayaraj, Nayanika Shome, Ojas Kadu, Parvathy V, Prashant Kumar, Preeti Shree Venkatram, Ravi K Boyapati, Raza Kazmi, Samira Agnihotri, Samyamee Sreevathsa, Sanjna GY, Sindhu Nagaraj, Soumya Swain, Sravya Darbhamulla, Venkat Srinivasan.

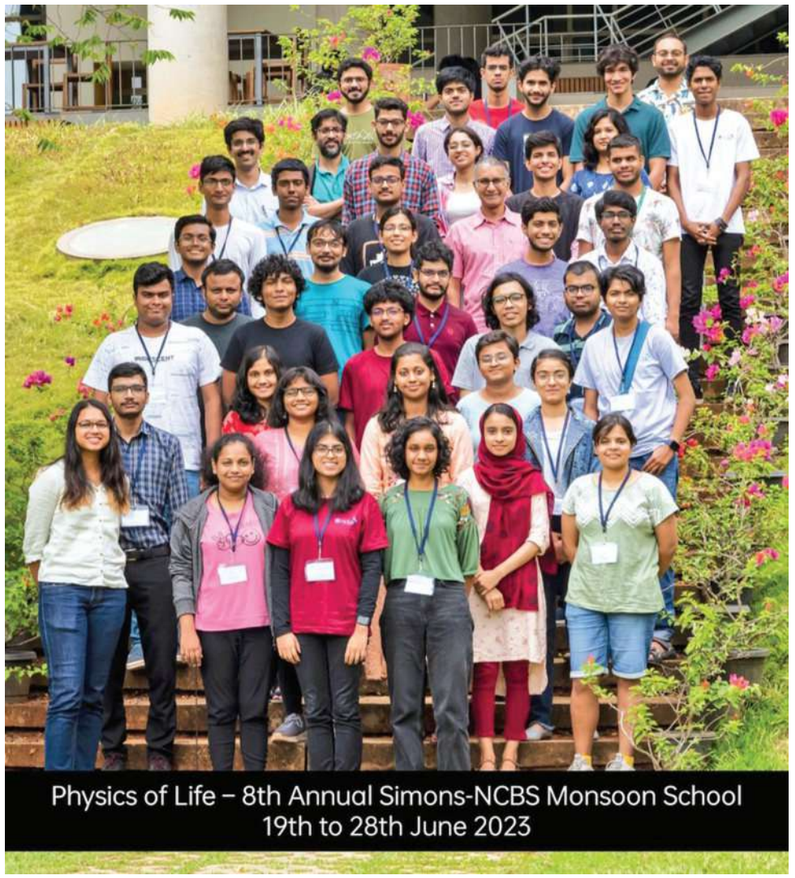
The Simons Centre for the Study of Living Machines at NCBS Bangalore

Siddharth Kankaria

The Simons Centre for the Study of Living Machines is a dedicated space for the study of molecules, cells, and organisms as living machines: products of natural selection that consume energy to achieve specific goals.

Our research relies on interdisciplinary approaches that catalytically blend theory and experiment to solve fundamental biological problems spanning across a range of length- and time-scales: from protein function, computational cell biology and evolution, to the physics of active systems.

The Simons Centre was established at NCBS in 2013 through a five-year $1 million grant from the Simons Foundation, which was renewed for another 5 years in 2018. It brought together five NCBS faculty and their research groups, with the aim of fostering an environment of active collaborations between theory and experiment in biology.



Physics of Life – 8th Annual Simons-NCBS Monsoon School
19th to 28th June 2023

At present, the Centre has grown further and comprises the following 7 faculty members and their groups: Archishman Raju, Madan Rao, Mukund Thattai, Sandeep Krishna, Shachi Gosavi, Shaon Chakrabarti and Shashi Thutupalli. The current Advisory Committee of the Simons Centre at NCBS includes Frank Julicher (MPI for the Physics of Complex Systems, Dresden) & Rob Phillips (California Institute of Technology, USA).

Keeping true to the vision of 'Biology without Boundaries', the Centre has grown into a fully functional 'centre for theory, embedded within an experimental biology research environment', and serves as an international hub for researchers from physics, mathematics, computer sciences, and engineering backgrounds to engage with biological problems.

The work culture and ethos of the Centre also specifically prioritise frequent and deep interactions, random collisions of ideas, and sustained collaborative efforts involving the use of theoretical approaches. Currently, the Centre's work is nucleated around three collaborative research themes: Cellular Compartments; Organismal Communities; and Programmable Landscapes.

With the backing of the Simons Foundation, the Centre has also organised several cross-disciplinary meetings and workshops such as "Stochasticity and Plasticity in Living Systems (SPLS)", "45th Annual Meeting of the Indian Biophysical Society", "Cellular Lineages and Development", and many more. The Centre has also for several years organised the "Simons-NCBS Annual Monsoon School - Physics of Life" which attracts some of the most talented undergraduate students from physics, engineering and computational backgrounds to come and engage with fundamental problems in biology.

Science Gallery Bengaluru

Science Gallery Bengaluru (SGB) is a new cultural space established as a not-for-profit public institution, with the single mission of bringing 'science back into culture'.

Asia's first and India's only member of Science Gallery International, SGB works on a range of themes that are central to the concerns of young adults. The Gallery's public engagement model moves beyond just participation, and towards proactive involvement through ever-changing exhibitions, programmes, and public events consisting of research-based engagements led by artists and scholars from diverse backgrounds. SGB is established with the founding support of the Government of Karnataka and three academic partners—Indian Institute of Science, National Centre for Biological Sciences, and Srishti Institute of Art, Design and Technology.

In the last five years, Science Gallery Bengaluru has successfully hosted five exhibitions so far, with the first two exhibitions - ELEMENTS and SUBMERGE - in physical spaces, and after the pandemic struck, the next three - PHYTOPIA, CONTAGION, and PSYCHE were fully online. In 2021, CONTAGION was featured in The Lancet and also selected as a Falling Walls Winner in the Science Engagement category.

On August 9, 2023, Science Gallery Bengaluru launched a pop-up exhibition CARBON #inthecity, as part of our larger exhibition-season CARBON. The pop-up exhibition features 4 exhibits in 4 metro stations in Bengaluru, that explores our relationship with carbon through films, live experiments and demonstrations. One of the exhibits, Jivanu, has been conceptualised based on the research of Nayan Chakraborty, Harshini Sangle, Malavika Anilkumar and Shashi Thutupalli from National Centre for Biological Sciences, and was set up at the Indiranagar Metro Station. The pop-up engaged over 10,000 visitors at the metro stations. Over 300 people have participated in the related programmes that included quizzes, workshops, and public talks. The full exhibition, featuring over 30 exhibits, will open to visitors in 2023 at SGB's dedicated facility — an upcoming purpose-built space of about 1,36,000 square feet on Bellary Road.

NCBS Involvement

National Centre for Biological Sciences has been an academic partner to Science Gallery Bengaluru since 2015, with the director of NCBS serving as a member on the SGB Board. The Gallery's office space has been within the NCBS campus since 2019 and the institution has supported SGB in many ways including:

- Office space at NCBS since 2019
- Venues for exhibition and programme related events since 2019
- Spaces on campus for mentorship, training, and learning programmes like
  - Carbon 101 lecture series
  - Teacher Orientation workshop for Open Courseware
  - Capturing Carbon writing workshop
  - Mediator Training
  - Carbon Summer School
- Scholars for programme facilitation, mentors, academic advisors, exhibits as detailed below:

Name	Involvement	Exhibition/Year	Event/Programme
Nayan Chakraborty, Harshini Sangle, Malavika Anilkumar, Shashi Thutupalli	Artist/Scholar	CARBON (2023)	Exhibition Installation
Debarshini Chakraborty (C-CAMP)	Expert/Facilitator	Carbon Summer School (2022)	Lecture
Mahesh Sankaran	Expert/Facilitator	Carbon Summer School (2022)	Lecture
Upinder S. Bhalla	Scholar	PSYCHE (2022)	Public Lecture
Ravi Muddashetty	Scholar	PSYCHE (2022)	Public Lecture
Yojet Sharma	Scholar	PSYCHE (2022)	Panel Discussion
Raghu Padinjat	Scholar	PSYCHE (2022)	Panel Discussion
Anzal K.S.	Expert/Facilitator	PSYCHE (2022)	Live Lab Session
Shashi Thutupalli	Expert/Mentor	CONTAGION (2021)	Xperimenter Programme
Uma Ramakrishnan	Scholar	CONTAGION (2021)	Public Lecture
Mukund Thattai	Invited Board Member	–	
	Expert/Scholar	CONTAGION (2021)	Academic Advisor
Shannon Olsson	Expert/Scholar	PHYTOPIA (2020)	Academic Advisor
Shashi Thutupalli	Artist/Scholar	SUBMERGE (2019)	Exhibition Installation
	Expert/Scholar		Public Lecture
Sahil Moza	Scholar/ Moderator	ELEMENTS (2019)	Panel Discussion

2023 Programmes

In its mission of bringing science into the cultural context, and engaging with young adults in the city, SGB has been running public engagement programmes and developing learning programmes in parallel to the exhibitions. Working with cultural and educational institutions locally and internationally, these programmes have been instrumental in contributing to the discourse around subjects such as climate change, mental health, fundamental sciences, and arts and culture among others. Some of the initiatives and programmes are as follows:

Global We for Climate Action 2023: From November 2022 - April 2023, Science Gallery Bengaluru partnered with the Museum for the United Nations – UN Live for the Global We programme in the lead up to the COP 27 for the 'Global We for Climate Action' programme. Supported by the IKEA Foundation and powered by Shared Studios, it featured twenty immersive conversation portals around the world, one of which was launched at the Jawaharlal Nehru Planetarium, Bengaluru. Visitors engaged in climate conversations, enjoyed film screenings and book readings, and participated in conversations with experts, workshops and other diverse formats of programming around the theme of climate change.

Visitors engaged in Bengaluru: 2752
Visitors engaged across locations: 9820
Experts engaged in Bengaluru: 134

Open Courseware 2023: The Open Courseware is a freely accessible set of modules designed for self-paced, non-evaluative, open-ended and interdisciplinary. The modules have been developed using resources from previous exhibition-seasons and expands on the existing knowledge commons. Instructor guides are available for educators, and orientation sessions have been held for those who wish to incorporate the Open Courseware in their classrooms and learning spaces.

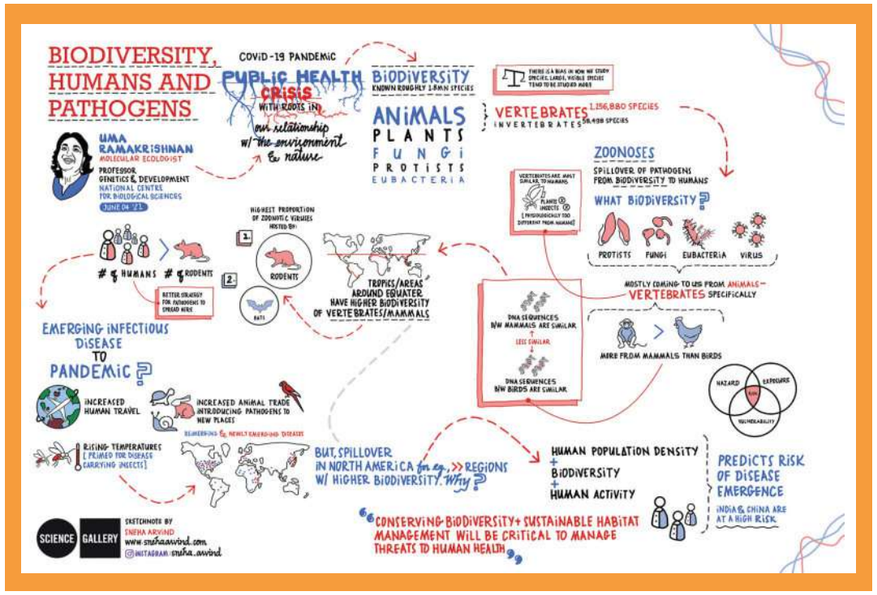
Online engagement: 4000 views **since launch in March.**

Capturing Carbon 2023: Capturing Carbon was a 12-week writing workshop for young adults from February - June 2023 that explores carbon and related themes through a literary lens. The workshop was facilitated by Jay Barber, a 2023 Fulbright-Nehru Academic and Professional Excellence Teaching Scholar. It aimed to instil an appreciation for all the aspects of the fundamental element that makes us, and the world, using writing and the arts as a medium of expression.

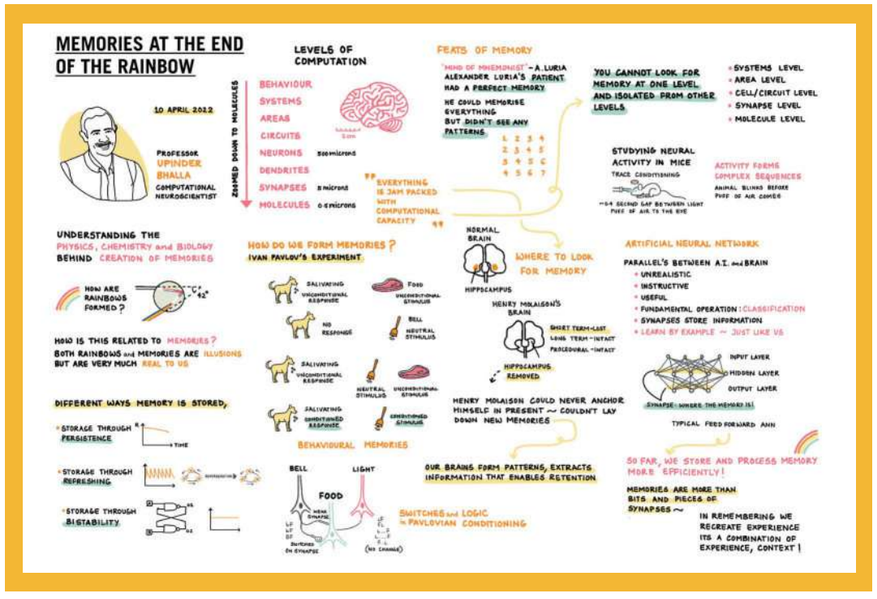
Young Adults Engaged: 17

Shashi Thutupalli: SUBMERGE lecture

Sahil Moza: ELEMENTS mod panel



UmaRamakrishnan: CONTAGION PL Sketchnote



UpinderBhalla: PSYCHE PL Sketchnote

IndiaBioscience: Continuing to Catalyse Change in the Life Science Ecosystem in India

Karishma S Kaushik

Even with a few months to go, the year so far has been marked by major changes, exciting growth and new plans at IndiaBioscience. First conceptualized in 2009 over a dinner table conversation, IndiaBioscience is a catalyst for change in the culture and practice of the life sciences in India. For this, IndiaBioscience works with partners across academic, industry and government sectors in India. Importantly, our stakeholders are science students and educators, PhD researchers, Postdoctoral fellows, early-career faculty, senior scientists, entrepreneurs and policymakers, making us an organisation with diverse reach and impact. Across the year, IndiaBioscience led a range of digital and in-person programs, each with multiple initiatives, broadly grouped under its seven verticals.

Some important highlights here!

Networking and Mentorship

YIM 2023

The first major event of the year at IndiaBioscience was the 15th Young Investigator Meeting (YIM), jointly held at IIT Gandhinagar and Ahmedabad University, the flagship meeting that brings together exceptional Young Investigators in India and Postdoctoral Fellows from across India and the world. As the first in-person YIM after the pandemic, YIM 2023 hosted mentors, scientists and science communicators for talks, discussions, breakout sessions and informal conversations. Read more about the key takeaways from YIM 2023 in the links shared below.

Galvanising Ideas: YIM 2023 in Gujarat (Part 1) - IndiaBioscience
https://indiabioscience.org/columns/indiabioscience-blog/galvanising-ideas-yim-2023-in-gujarat

Galvanising Ideas: YIM 2023 in Gujarat (Part 2) - IndiaBioscience
https://indiabioscience.org/columns/indiabioscience-blog/galvanising-ideas-yim-2023-in-gujarat-part-2

Regional Young Investigator Meeting Grants

This year, IndiaBioscience turned the **Regional Young Investigator Meetings** into a grant, which invited applications from Young Investigator teams from across India. Seven teams were awarded the RYIM grants, with meetings planned in Lucknow, Srinagar, Hyderabad, Kolkata, Bhubaneswar, Pilani and Pune. Read more about the RYIM awardees here.

Skill Building

Crafting Your Career (CYC) Workshops

The transition to in-person meetings meant that IndiaBioscience had the opportunity to re-start its well-appreciated **Crafting Your Career (CYC) Workshops**. So far this year, half and full-day workshops have been held for MSc students, PhD researchers and Postdoctoral Fellows in Bangalore, Lucknow and Srinagar, with several more lined up.

International Grants Awareness Program (iGAP)

In addition to webinars and discussion sessions, this year **iGAP** expanded to hosting monthly dispatches on open grant and fellowship opportunities. We hope this is useful for the life science community in India!

Digital Initiatives

YI Huddle

Recognising the need to keep conversations between Young Investigators in India open and ongoing throughout the year, we started the **YI Huddle series**. YI Huddles are informal and conversational meetings on matters relevant to the YI community such as starting a research group, open access publishing, research grants management, digital networking, and more. Join the series here!

Big Questions, Innovative Approaches

Wanting to bring cutting-edge global science to India, IndiaBioscience co-initiated **'Big Questions, Innovative Approaches'** a series of science talks for PhD researchers, Postdoctoral Fellows and early-career researchers in India. As part of this series, international researchers share their professional journeys and research findings with the broad science community in India.

Science Communication

Articles, News and Columns

With the aim to showcase best of science in India, the **IndiaBioscience website** hosts two new science articles, news or column features a week, which includes article collections such as PhD Café, 10 Women 10 Questions, and Contemporary Conversations.

Diversity, Equity and Inclusion Infographic

While it is encouraging to observe DEI in science in India becoming a part of open and honest conversations, our narratives and depictions of DEI are largely driven by dominant global conversations. In a **'Tenets of our Laboratory'** infographic campaign, IndiaBioscience captured the essence of DEI in India, through vivid and thought-provoking illustrations. In a sign-up campaign, infographic was sent to 50 labs across India for their front doors!

Education

Through this vertical, IndiaBioscience reaches undergraduate educators across the country with articles, webinars and compendia. Our recent **Teaching Graduate Biology** compendium discussed innovative teaching practices, student misconceptions, education policy and virtual learning.

Look out for a new infographic on Research Ethics for undergraduate students and educators in the next few months!

Community Building

The IndiaBioscience Outreach Grants (IOG) entered their 4th cycle this year, with several unique outreach ideas from across India. We had a hard time choosing the awardees! Look forward to your outreach proposals in subsequent cycles of this grant. We also have a very interesting science outreach resource book coming your way, so stay tuned!

Data and Policy

In addition to featuring jobs on our website and weekly **#ScienceJobsTuesdays** threads on Twitter, this year IndiaBioscience initiated a dedicated Jobs and Internships newsletter *(https://indiabioscience.org/meetings/jobs-and-internships-newsletter).* Free for the community, this newsletter releases the first week of each month and hosts recently advertised academic, industry

and other science jobs. Have a job or internship opening to advertise, check the link above!

We are always looking for ways to engage with the community via email, social media, our monthly newsletter, and in-person events! Importantly, we hope this outline provides the readers (our stakeholders!) with new information on the many ways they can continue to engage with IndiaBioscience.

Members of Team IndiaBioscience are Ankita Rathore, Arushi Batra, Karishma S Kaushik, Manjula Harikrishna, Shwetha C and Vijeta Raghuram.

Get in touch!

Email: hello@indiabioscience.org
Social Media: @IndiaBioscience (Twitter, YouTube, Instagram, Linkedin, Facebook)

IndiaBioscience is currently supported by the Department of Biotechnology, Government of India, in addition to several other independent partnerships. Since its inception, IndiaBioscience has been housed at NCBS, Bengaluru, which has served as a funding and administrative partner for the program. The community at NCBS has been a staunch supporter of, and contributor to, the various programs at IndiaBioscience.

Team IndiaBioscience

RYIM Bhuvaneshwar

RYIM Srinagar

RYIM Lucknow

PARTNERSHIPS AND FLAGSHIP PROGRAMMES

Benglauru Sustainability Forum

The Benglauru Sustainability Forum (BSF) is a multi-institutional initiative, which encourages interdisciplinary collaborations, fosters conversations and builds bridges in the area of sustainability. BSF does this by connecting diverse efforts in the domain of sustainability and ensures that work is not done in silos. BSF was founded in January 2018 and has since then awarded 36 projects over 5 cohorts under its Small Grants Programme, held multiple climate retreats, organized workshops, talks, webinars, film festivals and published a podcast, among other activities.

Supported by a grant from Wipro Foundation, and housed at the National Centre for Biological Science, the forum is steered by committed individuals from a number of institutions who are working towards the goal of sustainability in Bengaluru.

Events

Climate Resilience Retreat

Climate Resilience Retreat.
Credits: School of Ancient Wisdom

The retreat saw participation from climate researchers, social scientists, politicians, activists, journalists, citizens and representatives from the Domestic Workers Rights Union and the Auto Drivers Association. Over the two-days of the retreat, the participants discussed and deliberated on various themes like climate realities and local capacities, infrastructure and the politics of climate change, climate vocabulary and actionable climate science and adaptation strategies and their implementation.

Climate Charche

Climate Charche is an ongoing monthly series that will provide a platform for dialogue and debate between public representatives, media, government authorities, academia, civil society, activists and communities. The conversations will convene citizens across sectors of infrastructure and

engineering, housing, transport, planning, water and waste management, public health and education to discuss pertinent issues on the changing climate. It will aim to build on (but won't be limited to) recent climate reports, climate action plans and the processes of arriving at them. Overall, these discussions will focus on critical and relevant issues in both policy and action.

Jacaranda Tales Second Edition

Jacaranda Tales Second Edition Kannada Poster

BSF organized the second edition of the International Film Festival, *Jacaranda Tales* in October 2023, with Climate Resilience as the theme. The in-person film festival screened 20 films, had 4 panel discussions and saw attendance, participation and discussion by more than 600 people, across all age groups. The opening address was delivered by Ms. Padmavati Rao, and Dr. Ramchandra Guha delivered the closing note. Apart from these, the panels were populated by researchers, activists, eminent environmentalists, knowledge experts, professionals, and filmmakers among others.

The festival also had an online edition which featured 33 films across 3 themes, available to all and free of cost. With a viewership of more than 1000 people, the online festival took these stories across borders. The festival was organized in collaboration with Bangalore Film Society (BFS), Kriti Film Club, Karnataka Gandhi Smaraka Nidhi, Gamana Women's Collective, Environment Support Group (ESG), Mount Carmel College (MCC) and Bharat Gyan Vigyan Samiti (BGVS).

Global Science Film Festival

BSF in collaboration with Swissnex organized the Global Science Film Festival with film screenings and a global panel discussion. The film was simultaneously screened at six venues, one each in China, Japan and Switzerland and three in India. The global panel featured Dr Anil Kumar, Climate Scientist from IISc.

Global We Program

BSF was on board as a collaborator with Science Gallery Bangalore, for the Global We Program during which we brought over 50 practitioners working across the fields of water, waste/recycling, food, literature and planning, who added to the discussions in the portal studios.

Small Grants Project Updates

Suttha Muttha Project

The Suttha Muttha project aimed at creating resources on local biodiversity around Silvepura, in the outskirts of Bengaluru city. It was a collaborative project undertaken by the Fig Tree Learning Centre and Nature Classrooms/ NCF. The resources include posters, reading cards and most recently a bilingual picture book titled "There's Nothing There!"/ "ಅಲ್ಲಿ ಏನೂ ಇಲ್ಲಿ!" Though the project officially came to a close this year, the team hopes to continue using the teaching-learning material with students in Silvepura and beyond.

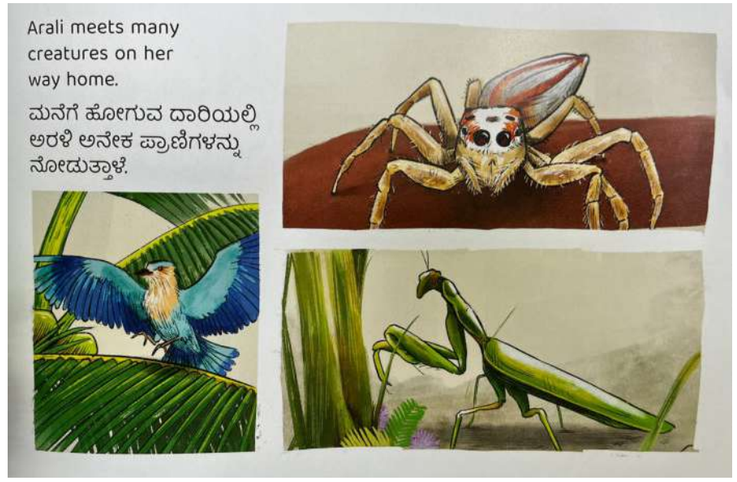


Image: A page from the book "There's Nothing There!"/ "ಅಲ್ಲಿ ಏನೂ ಇಲ್ಲಿ!"

Lake Health Index

The Lake Health Index project aims to create a space in the minds of all citizens about lakes in the city by involving them directly in the process of recording the necessary observations. The project by Friends of Lakes and India Cares Foundation uses citizen science to ensure that stakeholders drive the movement. The team has developed a website and a mobile app, which can be used by citizens and enthusiasts and contribute to the protection of lakes and a more sustainable future.

Civic Crowdsourcing

This project by Reap Benefit aims to change the way in which decision making for public good is done. It plans to involve citizens to ensure more substantial and real-time inputs and resolution. For this, the team developed a WhatsApp chat bot which is used to report potholes, broken footpaths, broken streetlights, broken urinals and garbage spots. The chatbot collects three key parameters; location, description and media, offering a comprehensive idea about the specific issue. The system is also being used for reporting other data points and is in use in more than 20 Indian cities as of now.

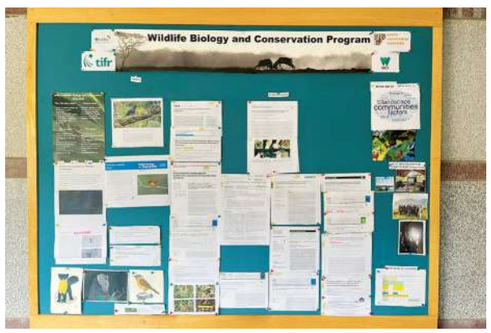
Team SF (from left to right): Namrata Narendra, Mukund Krishna Kumar and Manasi Pingle

Email us at bsf@ncbs.res.in
Twitter: @sustainBLR
Instagram: @sustainblr
Facebook: Bengaluru Sustainability Forum
LinkedIn: *https://www.linkedin.com/company/bengaluru-sustainability-forum/*
Website: *https://www.bengalurusustainabilityforum:org/*

NCBS Library. Photo Courtesy: Anshul Sukhwal

Archives stores untold stories of scientific history. Photo Courtesy: Ravi K Boyapati

Blooming of Jacaranda Tales.
Photo Courtesy: Bengaluru Sustainability Forum

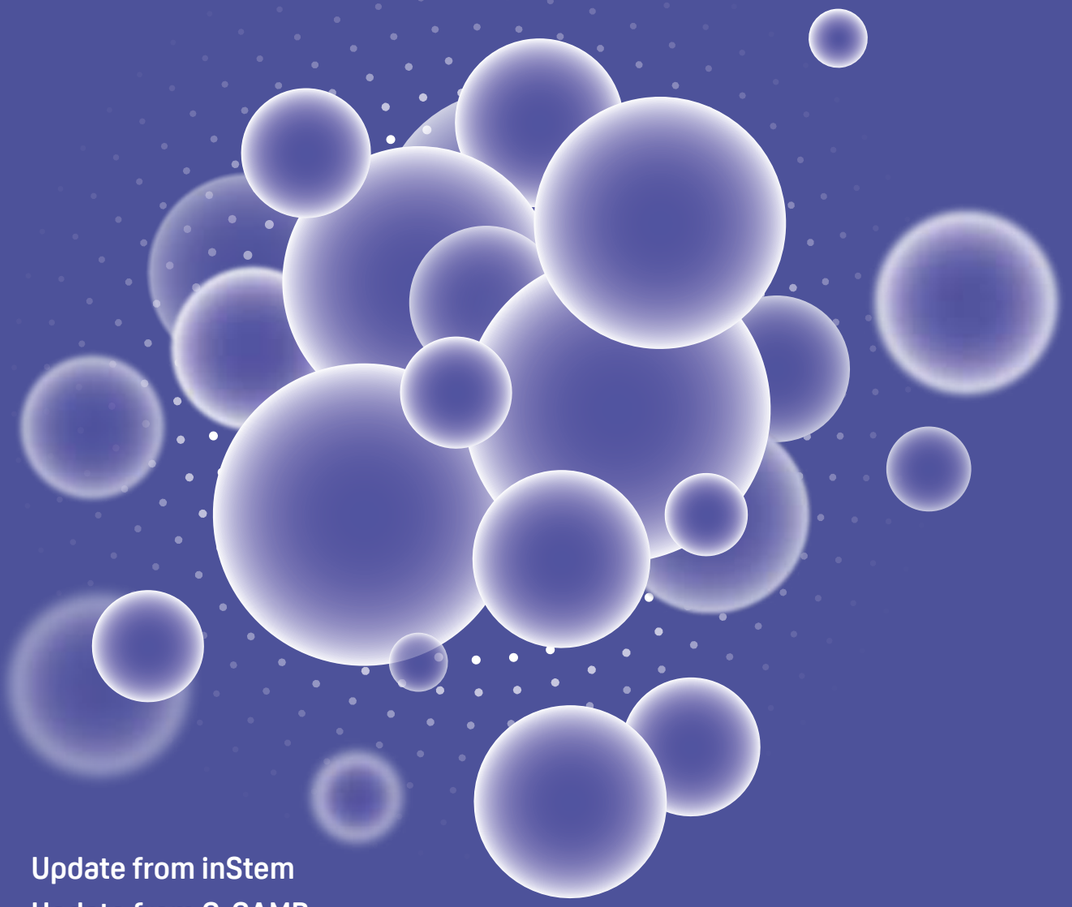


Onground work of alumni of MSc. Wildlife
Biology and Conservation Program

Upcoming Science Gallery Bengaluru space

Serene Corner of a reading room at Archives. Photo Courtesy: Ravi K Boyapati

Bangalore
Life Science Cluster (BLiSC)



Update from inStem
Update from C-CAMP
Update from TIGS

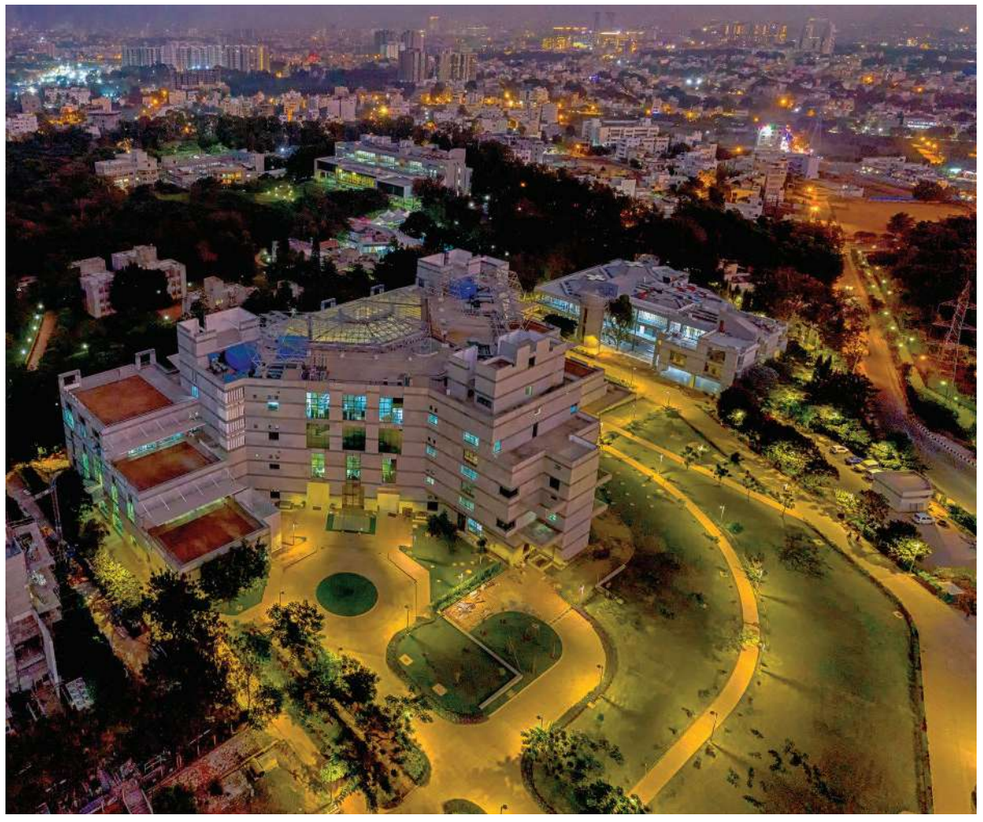
BANGALORE LIFE SCIENCE CLUSTER

Update from inStem

Maneesha Inamdar

DBT-inStem's mandate is to undertake world-class research in the area of stem cells and regenerative medicine for the benefit of humankind and society. Capitalizing on the diverse and cross-disciplinary expertise we have and our interactions with the BLiSC campus, new approaches to regenerative biology have been initiated. Our focus is on developing out-of-the-box solutions for stem cell research and its application. For this, we continue engaging with the BLiSC and the wider Bangalore research community, to initiate ambitious new research directions in stem cell science, foster new collaborations, recruit faculty and staff, and establish impactful training programs.

An important emphasis is also to "be local, go global". InStem has embarked on an ambitious plan to be a resource for quality Indian stem cell lines, research and training. With this goal, we set up the unique ESCORT program: A Platform Enabling Stem Cell and Organoid Research and Training, which is India's first state-of-the-art stem cell and organoid facility, will be funded by the Department of Biotechnology, Government of India, under the aegis of SAHAJ. We are pleased to partner with the International Stem Cell Banking Initiative (ISCBI) for training in stem cells, ethics, regulation, and policy.



inStem is at the forefront of discoveries, and inventions and progressing very rapidly to translation and the clinic. The addition of three faculty members with core stem cell expertise has boosted our efforts in cardiac and brain organoid models. Many inStem faculty have pivoted to include stem cell-derived models in their research programs, aiming for retinal, bladder, and lung organoids or developing better polymers and matrices for stem cell culture. Our efforts are expanding to include the nascent field of developing models of early human development, funded by the Bill & Melinda Gates Foundation, focused on developing organoid models of early human development, for de-risking drug discovery. At the Centre for Stem Cell Research (CSCR), DBT-inStem's translation unit in CMC, Vellore, research on gene editing and prime editing to treat inherited blood disorders has gained momentum. It is indeed a matter of national pride that the CSCR has entered the critical clinical trial phase for the treatment of haemophilia.

In recognition of their outstanding fundamental research and translation to application, our faculty and researchers have also been conferred with several prestigious grants, fellowships, and awards, including from HFSP, EMBO, and India Alliance. We continue our vibrant interactions with the community through several international and national meetings, workshops, training, and outreach activities. We have recently been included in the prestigious "Circle of Stem Cell Institutes and Centres" of the International Society of Stem Cell Research (ISSCR).

Our on-campus engagement with the BLiSC community was further bolstered with the joining of Prof. L. S. Shashidhara as Center Director of NCBS-TIFR. With our BLiSC partners, we are establishing an Animal BSL3 facility, that will support work on various infectious agents as well as help in future pandemic preparedness. A highlight of the year was the visit of the Secretary, DBT, Dr. Rajesh Gokhale to DBT-inStem and interactions with all BLiSC institutes. The year we also culminated in inStem being integrated as an iBRIC- an institute of the Biotechnology Research and Innovation Council of DBT. We further look forward to working together with other DBT institutes under the enabling umbrella of BRIC.

BANGALORE LIFE SCIENCE CLUSTER

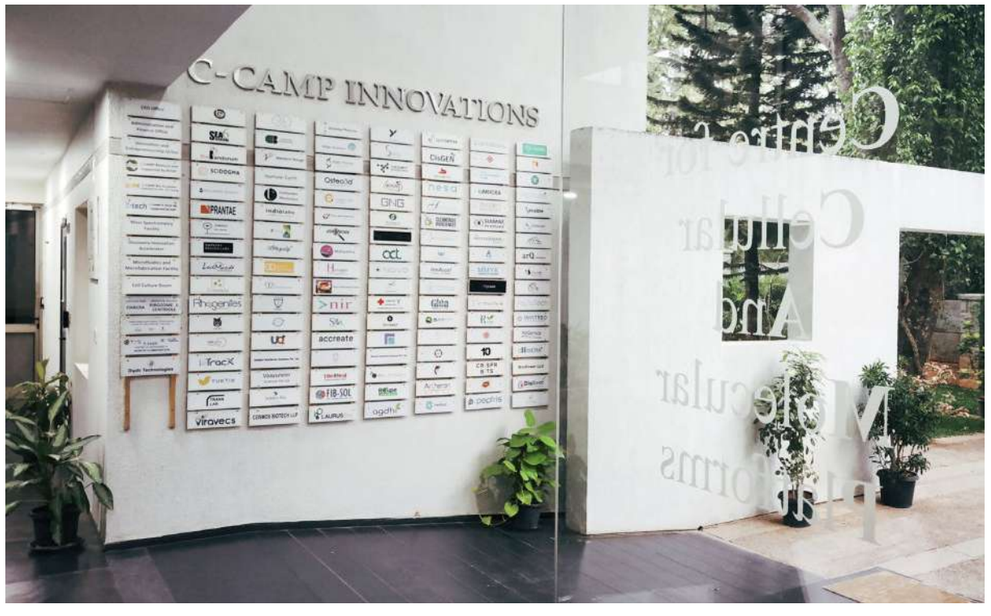
Update from C-CAMP

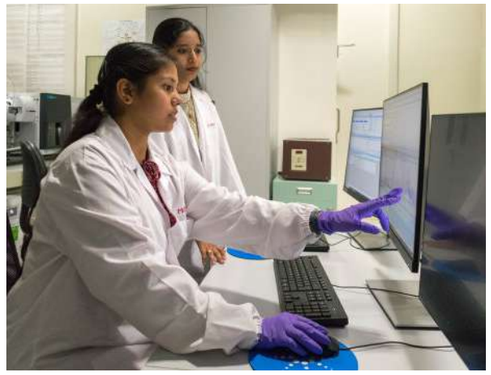
Taslimarif Saiyed

The Centre for Cellular and Molecular Platforms, C-CAMP, is enabling cutting-edge life sciences research and innovation for societal impact across India and the globe. It is a founding member of the Bangalore Life Sciences Cluster, one of the world's top biology campuses mandated to translate science to society. The Cluster comprises of 3 other institutes, National Centre for Biological Sciences, Institute for Stem Cell Science and Regenerative Medicine and Tata Institute for Genetics and Society.

Conceptualized by the Department of Biotechnology, Govt. of India in 2009 as a catalyst of research and innovation in life sciences, C-CAMP has now established itself as an architect of societal progress through science and technology. C-CAMP is a major platform technology base, industry-oriented innovation hub, and startup ecosystem that provides support to researchers, innovators and entrepreneurs developing solutions for socially relevant problems across healthcare, agriculture and environment domains.

C-CAMP is the industry-academia interface arm of the Bangalore Life Sciences Cluster and a gateway to the advanced high-end Technology facilities available on campus. It is one of the premier centres for services and training with the mandate to break down infrastructural silos in modern biological research and enable pursuits of frontline research unhindered by gaps in infrastructure and technical expertise. C-CAMP has completed over 4250+ research projects with 450+ research institutions across India and continues to contribute to the growing biosciences R&D in the country with technical skill development programmes. This has translated into over 240 publications and 2000+ trained scientists.





C-CAMP also has a slew of dedicated innovation and entrepreneurship development programs aimed at nurturing early-stage innovative ideas, transforming ideas into products and catalysing their journey to market. This program that started with the support of Govt of India a decade ago, C-CAMP is now working with close to 3000+ startups across India, with one of the strongest networks in the startup ecosystem. For context, as per Govt of India statistics, the biotech ecosystem of India has 6000+ startups.

Of these portfolios of 3000, C-CAMP directly supports 370+ through its funding, incubation, mentorship, acceleration and deployment programs. All these innovations provide world-class, affordable solutions to some of the most critical and socially relevant questions in the life sciences arena across the high-impact areas of healthcare, agriculture and environment. 80+ of these innovations are now in-market and more than 230+ are patent-protected. The success of C-CAMP lies in creating and fostering an open innovation culture in and around an Academic/Research environment of BLiSC for scientific know-how and an unparalleled peer-to-peer network.

Some of the key domains C-CAMP is focusing on are Agriculture, Medtech, Diagnostics, Antimicrobial Resistance, Digital Health, Maternal & Child Health. Future expansions are in the works in Synthetic Biology, Oncology and Climate.

Part of C-CAMP's third key objective is research translation and commercialization that envisions a journey of academic discoveries at the bench into technologies serving society. In the complex landscape of research and development, this journey of translating academic research to practical applications is a formidable challenge. The **"Research Translation and Commercialisation"** arm of C-CAMP is an endeavour focused on bridging this chasm facilitated by a twin program of **(i)** Discovery to Innovation Accelerator (DIA) and **(ii)** Office of Technology Transfer (OTT). The Discovery to Innovation Accelerator (DIA) program, which connects academia with industry, seeks to accelerate the process of research translation by transforming academic inventions into scalable, industry-ready solutions through research and technical support. The Office of Technology Transfer (OTT) at C-CAMP on the other hand plays an instrumental role by catalysing the technology transfer of laboratory breakthroughs into marketable technologies with commercial and societal impact. C-CAMP has licensed more than 10 technologies co-developed in-house and through its partner network.

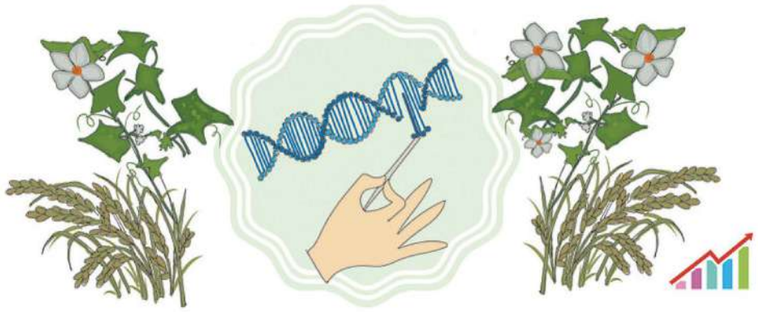
Update from TIGS

Communications Office

The Tata Institute for Genetics and Society (TIGS) is a non-profit research institute for developing solutions to challenges in human health and agriculture. TIGS has three major research programs focused on providing evidence-based solutions to combat diseases, foster health equity, and achieve nutrition security through sustainable models for agriculture.

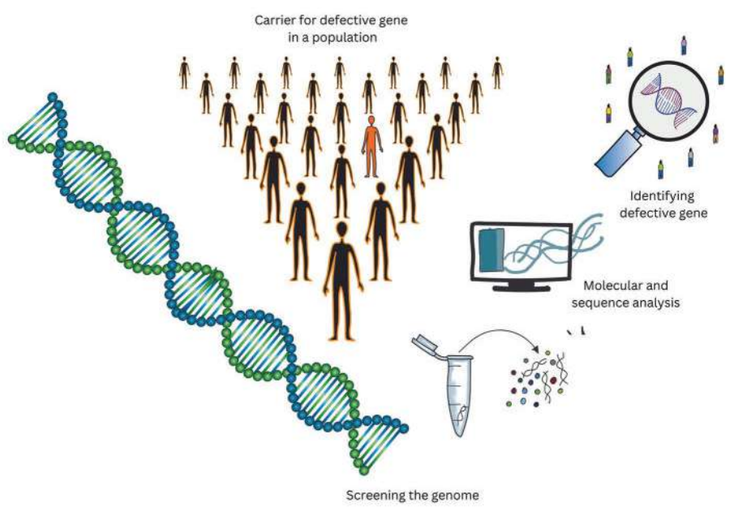
Crop Improvement Program

In the face of climate change and an increasing global population, food security and nutrition have become some of the biggest challenges. TIGS is committed to incorporating scientific techniques such as genome editing, mutation breeding, and pest management, to enhance the productivity, resilience, and nutritional content of staple food crops. We are developing new varieties of rice with desirable traits such as increased yield, resistance to diseases and pests, tolerance to environmental stresses, and improved nutritional profiles.



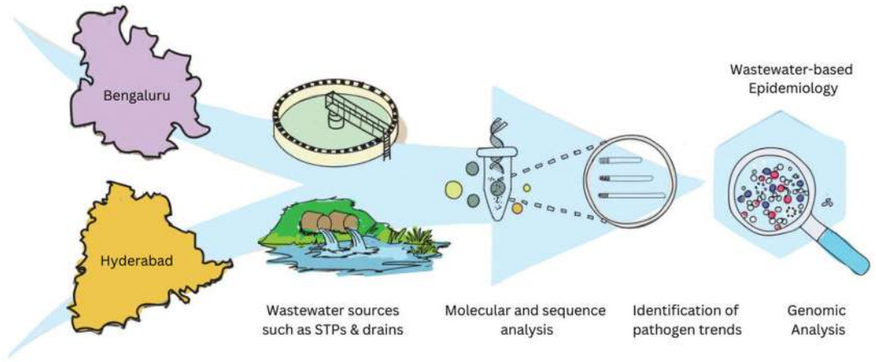
Rare Genetic Diseases Program

The RGD program at TIGS focuses on genetic diseases that affect a small percentage of the population and do not have sufficient therapeutic or management options. Our efforts are directed towards developing accessible diagnostic assays for screening carriers of these diseases as well as to indigenize and develop low-cost and affordable therapeutic interventions.



Infectious Diseases Program

Combating the spread of infectious diseases requires studying their vectors, pathogens, and their relationship to humans and the environment using the One Health approach. We work on multiple strategies, including the development of new diagnostics, devising novel approaches to control vectors such as mosquitoes, employing environmental surveillance to understand the prevalence of disease-causing pathogens and developing methods to monitor the threat of antimicrobial resistance.



TIGS in the Spotlight

Over the past couple of years, TIGS has played a prominent role in developing standardized models for wastewater surveillance for SARS-CoV-2, the virus that causes COVID-19, from both sewage treatment plants (in Bengaluru) and open drains (in Hyderabad). Our early warning system has been successfully used to monitor the spread of SARS-CoV-2 in Bengaluru city, where the results from the lab are shared regularly with the local municipal authorities, the Bruhat Bengaluru Mahanagara Palike (BBMP) to help them design containment and testing strategies to tackle the pandemic.

TIGS is also a part of the BeST (Bengaluru Science and Technology) cluster, now formalized by the Office of the Principal Scientific Adviser to the Government of India. BeST is a transdisciplinary collaborative effort to propose and implement research, policy, and programs at a local and regional scale in Karnataka. TIGS and NCBS have developed a comprehensive framework for developing the Bengaluru One Health City to build a Bengaluru One Health Platform - a network of practitioners and scientists who will evaluate the value of shared environment, biodiversity and livestock monitoring for pathogens in the changing milieu of a large urban city.

The Community Engagement program at TIGS provides a vibrant and active space to engage with various stakeholders including students, researchers, clinicians, policy makers, patient groups and experts in relevant fields, culminating in meaningful dialogues that inform science and policy perspectives.

Supporting Science

Dolna
NCBS Communications Office

SUPPORTING SCIENCE

Dolna

Bhuvana Shiva

It all started 25 years ago when a young scientist (Dr. Ramanathan Sowdhamini) joined NCBS in the year 1998. On one hand, she had to raise a young child and on the other concentrate on Science. These challenges sowed a seed in her to set up a daycare facility on campus, she led the seed germinate by pooling in like-minded people and started “Dolna”.

All the necessary ingredients for creating a crèche were brought into place rapidly and efficiently by Dr. Gayatri Saberwal. All faculty colleagues and their families, then on the campus, promptly participated in crèche meetings in the formative years and owned to make it happen with 10 children in-house. The founder members funded and set up the facility themselves: one painted the walls and named it Dolna (Ms Ruma Chattarji), another member organized extracurricular activities for the children (Ms Sangeeta Udgaonkar), one charted out the schedules (Ms Bina Mathew), some took up the wellbeing of staff (Dr Gayatri Saberwal and Dr Upinder Bhalla), so on and so forth. The Institute Administration observed its growth and provided their unwavering support in all ways.

From a seed sowed 25 years ago, the facility today has grown into a tree which caters to about 70 – 80 children who are nurtured by 18 dedicated staff. Dolna has become a role model to many research Institutes and Corporate sectors.

The summer camps are vibrant and designed to best utilize time and resources. These camps include varied activities, simple experiments and interactive sessions with experts from various walks of life right from Science to Martial arts. Visits to labs, field trips to Science museums, historical sites, architectural marvels, exhibitions, farmland, forests, nature camps, fire stations, botanical gardens make these camps more interactive.

Playground in the NCBS premise for kids at Dolna

Today parents from NCBS, INSTEM, CCAMP, TIGS, and attendees of conferences/workshops/meetings are availing the facility for babies and children aged from 6 months to 12 years. The mandate of Dolna is to ensure that children of BLiSc employees grow in a safe and intellectually stimulating environment while allowing the parents to work at their regular schedule. Dolna’s proximity to four campuses, access to their various facilities and the homely atmosphere make child care at Dolna a unique experience.

Sandhya Koushika, professor at TIFR and former NCBS faculty, says ***“Dolna continues to provide excellent much needed support to working parents to enable them to succeed in their scientific careers.”***

Dedicated team at Dolna

SUPPORTING SCIENCE

NCBS Communications Office

Ipsita Herlekar
Rupsy Khurana

Bridging Boundaries, Igniting Curiosity – Science Communications and Outreach at NCBS

The NCBS Communications Office envisions itself as an innovative hub, employing multimedia storytelling to portray the complexities, marvels, and processes of science. Our objective is to showcase science, with a special focus on NCBS research, in a manner that is engaging, meaningful, and easily accessible, akin to popular content.

Our main goal in 2023 has been to continue the work of our predecessors, and work towards reviving some of the popular pre-covid outreach programs. We have also been working towards building greater engagement between our researchers with non-expert audience. We hope to create and curate more opportunities that would provide our early career researchers a platform to showcase and hone their science communication skills.

Our team is involved in a broad spectrum of outreach initiatives across multiple platforms and in various formats, designed to reach and resonate with a diverse audience.

In the digital age, establishing and sustaining an online presence is essential. We interact with our followers through our website and various social media platforms. The objective is to engage with a global audience, generate interest in science, and maintain connections with the Institute's alumni and sponsors worldwide. We carefully curate and share posts to spark the interest and curiosity of our followers. For instance, we highlighted National Butterfly Month in September, Wildlife Week in October, and Moth Day and Anti-Microbial Resistance awareness week in November. We also initiated a new social media series titled #DidYouKnow, through which we share interesting science narratives, aimed at quipping the curiosity of young minds. Beyond sharing research-based narratives, our social media followers also get glimpses into the campus lives and academic achievements of students and researchers.

The Communications Office also disseminates content to the press, highlighting the latest research, news, partnerships, and scientist interviews. In addition to sharing press releases with the members of the press, we also invite them to visit our campus and participate in our events. Our growing association with press has helped reach a wider demography, through articles based on our recent research findings and interviews with scientists to be featured across various English and vernacular dailies, including widely distributed publications like The Hindu, Deccan Herald, The Indian Express and Nature India.

While the digital space allows us to reach people far beyond geographical boundaries, we recognize the positive impact interpersonal interactions have on young minds. Consequently, the Communications Team organizes campus and lab tours for school and college students throughout the year, offering them a first-hand glimpse at the process of how science is conducted at NCBS.

This academic year we have hosted students from over 25 schools and colleges from across the country- Bishop Cotton Women's Christian College (Karnataka), University of Horticulture and Forestry, (Himachal Pradhesh), Rishi Valley School (Andhra Pradesh), Jagdish Bose National Science Talent Search, (West Bengal), College of Forestry, Kerala Agricultural University, Forest College and Research Institute (Tamil Nadu), MIT- World Peace University (Maharashtra) and Lady Doak College (Tamil Nadu), have been among the visitors. These campus tours are tailored to match the interests of the students with an aim to kindle their interest and curiosity in science and maximize knowledge acquisition.

In addition to these tours, our team also collaborates with different labs and faculty to curate and facilitate outreach activities. For example, we helped Prof. Hiyaa Ghosh and her team to curate and host students from Jawahar Navodya Vidyalaya, Bengaluru, for a one-day long hands-on activity session focussed on neuroscience. The students learnt about the neural mechanisms in the brain, their functions, and associated disorders. We also worked with Prof. Sanjay Sane and other campus researchers to help organise and celebrate Moth Day on 3rd November 2023. The event involved hosting nine schools to showcase various exhibits displaying moth and insect specimens, and demonstrations around insect ecology and behaviour.

Another highlight of our outreach efforts this year has been hosting the public event titled "Demystifying Vaccines: Evolution of mRNA-based platforms in Vaccines and Therapeutics", on 7 November 2023, in collaboration with the Bangalore International Centre. This event was open to the members of the public and consisted of popular science talks and a panel discussion by scientists, pharmaceutical professionals, and entrepreneurs. They discussed the journey of vaccines, from research to market launch, drawing upon their experiences, including those from the recent COVID-19 pandemic. They also explored India's potential as a new global hub for vaccine development.

The Communications Office at NCBS goes beyond simply promoting research; it seeks to bridge the gap between scientists and public, fostering a deeper understanding and appreciation for science in diverse audiences.

Students from Rishi Valley School learning about mutations

High Schoolers from Bangalore International School in labs interacting with researchers on behavior C.elegans as part of a module on neuroscience

Learning in labs- Students from Jawahar Navodaya Vidayalaya interact with researchers on various neurodegenerative disorders and look at the different parts of brain under a microscope.

Scientists from NCBS, CCAMP and TIGS in a discussion with members of public on mRNA vaccines

Highlights of the Year

Centre for Brain and Mind

Meetings and Workshops

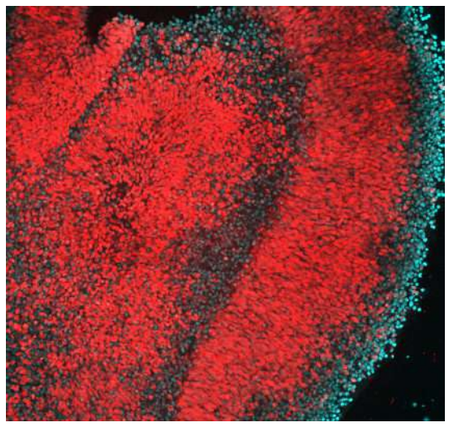
CENTRE FOR BRAIN AND MIND

Discovery Biology of Neuropsychiatric Syndromes (DBNS)

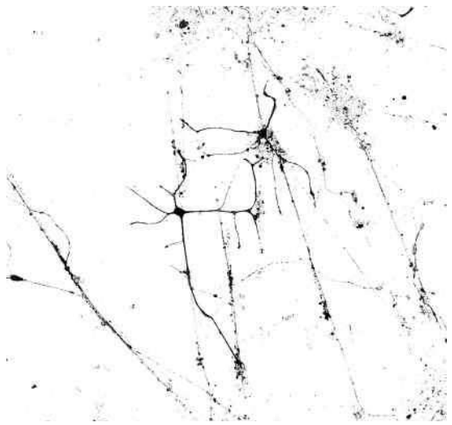
Raghu Padinjat

Severe mental Illness are a major source of disability in young adults with about 2-3 % of the population at risk for developing these disorders both in India and across the world. These disorders are recognized as one of the major non-communicable diseases (NCD) and a significant contributor to morbidity as articulated by the World Health Organization's New Delhi call for action on combating NCDs in India. Given this huge disease burden, the development of novel ways to diagnose and treat mental illness will have important positive social and economic benefits. To achieve this goal, there is a pressing need to understand the mechanistic basis of these disorders; such discovery could form the basis for the development of novel diagnostic and therapeutic approaches.

Since 2015, NCBS has led the development of a research program to understand the genetic and cellular basis of severe mental illness by harnessing the power of modern human genetics and stem cell technology. This program uses modern technology to create stem cells from human subjects with a strong history of severe mental illness and uses these to create "disease-in-a-dish" models of the human brain. The program was set up in 2015 as a collaborative initiative of three institutions from Bengaluru, India, the National Centre for Biological Sciences (NCBS) – the Institute for Stem Cell Science and Regenerative Medicine (inStem), and the National Institute for Mental Health and Neurosciences (NIMHANS) supported between 2016-2022 by the Department of Biotechnology, Government of India, and the Pratiksha Trust. Since 2023 the program is funded through generous support from Rohini Nilekani Philanthropies as a collaborative effort between NCBS and NIMHANS as the Rohini Nilekani Centre for Brain and Mind.



Brain organoids: iPSC derived 60 days old cortical forebrain organoids immunopositive for Sox2(red) and DAPI(blue).



Astrocytes: Human iPSC derived astrocytes 30 days old, stained for GFAP (black pseudo-coloured) exhibit characteristic processes

The DBNS program studies five major forms of severe mental illness (SMI): schizophrenia, bipolar disorder, obsessive-compulsive disorder, substance dependence and dementia. All these disorders are known to have an inherited basis. However, despite their high heritability, to date, few genetic correlates that could account for this high heritability have been identified. To study these disorders, a prospective cohort of families with a strong family history of SMI has been assembled.

The DBNS program is pursuing three distinct but complementary lines of analysis on these families:

(i) The families have been clinically studied to understand changes in structure and function at multiple levels of brain organization; they will continue to be followed over twenty years at 3-year intervals to define the temporal development of disease through regular and detailed clinical phenotyping.

(ii) We have established about 100 induced pluripotent stem cell lines from affected individuals in these families and unaffected controls. These lines are being used to generate cellular models to study the mechanistic aspects of cellular neurobiology that lead to disease.

(iii) Next Generation Sequencing and neuroinformatics are being used to uncover the genetic basis of SMI. The multiple types of data generated by the program are being assembled into an integrated database to facilitate the application of sophisticated methods of data analysis to uncover new disease biology. The stem cell lines, other biomaterials and other datasets have been assembled into a biorepository that will allow the sharing and use of this resource to drive discovery biology around SMI. The program has instituted mechanisms to facilitate the sharing of data and resources generated through its activities.

Inaugural Meeting of Centre for Brain and Mind

Rohini Nilekani inaugurating the centre at NCBS

PUBLICATIONS

- Ahmed P, H., Singh, P., Thakur, R., Kumari, A., Krishnan, H., Philip, R. G., Vasudevan, A. and Raghu P. (2021). Genomic sequencing of Lowe syndrome trios reveal a mechanism for the heterogeneity of neurodevelopmental phenotypes. bioRxiv 2021.06.22.449382.
- Akhtar BM, Bhatia P, Acharya S, Sharma S, Sharma Y, Aswathy BS, Ganapathy K, Vasudevan A & Raghu P*. A human stem cell resource to decipher the biochemical and cellular basis of neurodevelopmental defects in Lowe Syndrome. Biology Open 2022 15;11(1):bio059066. doi:10.1242/bio.059066.
- Sharma, Y., Saha, S., Joseph, A., Krishnan, H. and Raghu, P. (2020). In vitro human stem cell derived cultures to monitor calcium signaling in neuronal development and function [version 1; peer review: 3 approved]. Wellcome Open Res. 5:16, doi: 10.12688/wellcomeopenres.15626.1. eCollection.
- Saha S, Krishnan H, Raghu P. IMPA1 dependent regulation of plasma membrane phosphatidylinositol 4,5-bisphosphate turnover and calcium signalling by lithium. Life.Sci.Alliance 2023 (in press).

Meetings & Workshops 2023

January

23-25
NCBS Annual Talks 2023: Patterns in Biology

February

6-9
EMBO meeting for Organoid

6-10
EMBO: Bacterial Morphogenesis, Survival and Virulence: Dynamic Genomes and Envelopes

12-25
10th Annual Science Journalism Workshop

March

6-10
Basic Training Course for Laboratory Animal Veterinarians

24-25
ACRC Planning & Team Building Meeting

25-29
The 45th Indian Biophysical Society Meeting

April

7-9
Genomics Meeting

May

4
Technology Platforms for Advancing Biological Research

June

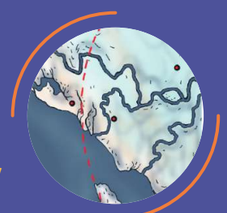
5-11
CRISPR/ Cas Technology and Genome Engineering Workshop

14
NSTMIS-Project Advisory Committee (PAC) meeting

15
Brainstorming Discussion Meeting on Clinical Research

19-28
Physics of Life: The 8th Annual Monsoon School

July



4
RNP CBM Inauguration Meeting

17-21
Training Workshop on Basic Bio-Methodology of Laboratory MICE & RATS

31 July - 13 August
SAGE Training Program

August

11
IGNITE Annual Science Review Meeting

16-19
Statistical Genomics Workshop

17-18
Eye Stem Cell Meeting

24
MoU signing between NCBS and Forest research institutes

28 August - 2 September
4th Hands-on Workshop on Integrated OMICS (Genomics, Proteomics and Bioinformatics)

31 August - 1 September
Surveillance Workshop

September

11-14
Hands-on Workshop on Cryobiology and Assisted Reproductive Technologies (ARTs) in the Laboratory Mouse

24 September - 1 October
Bangalore Microscopy Course

October

9-12
Student conference of conservation science

29-31
Indo-Swiss AMR dialogue: Innovative approaches to tackle the global AMR crisis

November

9-10
Ciliopathy pe Charcha

14-18
Stochasticity and Plasticity in Living Systems

23-24
Rare Genetic Diseases Research Summit (REDRESS-2023)

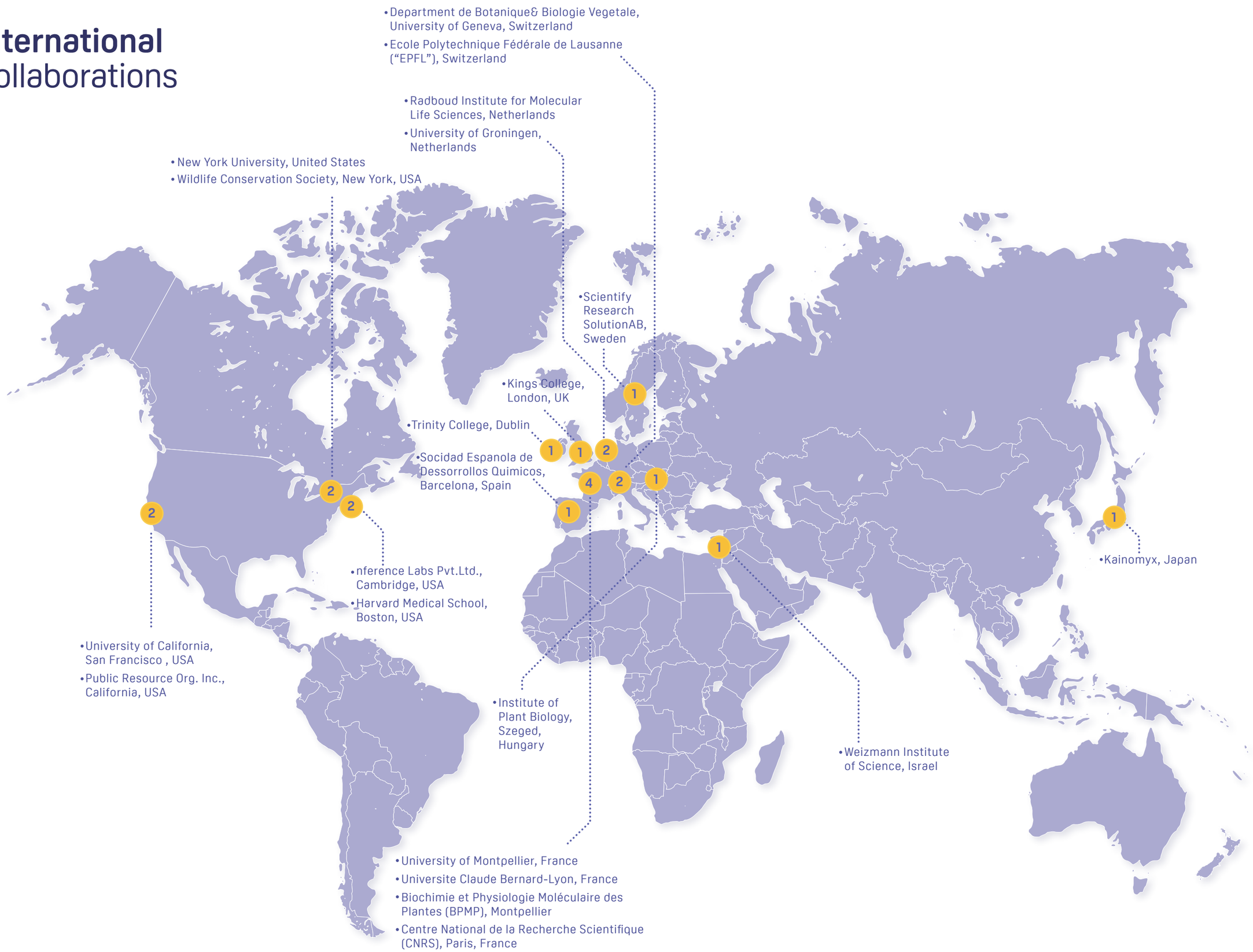
December

4-9
5 th Hands-on Workshop on Integrated OMICS (Genomics, Proteomics and Bioinformatics)

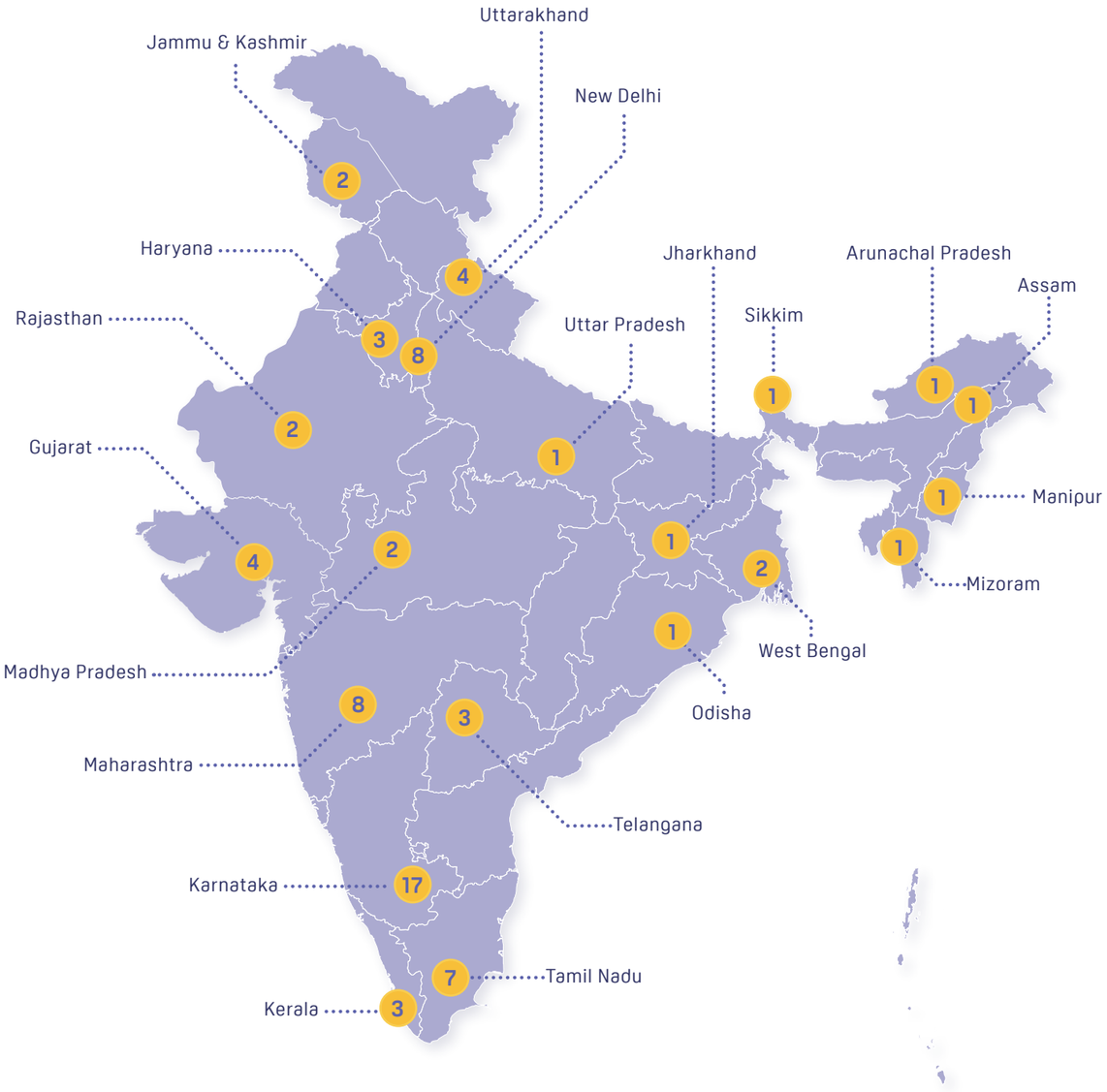
NCBS Collaborations

International Collaborations
National Collaborations

International Collaborations



National
Collaborations



- DBT-inStem, Bangalore
- TIGS, Bangalore
- C-CAMP, Bangalore
- NIMHANS, Bangalore
- Indian Institue of Science (IISc), Bangalore
- Rajiv Gandhi University, Arunachal Pradesh
- Indian Institute of Technology (IIT), Gandhinagar
- Sikkim University, Gangtok
- National Institute for Plant Genome (NIPGR), New Delhi
- St.John's Research Institute, Bangalore
- Bangalore Baptist hospital, Bangalore
- Pune Knowledge cluster foundation (PKCF), Pune
- IISER, Pune
- CMC, Vellore
- Institute of Life Sciences , (ILS), Bhubaneshwar
- Regional Centre for Biotechnology (RCB), Faridabad
- NIBMG, Kalyani, West Bengal
- Centre for DNA Fingerprinting and Diagnostics (CDFD), Hyderabad
- National Centre for Cell Sciences (NCCS), Pune
- Centre for Cellular & Molecular Biology (CCMB), Hyderabad
- Gujarat Biotechnology Research Centre(GBRC), Gandhinagar
- Bayramjee Jeejeebhoy Government Medical College & Sassoon Hospital (BJGMC), Pune
- Institute of Liver and Biliary Sciences (ILBS), New Delhi
- Centre for Brain Research (CBR), IISc, Bangalore
- National Institute of Immunology (NII), New Delhi
- Institute of Bioresources and Sustainable Development (IBSD), Imphal
- Translational And Health Scienceand Technology Institute (THSTI), Faridabad
- Rajiv Gandhi Centre for Biotechnology (RGCB), Thiruvananthapuram
- Institute of Genomics and Integrative Biology (IGIB), New Delhi
- International Centre for Genetic Engineering and Biotechnology (ICGEB), New Delhi
- AIIMS Jodhpur
- Mizoram University Aizawl, Mizoram
- NIBMG-West Bengal
- SKIMS- Srinigar, Jammu and Kashmir
- IIT, Delhi
- IIT, Madras
- IIT, Bombay
- IIT, Jodhpur
- IIIT, Allahabad
- CDFD, Hyderabad
- Wildlife Institute of India (WII), Dehradun
- Dakshin Foundation, Bangalore
- nature Conservation Foundation, Mysore
- Zoological Survey of India, Chennai
- Indian Institue of Forest Management (IIFM), Bhopal
- GEER Foundation, Gandhinagar
- Indian Cancer Genome Atlas (ICGA), Maharastra
- M. S. Swaminathan Research Foundation, Chennai
- Kadamane Estates Company, Ernakulam, Kerala
- Wipro Foundation, Bengaluru, Karnataka
- CBCI Society for Medical Research, Jharkhand
- Cytecare Hospitals Pvt.Ltd, Bengaluru
- Punjab National Bank
- India Malabar Cancer Centre, Thalassery, Kerala
- Tata Memorial Centre, Bengaluru
- Rajiv Gandhi University of Health Sciences (RGUHS), Bengaluru
- University of Kashmir, Srinagar
- Indian Institute of Forest Management, Bhopal
- Manomanian Sundaranar University, Tirunelveli
- Tezpur University,Tezpur
- University School of Environment Management, New Delhi
- Ashoka University, Sonepat, Haryana
- Appolo Hospital, Bengaluru
- Lakeshore Hospital, Bengaluru
- Unilever Pvt.Ltd.
- Advance Centre for Treatment, Research and Education in Cancer, Mumbai
- Feather Library Charitable Trust, Ahmedabad
- Wildlife Conservation Society, Bengaluru
- Tadoba Andhari Tiger Reserve Conservation Foundation (TATRCF), Chandrapur, Maharashtra
- NIKON
- Central Zoo Authority (CZA), Delhi
- Indian Council of Forestry Research and Education (ICFRE), Dehradun
- ICFRE,Coimbatore
- IGNFA, CASFOS, Dehradun
- ICFRE - Institute of Forest Genetics and Tree Breeding, COIMBATORE (IFGTB)
- Forest Survey of India, Dehradun

Scientific and Management Board

Management Board

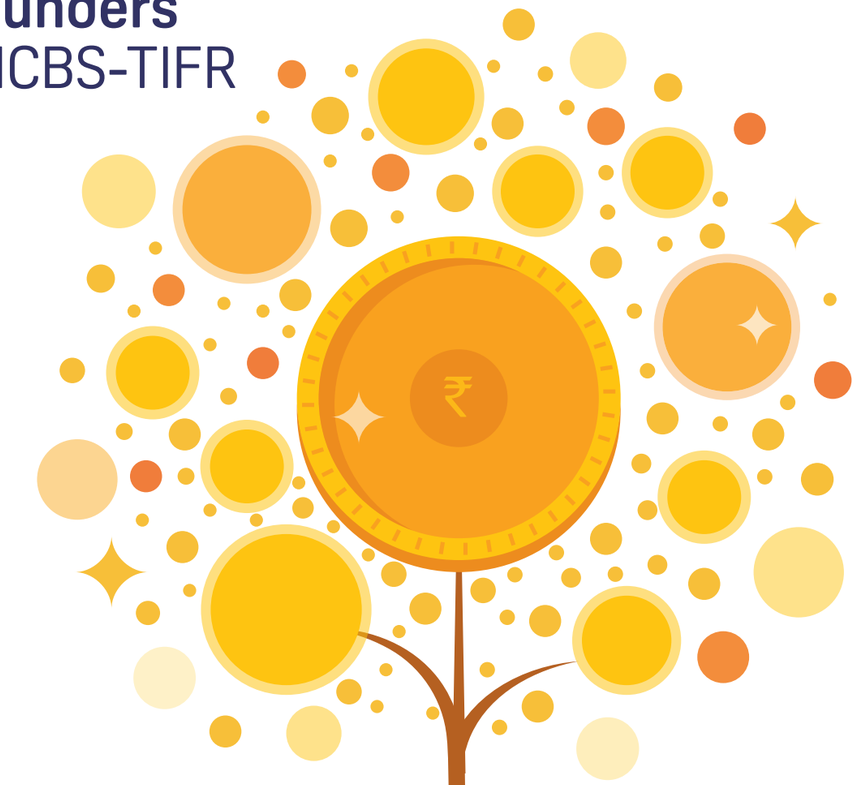
The Management Board is in charge of the overall management of NCBS, and also functions as a research council.

- **Prof. Mary Beckerle,** University of Utah, USA
- **Prof. Benny Shilo,** Weizmann Institute of Science, Israel
- **Prof. Thomas Daniel,** University of Washington, USA
- **Prof. Satyajit Rath,** IISER, Pune
- **Prof. Gagandeep Kang,** Christian Medical College, Vellore
- **Dr. Anurag Behar,** Azim Premji Foundation, Bangalore
- **Prof. Vidita A. Vaidya,** TIFR, Mumbai
- **Prof. L.S. Shashidhara,** Centre Director, NCBS, Bangalore
- **Prof. Raghu Padinjat,** Dean of Research, NCBS, Bangalore
- **Prof. Sanjay Sane,** Dean of Faculty, NCBS, Bangalore
- **Prof. Raj Ladher,** Dean of Academics, NCBS, Bangalore
- **Prof. Mukund Thattai,** NCBS, Bangalore
- **Prof. Maneesha Inamdar,** Director, inStem, Bangalore
- **Prof. Jayaram Chengalur,** Director, TIFR, Mumbai
- **Col. Rajeev Anand,** Registrar, TIFR, Mumbai
- **Ms. Sushma Taishete,** Joint Secretary (R&D), DAE, Mumbai
- **Mr. Ravi Shankar,** A&F (Non member secretary), NCBS, Bangalore

Scientific Advisors

- **Prof. Kamal Bawa,** University of Massachusetts, USA
- **Prof. Albert J. Libchaber,** Rockefeller University, USA
- **Prof. Venkatraman Ramakrishnan,** MRC Laboratory for Molecular Biology, Cambridge, UK
- **Prof. Joan E. Strassmann,** Washington University in St Louis, USA
- **Prof. Jan Marino (Nino) Ramirez,** University of Washington, Seattle, USA

Funders
NCBS-TIFR



- Department of Biotechnology, Govt. of India
- Department of Science and Technology, Govt. of India
- Science and Engineering Board, Govt. of India
- Biotechnology Industry Research Assistance Council (BIRAC), Govt. of India
- Ministry of Environment, Forest and Climate Change (MOEFCC), Govt. of India
- DBT/Wellcome Trust India Alliance
- Indian Council for Medical Research, Govt. of India
- Department of Health Research (DHR), Govt. of India
- CEFIPRA
- One Health (PSA, Govt. of India)
- Tata Trust
- Rohini Nilekani Philanthropies Foundation
- Hindustan Unilever Limited and Unilever Industries P Ltd.
- Rockefeller Foundation (via CCMB, Hyderabad)
- Infosys Foundation
- Kiran Mazumdar Shaw
- TTK, Prestige
- Narayana Murthy
- Srikanta and Radhika Gopalakrishnan (Philanthropic Donors)
- Simons Foundation
- DeFries-Bajpai Foundation
- Human Frontier Science Program (HFSP)
- European Molecular Biology Organization (EMBO)
- Air Force Office of Scientific Research (AOARD), USA
- National Geographic
- Max Planck Group
- Wildlife Conservation Trust
- Panthera Corporation, New York, USA
- ICA (International Council on Archives) Fund for the International Development of Archives (FIDA)
- Arcadia Philanthropic Trust, UK
- Duleep Mathai Trust
- On the Edge Conservation (OTEC), UK
- Global Partnerships Fund. International Relations and Partnerships Team, Newcastle University, UK
- Conservation, Food and Health Foundation, USA
- TNQ Technologies

Catalysis: the speeding up of a chemical reaction by addition of a catalytic agent to it

Uma Ramakrishnan
Head, Outreach and Development

In this years' annual report, we explore this possibility. Has NCBS been the catalytic agent? Does the NCBS institutional culture allow others to build things that might have taken longer, or never have happened at all without it? We bring you some examples of what we believe are the catalytic roles that NCBS played in the histories of other institutions and endeavours.

Last year many things changed at NCBS, and yet much stayed the same. We tried to regain our pre-pandemic energy, with renewed wisdom, and we hope that the sense of possibility, curiosity and exploration that is a hallmark of NCBS continues. Through the communications office, we hope to build many new, interesting and catalytic engagements in science outreach going forward.

We hope that this report leaves you with a sense of the tempo and flavour of 2023, but also its lived experience for the NCBS community.

Designer's Note

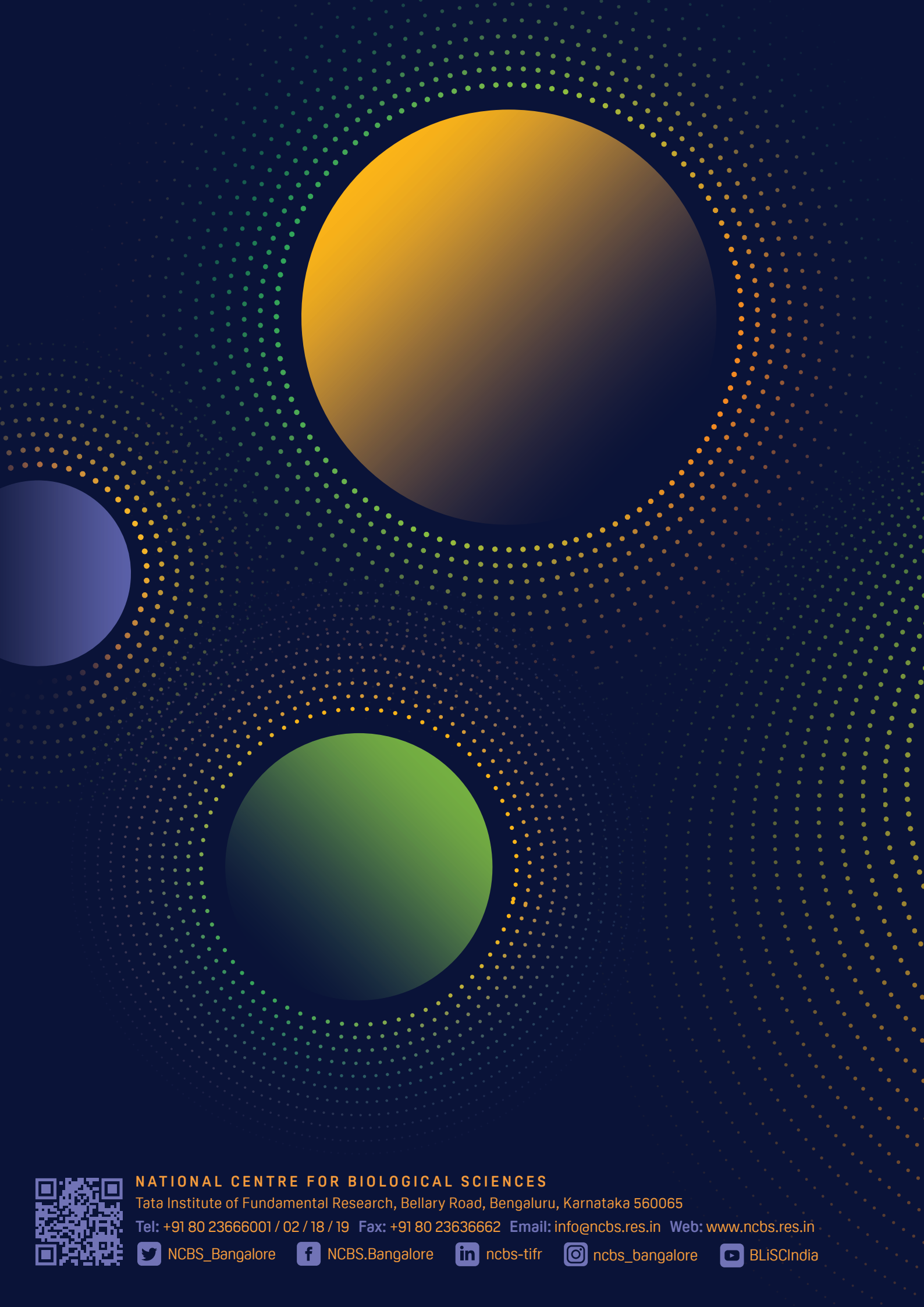
Sumita Nanda
Designer, www.superpixel.in

This year, the NCBS Annual Report focuses on how the institute has been a catalyst in the genesis of various out-of-the-box initiatives *(like BLiSC, NCBS Archives, IndiaBioscience, and more).*

The cover design abstractly illustrates this idea of catalysis using circles, where the addition of the catalytic agent *(green circle coming together with the purple one)* is resulting in a sped up reaction *(shown as the dotted, expanding system of concentric circles)*, leading to the origination of new initiatives *(shown as the multiple, smaller circles around).* Extending this theme throughout the report, we have utilized circular shapes as design elements to illustrate the various research domains of NCBS and all other sections as well.

It was a wonderful experience working with **Uma Ramakrishnan**, **Rupsy Khurana**, and **Ipsita Herlekar** from the NCBS Communications Office, their inputs and support were a big help throughout. A special mention here of Rupsy for the faculty illustrations which beautifully complement and elevate the look of the report.

Faculty illustrations: **Rupsy Khurana**
Report design: **www.superpixel.in**



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