ANNUAL REPORT
2020-21

CSIR-CCMB

CENTRE FOR CELLULAR AND MOLECULAR BIOLOGY,
HYDERABAD

CONTENTS

प्राक्कथन

सीएसआईआर-सीसीएमबी, जैविक विज्ञान के विभिन्न पहलुओं पर कोशिकीय एवं आणविक स्तर पर विस्तृत अध्ययन में संलिप्त प्रमुख शोध संस्थानों में से एक है। मुझेसीसीएमबी काहिस्सा बनकरबेहद खुशीहो रहीहै औरमैं इस वर्ष वार्षिक रिपोर्टके लिएप्रतिवेदन लिख रहा हूँ। यहएक ऐसावर्ष भी रहा है जब दूसरीघातक लहरऔर SARS-CoV2 केडेल्टा वेरिएंट के उद्भवने भारतको झकझोरदिया। पिछलेडेढ़ वर्ष समूची दुनियाके लिएकाफी चुनौतीपूर्णरहे हैं।सदी में आयी इस एक महामारीने पूरी दुनियाको अपनीचपेट मेंले लियाऔर हमारेसोचने, कामकरने औरव्यवहार करनेके तरीकेको बदल कर रख दिया।हममें सेकई लोगोंने अपने प्रियजनों कोखो दिया।अभी हम इस महामारीसे बाहरनिकल ही रहे हैं, जिसने हमारेदेश कीअर्थव्यवस्था कोभी काफी प्रभावित कियाहै। आगे आने वाले एक - दोवर्ष हमारेदेश केलिए चुनौतीपूर्णहोंगे जबकिहम पूरी ईमानदारी सेवापसी करनेका प्रयासकर रहेहैं।

केंद्रीकृतसुविधाओं से सुसंपन्न सीसीएमबी भारत के सर्वोत्कृष्ट संस्थानोंमें से एक है। ये बेहतरीन सुविधाएँ संस्थानमें चलरहे शोधको गतिप्रदान करती हैं औरसाथ ही वैज्ञानिकोंका सहयोग करती हैं कि वे अपने शोध लक्ष्यों को प्राप्त कर सकें । मैंइस बातपर ज़ोर देना चाहताहूँ किसीसीएमबी मेंहमारे सहयोगियोंने ऐसीविषम परीक्षणपरिस्थितियों केबावजूद उत्कृष्टशोध में अपना योगदानदिया।

प्रमुखविज्ञान पत्रिकाओंजैसे साइंसएडवांस, ईलाइफऔर पीएनएएसमें परिणामीप्रकाशनों में इन प्रयासों की झलक देखने को मिलती है।हमारे सहयोगियों के वैज्ञानिक अनुसंधानों कोइंफोसिस पुरस्कार, विज्ञान अकादमीफेलोशिप औरयुवा वैज्ञानिकपुरस्कारों से सम्मानित किया गया है। ऐसे कठिन समय मेंसीसीएमबी केयोगदान परहमें बहुतगर्व है।

कोविड-19 की भयानकता कमकरने कीदिशा में, सीसीएमबी ने नयी दवाओंके परीक्षण, नए निदानपद्धति के विकास, कुल जीनोमअनुक्रमण में लगभग 12% अनुक्रमण का योगदानऔर निगरानीतंत्र केविकास मेंबहुत महत्वपूर्ण योगदानदिया है।इस अवसरपर मैंउन सभीवैज्ञानिकों, छात्रोंऔर तकनीकीकर्मचारियों कोहार्दिक बधाईदेना चाहताहूँ जिन्होंनेइस तरहके प्रयासोंमें अपना योगदान दियाहै। हमेंअपने योगदानपर गर्वहै, लेकिन अभी भी इस जानलेवा वायरसके जीवविज्ञान कोसमझने केलिए बहुतकुछ करनेकी आवश्यकताहै। कईअनुत्तरित प्रश्नोंपर वैज्ञानिकदृष्टिकोणों के साथ हल ढूँढने कीआवश्यकता है।वर्तमान में हम आईआईसीटीऔर इमटैकके सहयोगसे एकस्वदेशी एमआरएनएवैक्सीन के विकासकी दिशा में कार्यरत हैं ।आगे आने वाले दिनों में, उत्कृष्ट बुनियादी अनुसंधान एवं समाज कल्याण की दिशा में शोध के माध्यम से योगदान देना हमारी मुख्य चुनौतियाँ हैं।

विनय कुमार नंदिकूरी
निदेशक, सीसीएमबी

FOREWORD

CSIR-CCMB is among the preeminent research institutes doing exceptional work in investigating various aspects of biological sciences at cellular and molecular detail. I am delighted to be a part of CCMB and pen this year's foreword for the annual report. It is also a year when a deadly second wave and the emergence of a delta variant of SARS-CoV2 swept India. The past one and a half years have been quite challenging to the whole world. A once in a century pandemic engulfed the world and changed how we work, think, and conduct ourselves. Many of us lost loved ones in the family, friends, or a colleague. We are just emerging out of a pandemic, which has also impacted the financial well-being of our country. The next one or two years will be challenging for our country while we sincerely make efforts to bounce back.

CCMB is unique among the Institutes in India with excellent, well-oiled centralized facilities. This gives impetus to the ongoing research in the institute and supports its scientists tremendously in their endeavours towards achieving their research goals. I want to emphasize that our colleagues at CCMB contributed in outstanding research despite such testing circumstances. Prime examples of such efforts are the resulting publications in premier science journals like Science Advances, eLife, and the PNAS, among many others. The high-quality scientific research of our colleagues has been recognized in form of Infosys awards, Science Academy fellowships, and Young Scientist Awards. We are very proud of CCMB's contribution amid unprecedented times.

Towards mitigating COVID-19, CCMB has contributed immensely in testing new drugs, developing a novel diagnostic method, contributing almost 12% of all genomes sequenced, and coming up with surveillance mechanisms. On this occasion, I would like to extend my heartiest congratulations to all the scientists, students, and technical staff who have contributed to such efforts. While we can be proud of our contributions, there is a lot that needs to be done to understand the biology of this dreadful virus. Many scientifically unanswered questions require our attention. One of the ongoing activities in this direction is the development of an indigenous mRNA vaccine in collaboration with IICT and IMTECH. Going forward, the challenges are to contribute both high-quality basic research and perform research that has societal relevance.

VINAY KUMAR NANDICOORI
DIRECTOR, CCMB

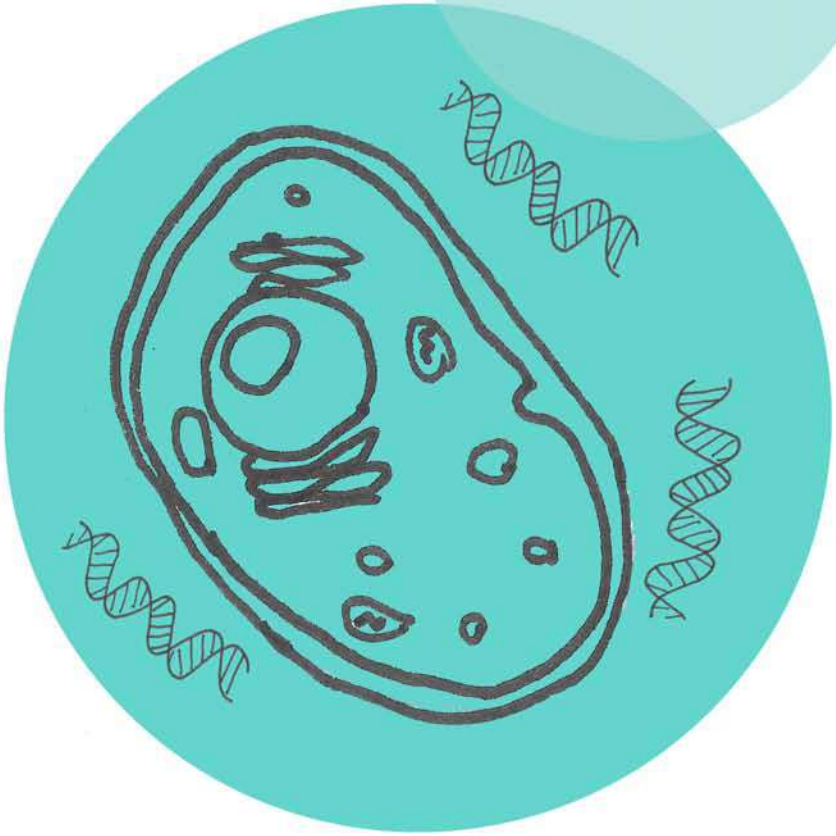
CHARTER

The Centre for Cellular and Molecular Biology (CCMB) is one of the constituent national laboratories of the Council of Scientific and Industrial Research (CSIR), New Delhi, India.

The objectives of the Centre are:

- To conduct research in frontier and multi-disciplinary areas of modern biology, and to seek potential applications of this work
- To carry out exploratory work in areas of biology with a view to aid the development of biochemical and biological technology in the country on a sound basis
- To train people in the advanced areas of biology to serve the needs of development in these areas, with special provision for short-term training of staff from other institutions in techniques for which adequate facilities may not exist elsewhere
- To provide centralized facilities in the country for new and modern techniques in the inter-disciplinary areas of biology, and to ensure that these facilities are so organized, maintained and administered that they can be put to maximal use by research workers from other laboratories and institutions in the country
- To interact adequately with other institutions doing basic or applied work in areas related to the activities of the Centre
- To collect, collate and disseminate information relevant to biological research

1.1 Research Programmes



1.1A Research Summaries

AJAY GAUR

Conservation Genetics of Endangered Indian Species

From top, left to right: V. P. Nidhi, Arnold Moses, Purushotham V. and Ajay Gaur

Research interests

- Conservation of Indian Endangered Species
- Population Genetics
- Evolutionary Genetics
- Wildlife Forensics
- Conservation Breeding

Conservation genetics of Indian wild hare

Indian wild hare (*Lepus nigricollis*), belongs to the genus *Lepus* and family *Leporidae*. There are almost over 30 different species within the genus *Lepus* and are commonly found across the globe. They are well adapted to diverse environments and their position in the food chain makes them an integral part of the ecosystem. Being an important prey, they are crucial for the survival of bigger predators and maintaining the balance of the ecosystem. The species is subjected to various threats like habitat fragmentation, predation, intensive hunting, competition with livestock and human-induced fires, and is a potential model to study various zoonotic diseases and climate change. There is a large information gap for this species with limited information about its ecology and no available genetic data. This study was planned to assess the phylogenetic position of *Lepus nigricollis* and to evaluate its evolutionary affinities with other species of genus *Lepus* using mitochondrial DNA markers.

Partial nucleotide sequences of three mitochondrial genes namely; *CYTB*, *16SrRNA*, and *COX1* were generated for Indian wild hare using universal primers. These nucleotide sequences were compared with sequences of other *Lepus* species from NCBI GenBank. Phylogenetic trees were constructed for these sequences and pairwise distances were also calculated. The preliminary analyses showed monophyletic evolution for Indian wild hare and suggested close evolutionary relationships with Burmese hare (*L. peguensis*) and Hainan hare (*L. hainanus*). Presently, efforts are being done to sequence the complete mitogenome of this important species. Apart from gaining some initial clarity on the phylogenetic position of Indian wild hare amongst the other species of genus *Lepus*, the study will help to bridge the information gap, and lay a foundation for future genetic studies related to this species and the genus *Lepus* at a larger scale.

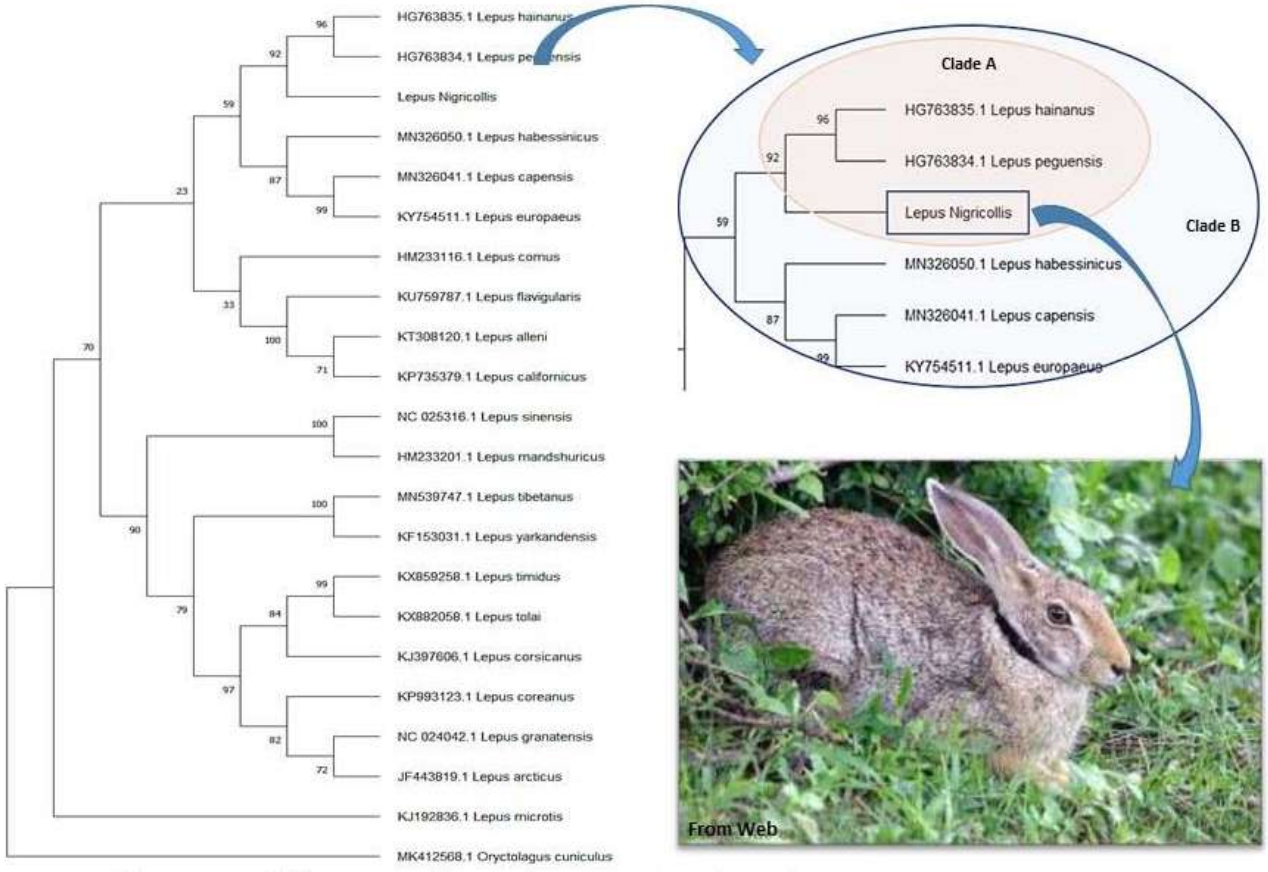


Fig. 1. Neighbour-joining phylogenetic tree for partial sequence of Cytochrome b gene region

AMITABHA CHATTOPADHYAY

Membrane and Receptor Biology

From left to right, starting from top: Md. Jafurulla, Sandeep Shrivastava, Amitabha Chattopadhyay, Aritri Dutta, Amrita Samanta, G. Aditya Kumar, Bhagyashree D. Rao, Sreetama Pal, Parijat Sarkar, Ashwani Sharma, Subhashree Shubhrasmita Sahu, Abhishek Kumar, Muskan Gupta (Jointly with Dr. Raghunand Tirumalai), K. Venkatlaxmi

Research Interests

- Interaction of membrane lipids and actin cytoskeletal with G protein-coupled receptors (GPCRs): implications in health and disease
- Role of membrane lipids in the endocytosis and intracellular trafficking of GPCRs, and the entry of pathogens into host cells
- Dynamics of solvent relaxation in membranes and proteins

Selected recent publications

- Rao, B.D., Sarkar, P., and Chattopadhyay, A. (2020) Selectivity in agonist and antagonist binding of serotonin1A receptors via G-protein coupling. ***Biochimica et Biophysica Acta - Biomembranes.*** doi: 10.1016/j.bbamem.2020.183265
- Shrivastava, S., Paila, Y.D., Kombrabail, M., Krishnamoorthy, G., and Chattopadhyay, A. (2020) Role of cholesterol and its immediate biosynthetic precursors in membrane dynamics and heterogeneity: Implications for health and disease. ***The Journal of Physical Chemistry B.*** 124, 6312–6320
- Sarkar, P., and Chattopadhyay, A. (2020) Cholesterol interaction motifs in G Protein-coupled Receptors: Slippery hot spots? ***Wiley Interdisciplinary Reviews: Systems Biology and Medicine.*** 12 - e1481

- Sarkar, P., Rao, B.D., and Chattopadhyay, A. (2020) Cell cycle dependent modulation of membrane dipole potential and neurotransmitter receptor activity: Role of membrane cholesterol. ***ACS Chemical Neuroscience.*** 11, 2890–2899

- Pal, S., Koeppe, R.E., and Chattopadhyay, A. (2020) Membrane electrostatics sensed by tryptophan anchors in hydrophobic model peptides depends on non-aromatic interfacial amino acids: Implications in hydrophobic mismatch. ***Faraday Discussions.*** doi: 10.1039/d0fd00065e

- Sarkar, P., Jafurulla, M., Bhowmick, S., and Chattopadhyay, A. (2020) Structural stringency and optimal nature of cholesterol requirement in the function of the serotonin1A receptor. ***The Journal of Membrane Biology.*** 253, 445-457

- Fatakia, S.N., Sarkar, P., and Chattopadhyay, A. (2020) Molecular Evolution of a Collage of Cholesterol Interaction Motifs in Transmembrane Helix V of the Serotonin1A Receptor. ***Chemistry and Physics of Lipids.*** 232, 104955

- Sarkar, P., and Chattopadhyay, A. (2020) Exploring membrane lipid and protein diffusion by FRAP. ***Analysis of Membrane Lipids, Springer.*** doi.org/10.1007/978-1-0716-0631-5_8

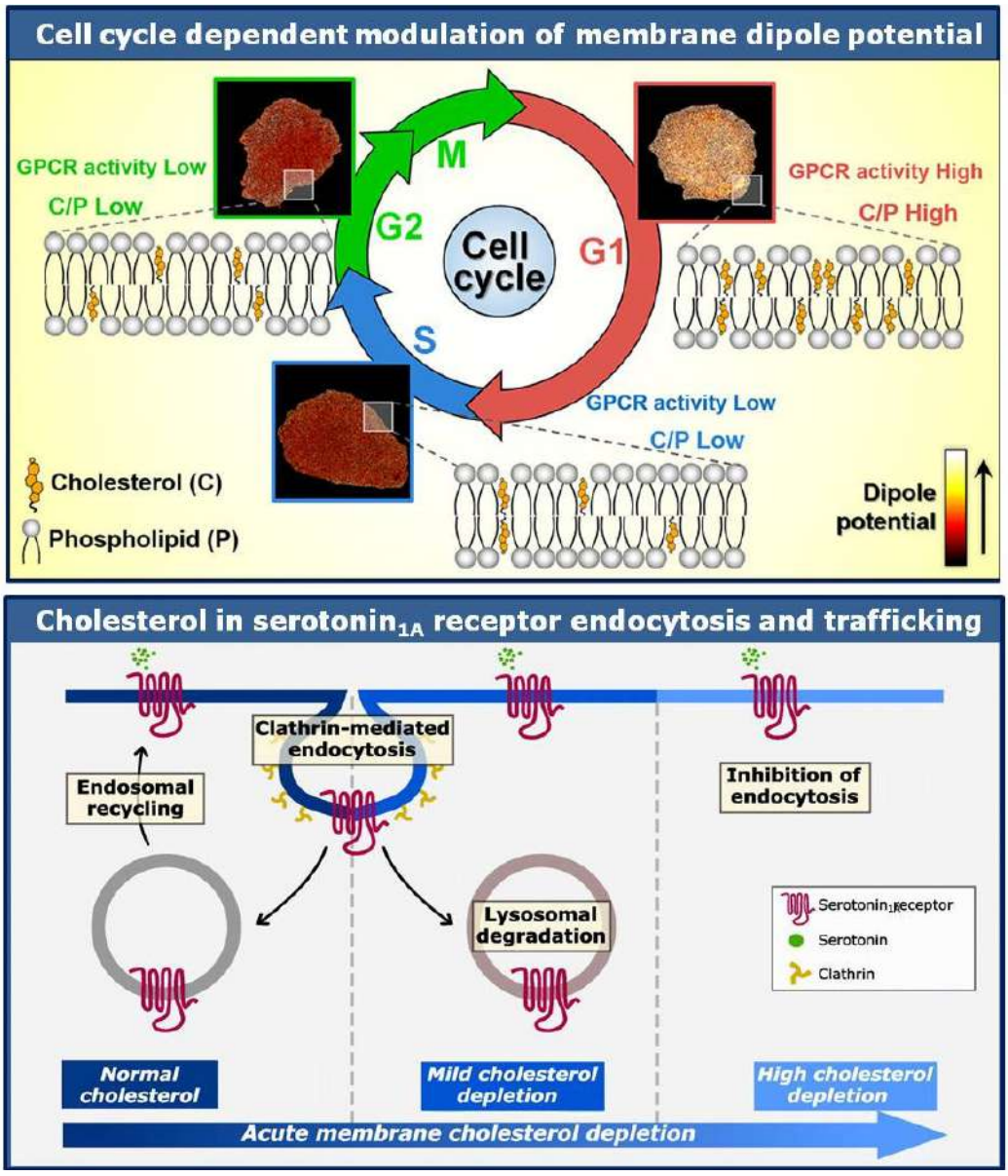
- Kumar, A., Sarkar, P., and Chattopadhyay, A. (2021) Metabolic depletion of sphingolipids reduces cell surface population of the human serotonin1A receptor due to impaired trafficking. ***ACS Chemical Neuroscience.*** 12, 1189-1196

- Kumar, G.A., and Chattopadhyay, A. (2021) Membrane cholesterol regulates endocytosis and trafficking of the serotonin1A receptor: Insights from acute cholesterol depletion. ***Biochimica et Biophysica Acta - Molecular and Cell Biology of Lipids.*** 1866, 158882

- Rao, B.D., Sarkar, P., and Chattopadhyay, A. (2021) Effect of tertiary amine local anesthetics on G protein-coupled receptor lateral diffusion and actin cytoskeletal reorganization. ***Biochimica et Biophysica Acta - Biomembranes.*** 1863, 183547

Our laboratory focuses on a comprehensive understanding of the subtle interplay between G protein-coupled receptors (GPCRs) and membrane lipids with far reaching implications in health and disease, utilizing a judicious combination of biophysical, biochemical, cell biological and computational approaches. Endocytosis is a key regulatory mechanism adopted by GPCRs to modulate downstream signaling responses within a stringent spatiotemporal regime. With an overall goal to explore the role of cholesterol in GPCR endocytosis, we carried out endocytosis of the serotonin1A receptor under acute cholesterol-depleted conditions using methyl-β-cyclodextrin (MβCD). We show that the serotonin1A receptor exhibits agonist-induced clathrin-mediated endocytosis with a concentration-dependent inhibition in internalization with increasing concentrations of MβCD, which was restored upon cholesterol replenishment. Interestingly, subsequent to internalization, receptors were re-routed toward lysosomal degradation, instead of endosomal recycling observed under normal conditions, thereby implicating cholesterol in modulation of intracellular trafficking of the receptor.

The role of lipids, membrane organization and physical properties in cell cycle progression remains largely elusive. Membrane dipole potential is an important physicochemical property and originates due to the electrostatic potential difference within the membrane because of non-random arrangement of amphiphile dipoles and water molecules at the membrane interface. In a recent work, we show for the first time, how membrane dipole potential and activity of the serotonin1A receptor gets modulated with the progress of the cell cycle. We envision that understanding the basis of cell cycle events from a biophysical perspective would result in a deeper appreciation of the cell cycle and its regulation in relation to cellular function.



Top panel: A schematic showing the modulation of membrane dipole potential in various stages of the cell cycle in CHO-K1 cells. Membrane dipole potential is highest in the G1 phase relative to S and G2/M phases. Interestingly, we observed a similarity in the dependence of membrane dipole potential and cholesterol with progress of the cell cycle. Further, a cell cycle dependent modulation in ligand binding activity of serotonin1A receptors expressed in CHO-K1 cells correlated with membrane cholesterol.

ANANT B PATEL

Brain Energy Metabolism in Neurological and Psychiatric Disorders

From left to right (top row): Anant, Varadarajan, Kamal, Dipak
Middle row: Bedaballi, Ajay, Akila, Chaynita
Bottom row: Prajakta, Sanjana, Naveleen, Lipali

Research interests

- Development of the state of the art NMR spectroscopy and stable 13 ^{0}C isotope (glucose and acetate) techniques to study neurometabolism
- Investigation of energetics of excitatory and inhibitory neurotransmission in neurodegenerative (Alzheimer's Disease, Amyotrophic lateral sclerosis) and psychiatric (Depression and addiction) diseases
- Development of contrast agents for MRI

Selected recent publications

- Pravin Kumar Mishra, Madhavi Adusumilli, Pallavi Deolal, Graeme F Mason, Arvind Kumar, Anant Bahadur Patel (2020) Impaired neuronal and astroglial metabolic activity in chronic unpredictable mild stress model of depression: Reversal of behavioral and metabolic deficit with lanicemine. ***Neurochemistry Internatal***. 137:104750
- Sthitapranjya Pati, Kamal Saba, Sonali S Salvi, Praachi Tiwari, Pratik R Chaudhari, Vijaya Verma, Sourish Mukhopadhyay, Darshana Kapri, Shital Suryavanshi, James P Clement, Anant B Patel, Vidita A Vaidya (2020) Chronic postnatal chemogenetic activation of forebrain excitatory neurons evokes persistent changes in mood behavior. ***eLife.*** 9:e56171
- A Albors-Vaquer, A Rizvi, M Matzapetakis, P Lamosa, A V Coelho, Anant B Patel, SC Mande, S Gaddam, A Pineda-Lucena, S Banerjee, L Puchades (2020) Active and prospective latent tuberculosis are associated with different metabolomic profiles: Clinical potential for the identification of rapid and non-invasive biomarkers. ***Emerging Microbes & Infections.*** 9(1):1131-1139

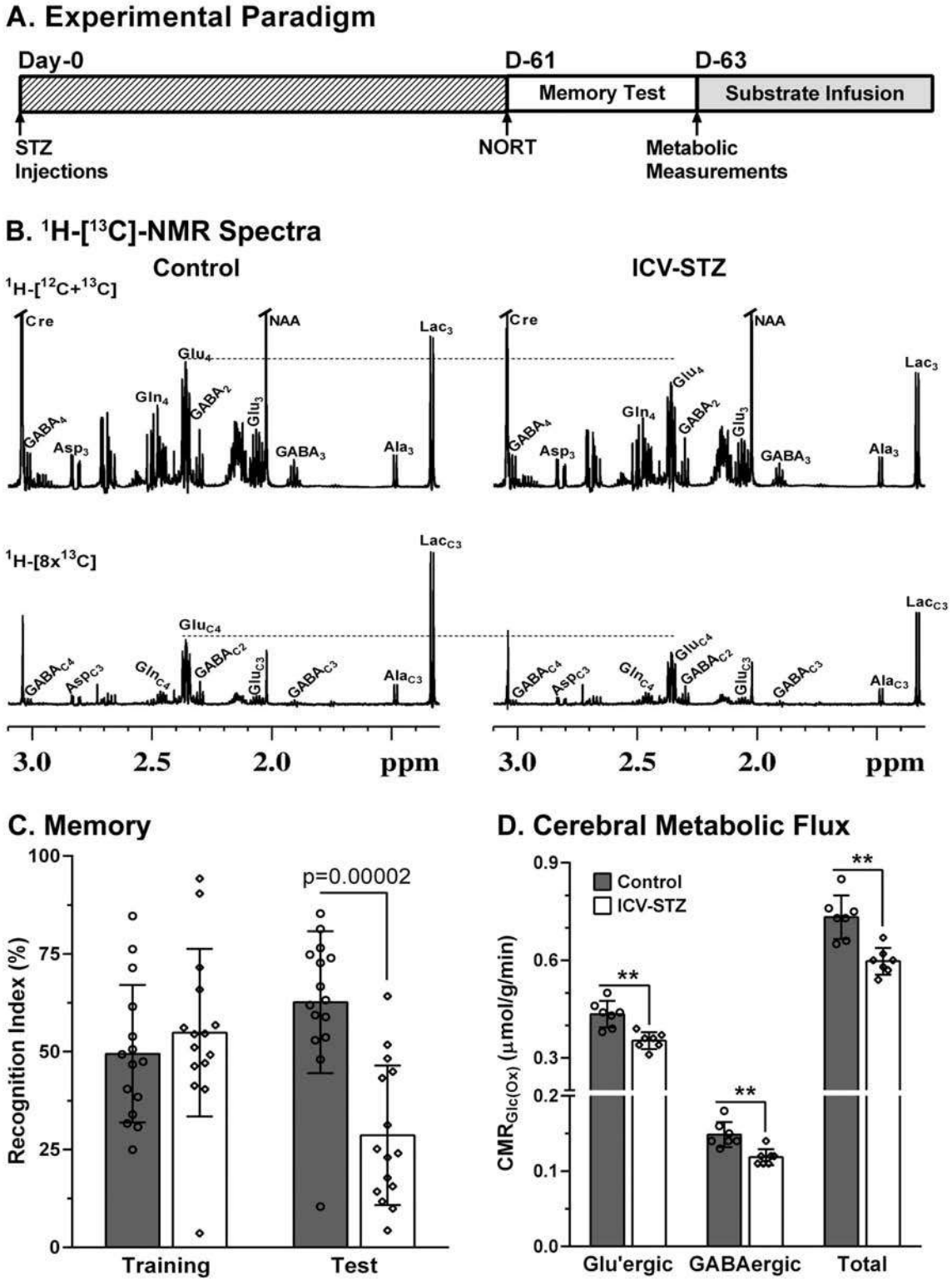
Anant Bahadur Patel, Pandichelvam Veeraiah, Mohammad Shameem, Jerald Mahesh Kumar, Kamal Saba (2021) Impaired GABAergic and Glutamatergic Neurometabolic Activity in Aged Mice Brain as Measured by 1H-[13C]-NMR Spectroscopy. ***The FASEB Journal.*** 35(2)

Narayan Datt Soni, Akila Ramesh, Dipak Roy, Anant Bahadur Patel (2021) Brain Energy Metabolism in Intracerebroventricularly Administered Streptozotocin Mouse Model of Alzheimer's disease: A 1H-[13C]-NMR Study. ***J Cereb Blood Flow Metab.*** 41(9) 2344-2355

Neurotransmitter Energetics in Sporadic Alzheimer's Disease

Although the human brain represents only ~2% of the body weight, it accounts for ~20% of total oxygen utilization of the whole body indicating the overwhelming energy demands of the brain. Most of the brain energy is used to support processes related to glutamatergic and GABAergic neurotransmission. Alzheimer's disease (AD) is the most common neurodegenerative disorder, and a leading cause of dementia worldwide. Although a majority of the AD cases are sporadic in nature, transgenic models are routinely used to understand the pathophysiology of the disease. Intracerebroventricular (ICV) administered streptozotocin (STZ) in rodents have been used to model sporadic AD. We have investigated neurotransmitter energetics and astroglial metabolic activity in ICV-STZ administered C57Bl6 mice.

The STZ-administered mice exhibited reduced memory in the novel object recognition test. These mice exhibited a reduction in the levels of creatine, GABA, glutamate and N-Acetylaspartate, and increased myo-inositol in the cerebral cortex and hippocampus. The astroglial metabolic activity, as assessed by labeling of brain amino acids from [2-13C]acetate, was found to be unperturbed in the ICV-STZ administered mice. The rates of glucose oxidation in the glutamatergic and GABAergic TCA cycle were reduced in the cerebral cortex and hippocampus of STZ treated mice. As neuronal glucose oxidation flux is shown to be stoichiometrically coupled with neurotransmitter cycling, these findings suggest reduced synaptic glutamatergic and GABAergic transmission in the ICV-STZ-treated mice. This was further supported by reduced GlnC4 in STZ-administered mice. These data provide experimental evidence for impairment in neurotransmission in sporadic AD.



A. Schematic representation of experimental paradigm. Streptozotocin (STZ) was administered on the 0th day. The memory assessment was carried out on the 61st day, and the neurometabolic analysis on the 63rd day which follows infusion of [1,6-13C2]glucose. B. 1H-[13C]-NMR spectra of cortical extracts. Mice were infused with [1,6-13C2]glucose for 7 minutes, and the brain metabolism was arrested using a focus beam microwave irradiation. The 13C labeling of metabolites was measured in cortical extract using 1H-[13C]-NMR spectroscopy. C. Memory of STZ treated mice.. The working memory of mice was evaluated using Novel Object Recognition Test. D. Rate of glucose oxidation in the hippocampus of ICV-STZ-treated mice. The 13C labeling of amino acids from [1,6-13C2]glucose was measured in the hippocampal extract using 1H-[13C]-NMR spectroscopy, and was used for calculation of the metabolic rates.

ARVIND KUMAR

Epigenetics & Neuropsychiatric Disorders

From left to right: Sachin Singh, Devika Mahimkar, Aaheli Chakrabarty, Pratishtha Wadnerkar, Annapoorna P, Bhanu Pranav, Arpan Mukhoti, Aditya Undru, Unis Ahamad Bhat, Arvind Kumar

Research interests

- Uncovering the molecular mechanisms in the etiology of neuropsychiatric diseases using animal models
- Biomarker discovery for neuropsychiatric disorders
- Drug discovery for CNS disorders until the Pre-clinical stage

Selected recent publications

- R Gajendra Reddy, Unis Ahmad Bhat, Sumana Chakravarty, Arvind Kumar (2020) Advances in Histone Deacetylase Inhibitors in Targeting Glioblastoma Stem Cells. ***Cancer Chemotherapy and Pharmacology.*** doi: 10.1007/s00280-020-04109-w
- Swati Maitra, Nitin Khandelwal, Scherazad Kootar, Pooja Sant, Salil S Pathak, Sujatha Reddy, Annapoorna P K, Upadhyayula Suryanarayana Murty, Sumana Chakravarty, Arvind Kumar (2020) Histone lysine demethylase JMJD2D/KDM4D and family members mediate effects of chronic social defeat stress on mouse hippocampal neurogenesis and mood disorders. ***Brain Science.*** doi: 10.3390/brainsci10110833
- Sridhar Amalakanti, Unis Ahmad Bhat, Madhavi B Mylavarapu, Nitin Khandelwal, N V Sundarachary, Sumana Chakravarty, Arvind Kumar (2021) Gene Expression analysis identifies cholesterol metabolism dysregulation in hippocampus of phenytoin resistant pentylenetetrazol kindled epileptic mice. ***Neuromolecular Medicine.*** doi: 10.1007/s12017-021-08648-0

Depression is a debilitating psychiatric disorder characterized by low mood, reduced energy, inability to feel pleasure, and in extreme cases thoughts of self-harm and suicide. The major risk factor for depression is chronic psychological stress. Stress affects the circuitry in the brain that controls mood, motivation, reward, learning and memory by dysregulating diverse epigenetic mechanisms, including histone lysine methylation. We and others have shown dysregulation in transcriptionally repressive epigenetic modifications H3K9 & K27me2 in the affected circuitry and on neural gene promoters. But to understand the role of these modifications in neural gene regulation, investigation into another class of epigenetic regulators, methyl group erasers of KDM4 & KDM7 family Histone Lysine Demethylases (KDMs) is warranted. We are trying to uncover the exact role these and one putative demethylase play in the hippocampus, specifically on the dynamic neurogenesis in its dentate gyrus region, in contributing to the depression-like phenotype and comorbid cognitive impairment. Using the mouse model of chronic social defeat stress (CSDS), and molecular and epigenetic tools, we could implicate KDM7 family demethylases PHF8, PHF2 & KIAA1718 in altered neurogenesis, differentiation and circuit remodeling in a depression-like condition. We also identified the critical role of a putative histone demethylase in this. Our studies on in vitro cultured neural stem/progenitor cells (NSCs/NPCs) derived from the DG, show its involvement in differentiation. Overexpression of this novel demethylase in mouse DG using Adeno Associated Viral vector, induced a depression and anxiety-like phenotype without CSDS. Some of the tentative histone lysine methyl targets of the novel demethylase have also been identified by us.

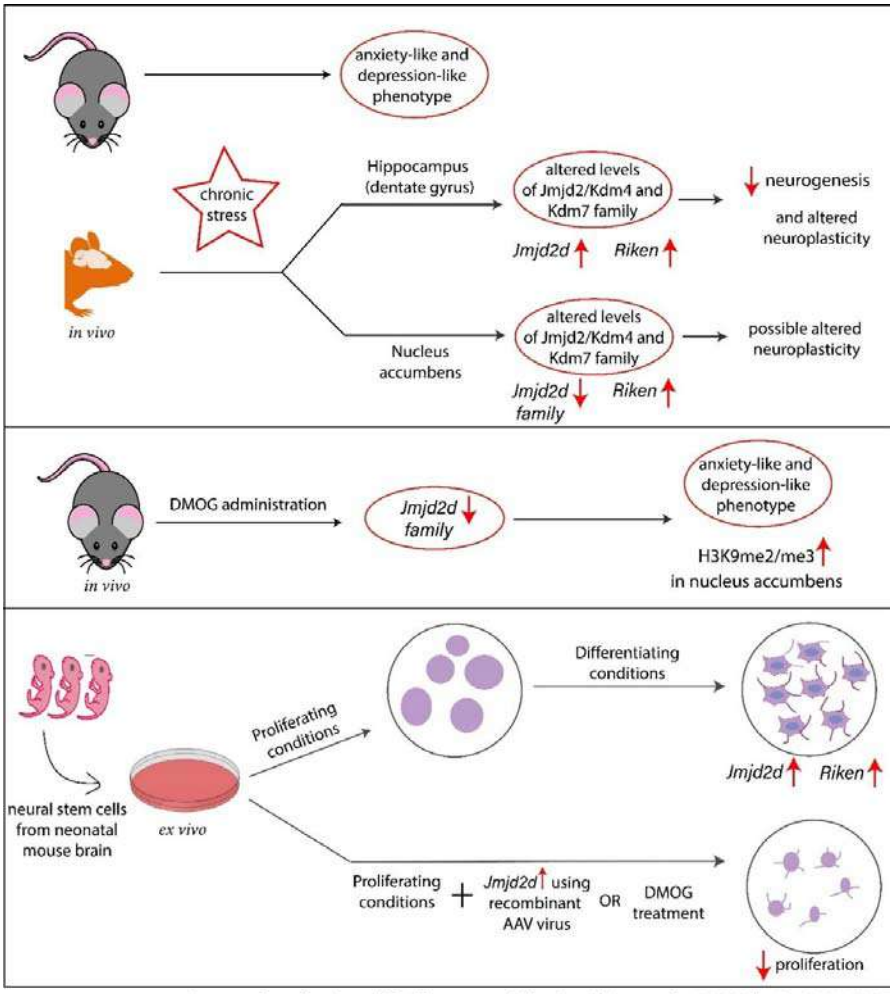


Image adapted and modified from our publication, Maitra et al., 10.3390/brainsci10110833

Critical role Jumonji domain containing histone lysine demethylases of KDM4 and 7 family play in chronic stress induced alteration in mouse reward & cognitive circuitries.

A S SREEDHAR

Stress Biology and Molecular Medicine

From left to right (starting from top): Athira Venugopal, Pankaj Kumar, Akhil Kotwal (starting from bottom): Khanderao Paithankar, Amere Subbarao Sreedhar, Shrikant Purushottam Dharaskar, Amash Vijayalakshmi

Research interests

Molecular basis of stress responses and unconventional roles of cancer chaperone Hsp90 and its isoforms in tumor adaptations such as

- Oncogene adaptation
- Acquired multidrug resistance
- Epigenetic regulation
- Altered energy metabolism

Development of novel antitumor strategies to combat cancer irreversibly.

Selected recent publications

- Kanugovi AV, Joseph C, Siripini S, Paithankar K, Amere SS (2020) Compromising the constitutive p16INK4a expression sensitizes human neuroblastoma cells to Hsp90 inhibition and promotes premature senescence. ***J Cell Biochem.*** doi: 10.1002/jcb.29493

Selected recent publications

- Vijayalakshmi A, Khanderao P, Shrikant PD, Abirami A, Sreedhar AS (2020) Development of nanocarrier-based mitochondrial chaperone, TRAP-1 inhibitor to combat cancer metabolism. ***ACS Appl. Bio Mater.*** doi.org/10.1021/acsabm.0c00268

- Kumar P, Siripini S, Sreedhar AS (2020) The matrix metalloproteinase 7 (MMP7) links Hsp90 chaperone with acquired drug resistance and tumor metastasis. ***Cancer Reports.*** doi:10.1002/cnr2.1261

- Vykuntham NG, Suran S, Siripini S, John S, Kumar P, Paithankar K, Amere Subbarao S (2020) Altered molecular pathways decides the treatment outcome of Hsp90 inhibitors against breast cancer cells. ***Toxicol In Vitro.*** doi: 10.1016/j.tiv.2020.104828

- Kumar P, Devaki B, Jonnala UK, Amere Subbarao S (2020) Hsp90 facilitates acquired drug resistance of tumor cells through cholesterol modulation however independent of tumor progression. ***Biochim Biophys Acta Mol Cell Res.*** doi: 10.1016/j.bbamcr.2020.118728

- Purushottam Dharaskar S, Paithankar K, Kanugovi Vijayavittal A, Shabbir Kara H, Amere Subbarao S (2020) Mitochondrial chaperone, TRAP1 modulates mitochondrial dynamics and promotes tumor metastasis. ***Mitochondrion.*** 54:92-101

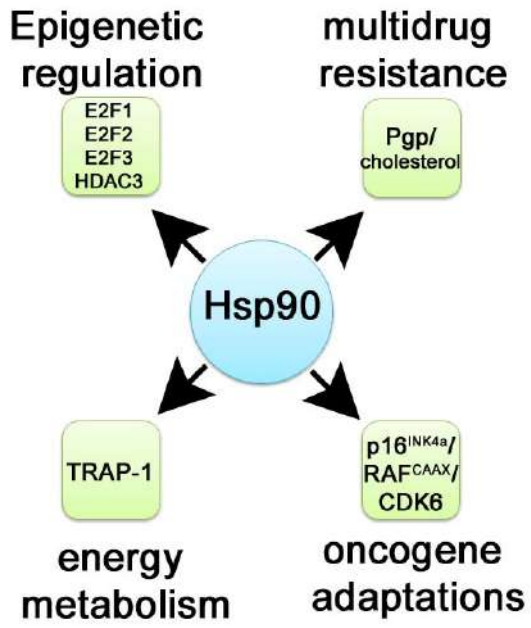
- Kotwal A, Amere Subbarao S (2020) Hsp90 regulates HDAC3-dependent gene transcription while HDAC3 regulates the functions of Hsp90. ***Cell Signal.*** doi: 10.1016/j.cellsig.2020.109801

- Kotwal A, Sourabh Suran, Amere Subbarao S (2021) Hsp90 chaperone facilitates E2F1/2-dependent gene transcription in human breast cancer cells. ***Eur J Cell Biol.*** 100(1):151148

- Kanugovi Vijayavittal A, Amere Subbarao S (2021) The conformation-specific Hsp90 inhibition interferes with the oncogenic RAF kinase adaptation and triggers premature cellular senescence, hence, acts as a tumor suppressor mechanism. ***Biochim Biophys Acta Mol Cell Res.*** 1868(3):118943

Hsp90 functions as a cancer chaperone and stabilizes the functions of several mutated oncogenes, transcription factors, epigenetic modulators and kinases. Therefore, Hsp90 inhibition may act as an alternate strategy to combat cancer. Hsp90 inhibitors are in phase II/III clinical trials against tumors. By understanding the novel roles of Hsp90, our laboratory exposes the hidden dimensions of this chaperone. Cancer is a polygenic disease, and tumor cells are highly adaptive to the microenvironment. We speculate that Hsp90 helps tumor cells to evolve, thus challenging the conventional chemotherapeutic approaches.

For this reason, in continuation of our findings reported last year, we focused on understanding the role of Hsp90 and its isoforms in oncogene adaptations, epigenetic signal transduction, acquired multidrug resistance, and altered energy metabolism against brain, lung, breast, and cervical cancer cells compared to primary and immortal cells. This year, we focused more on metabolic reprogramming. We found that Hsp90 homologue, TRAP-1 contributes to tumor aggression by inducing mitochondrial fission and lowering oxidative phosphorylation. Although we could not identify how TRAP-1 acts as a metabolic switch, we could narrow down the altered pathways to glutaminolysis and pentose phosphate pathway, however, partially excluding glycolysis. The studies from normal cells and experimental models such as *Caenorhabditis elegans* are underway to strengthen the *in vitro* findings at the organism level. Based on these results, we propose that in addition to Hsp90 inhibitors, TRAP-1 inhibitors can also be used alone or combined with conventional anticancer agents to combat cancer.



Hsp90 regulates various cellular processes that contribute to tumor adaptations and the evolution of aggressive cancer phenotypes. We study the key molecules that regulate epigenetic mechanisms, multidrug resistance, oncogene adaptations, and altered energy metabolism in an Hsp90-dependent manner.

B KIRAN KUMAR

Niche and micro environment following cellular injuries

From left to right (front row): Mrunal Kulkarni, Ekta Dagar, Dr B Kiran Kumar, Jessie Thomas, Aniti
Back row: Mohammed Ghalib, Yash Rajendra Parekh, Joel George

Research interests

- Factors that influence the tissue recovery/regeneration process
- Therapeutic molecules along with stem cells to help the regeneration process

Selected recent publications

- Abhinav Reddy Kethiri , Vijay Kumar Singh , Mukesh Damala , Sayan Basu , Ch Mohan Rao , Kiran Kumar Bokara , Vivek Singh (2021) Long term observation of ocular surface alkali burn in rabbit models: Quantitative analysis of corneal haze, vascularity and self-recovery. ***Experimental Eye Research.*** 108526 - 205
- Chameettachal, Shibu, Prasad, Deeksha, Parekh, Yash, Basu, Sayan, Singh, Vivek, Kiran Kumar Bokara*, Pati, Falguni (2020) Prevention of corneal myofibroblastic differentiation in vitro using biomimetic ECM hydrogel for corneal tissue regeneration. ***ACS Applied Biomaterials.*** 4:533-544
- Naveen Kumar Mekala, Shyama Sasi Kumar, Kranthi Kiran Akula, Yash Parekh, Ch Mohan Rao, Kiran Kumar Bokara* (2020) HspB5 protects Mouse Neural Stem/Progenitor Cells from Paraquat Toxicity. ***American Journal of Stem Cells.*** 25;9(5) - 68-77
- Vijayishwer S. Jamwal, Vijay V. Vishnu, Anusha Domreddy, Yash Parekh, Bokara Kiran Kumar, P. Chandra Shekar, Shashi Singh (2020) Generation of iPSC from fetal fibroblast cells obtained from an abortus with type-I tri-allelic variants. ***Stem Cell Research.*** 48 - 101963

Corneal scarring is one of the major causes of blindness, affecting millions worldwide. Despite recent advancements in surgical strategies, there is an unmet need for a clinically feasible material and methods to prevent scarring following corneal injury. In our study, we report the potential utility of a hydrogel derived from cadaveric animal corneas, using a decellularized corneal matrix hydrogel (abbreviated as dCMH), prepared by a simple method. This hydrogel is easily injectable, biocompatible, and can maintain good shape-retention properties at 37°C, which makes it suitable for *in vivo* applications. Our studies demonstrate that dCMH maintains the keratocytes with the ability to regenerate the corneal defect without a scar. Our results demonstrate a simple, yet effective approach to prevent scar formation in corneal injuries by using hydrogel and also describes the process of decellularizing the cadaver corneas to prepare dCMH (Bokara et al., ACS Applied Biomaterials, 2021).

HspB5 is known to be involved in a variety of cellular functions, including, protection of cells from oxidative damage and inhibiting apoptosis. Neural stem/progenitor cells (NSPCs) have significant therapeutic value, especially in NSC/NPC transplantation therapy. However, the viability of the transplanted NSPCs remains low because of various factors, including oxidative stress. Our results clearly demonstrate that exogenously added recombinant human HspB5 enters the mNSPCs and confers protection against paraquat toxicity. Our studies demonstrates that HspB5 treated neurospheres showed differentiation towards neuronal rather than glial lineage (Bokara et al., American Journal of Stem Cells, 2020). Further, studies are being carried to elucidate the molecular mechanisms by which HspB5 triggers cytoprotection and neuronal differentiation.

Figure 1

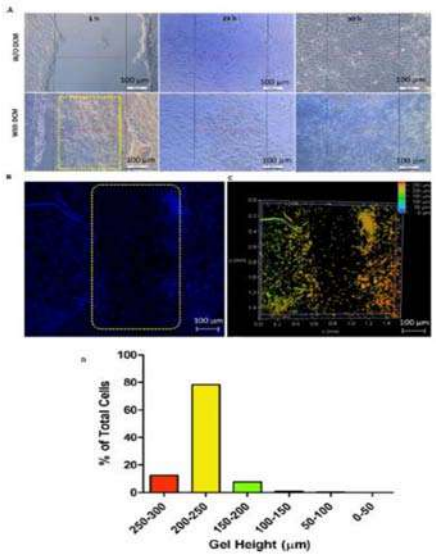


Figure 2

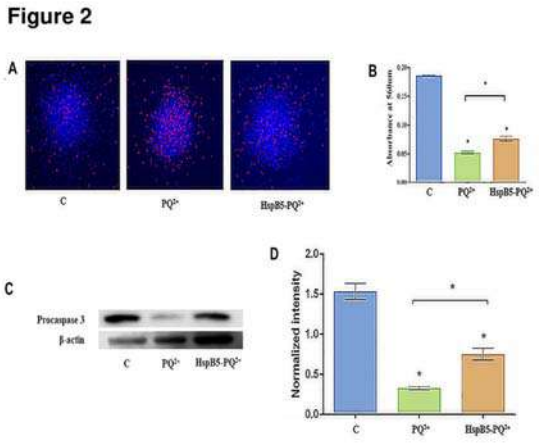


Figure 1: A) optical microscopy images of the analysis of HK migration by the modified scratch assay. Images were acquired at 1, 24, and 30h. The horizontal red line between the black vertical lines define the area where the scratch was made. (B) Confocal microscopy images of the DAPI stained in the scratch assay at 30 h showing the cellular migration (yellow dotted line indicates the area of dCMH present). (C) Depth code analysis of the confocal microscopy images of the scratch assay at 30 Figure 2:Anti-apoptotic activity of HspB5 against paraquat-induced oxidative stress. A. mNSPCs were exposed to 3 mM paraquat for 4 h, stained with Hoechst (10 µg/mL) - PI (50 µg/mL) and observed under the fluorescence microscope. Here, [C] represents the control mNSPCs without any paraquat stress, [PQ2+] represents the mNSPCs treated with paraquat, and [HspB5-PQ2+] represents the mNSPCs pre-treated with HspB5 (100 µg/mL). Scale bar = 100 µm; B. Quantification of cell viability using the MTT assay; ∗ represents statistical significance between the different treatment groups at p<0.001. C. Immunoblotting of apoptotic procaspase-3 in mNSPCs after paraquat stress. D. Western blot showing the expression of procaspase-3 expression in control, PQ2+ treated, and HspB5-PQ2+ treated.

GHANSHYAM SWARUP

Molecular Mechanism of Neurodegreneration caused by Mutations in Optineurin

From left to right (upper row): Rajashree Ramaswamy, Shivranjani Moharir, Swetha Medchalmi (lower row): Zuberwasim Sayyad, Akhouri Kishore Raghawan, Ghanshyam Swarup

Research interests

- **F**unctions of the protein optineurin, and how mutations alter its functions to cause neurodegenerative diseases
- Signalling by cytoplasmic immune receptors NLRC4 and NLRP3, and how mutations alter this signalling to cause autoinflammatory syndromes

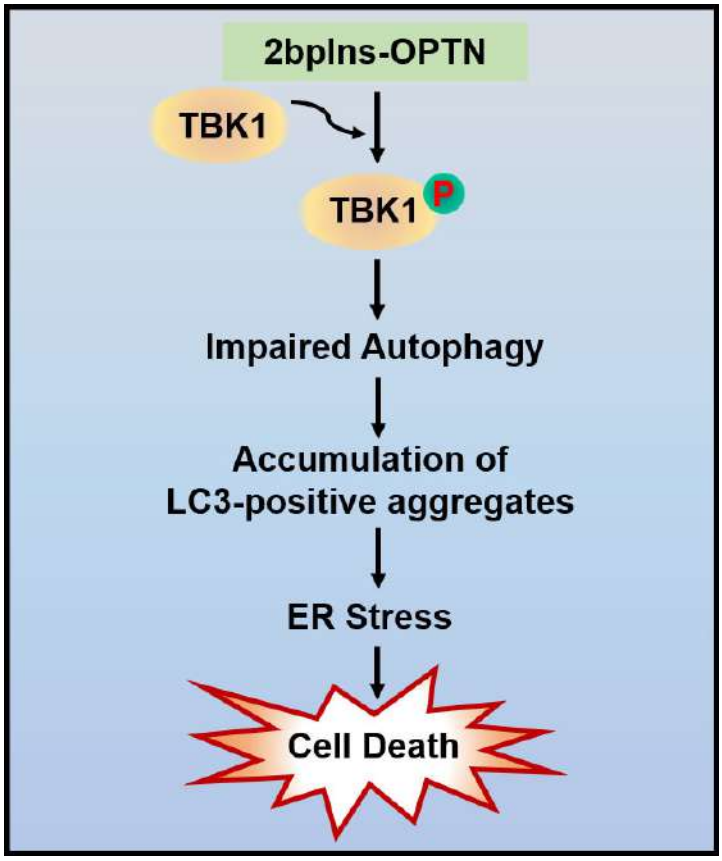
Selected recent publications

- Ramachandran, G., Moharir, S. C., Raghunand, T. R., and Swarup, G (2021) Optineurin modulates ER stress-induced signaling pathways and cell death. ***Biochemical Biophysical Research Communications.*** 534:297-302

We have investigated the physiological role of the autophagy receptor Optineurin/Optn in endoplasmic reticulum (ER) stress response using cellular and animal models. In comparison to their normal counterparts, Optn-deficient mouse embryonic fibroblasts showed significantly higher cell death and caspase-3 activation upon treatment with tunicamycin and thapsigargin, inducers of ER stress. The transcript levels of genes regulated by the IRE1-XBP1 and PERK-ATF4 pathways were upregulated in Optn-deficient cells, in comparison with normal cells, upon treatment with tunicamycin, and also in the brain cortex and liver of tunicamycin treated Optn-deficient mice. Also, the basal levels of IRE1α and PERK were higher in Optn-deficient cells. These results suggest that Optn modulates ER stress-induced signaling pathways and provides protection from ER stress-induced cell death.

Mutations in OPTN are associated with glaucoma, an eye disease, and also with amyotrophic lateral sclerosis (ALS), a motor neuron disease. A 2bp insertion in OPTN (2bp Ins-OPTN) is associated with both glaucoma and ALS. We have explored the mechanism of induction of cell death by this mutant, which interacts with Tbk1 protein kinase, and activates it to induce neuronal cell death dependent on autophagy and ER stress (Figure).

Cytoplasmic immune receptors NLRC4 and NLRP3 mediate caspase-1 activation and cytokine maturation upon sensing of certain pathogen-derived molecules. Mutations of NLRP3 and NLRC4 cause familial cold autoinflammatory syndrome (FCAS). We are investigating the mechanisms involved in regulating mutant receptors by HSC70 and related proteins, and potential role of HSC70/HSP70 in sensing of low temperature in the context of FCAS.



Schematic showing mechanism of induction of cell death by 2bpIns-OPTN associated with both glaucoma and ALS: 2bpIns-OPTN interacts with Tbk1 and activates it. Uncontrolled activation of Tbk1 by 2bpIns-OPTN leads to impaired autophagy that results in accumulation of LC3-positive aggregates, which induces ER stress and cell death.

GIRIRAJ RATAN CHANDAK

Genomic Research on Complex Diseases

From left to right: Inderdeo Mali, P. Ashok, Sohail Rafik Mansuri, Swati Bayyana, Shoma Naskar, Bernadette Mathew, Ajay Deepak Verma, PSKDB Punyasri, Alagu Sankareswaran, Shagufta Tasneem, Riya Dogra, Manisha Arumalla, Ashutosh Singh Tomar, Giriraj Ratan Chandak, Varsha Kolaria
In-set (from top to bottom): Nongmaithem Suraj Singh, Sara Sajjadi, Seema Bhaskar, Prachand Issarapu

Research interests

- Genetic and epigenetic basis of non-communicable diseases like type 2 diabetes and related intermediate traits using gene-gene and gene-nutrient interaction and pre- and peri-conceptional nutritional intervention to understand causality

Selected recent publications

- Vinay Singh Tanwar, Sourav Ghosh, Satish Sati, Subhoshree Ghose, Lovejeet Kaur, Kalle Anand Kumar, K V Shamsudheen, Ashok Patowary, Meghna Singh, V Jyothi, PujithaKommineni, Sridhar Sivasubbu, Vinod Scaria, Manchala Raghunath, Rakesh Mishra, Giriraj Ratan Chandak, Shantanu Sengupta (2020) Maternal vitamin B 12 deficiency in rats alters DNA methylation in metabolically important genes in their offspring. ***Mol Cell Biochem.*** 468(1-2):83-96
- Shalini Mani, G R Chandak, Keshav K Singh, Rajender Singh, S Narasimha Rao (2020) Novel p.P298L SURF1 mutation in thiamine deficient Leigh syndrome patients compromises cytochrome c oxidase activity. ***Mitochondrion.*** 53:91-98
- Kim Maasen, Philip T James, Andrew M Prentice, Sophie E Moore, Caroline H Fall, Giriraj R Chandak, Modupeh Betts, Matt J Silver, Jessica L Buxton (2020) Periconceptional environment predicts leukocyte telomere length in a cross-sectional study of 7-9 year old rural Gambian children. ***Sci Rep.*** 10(1):9675
- James W Harrison, Divya Sri Priyanka Tallapragada, Alma Baptist, Seth A Sharp, Seema Bhaskar, Kalpana S Jog, Kashyap A Patel, Michael N Weedon, Giriraj R Chandak, Chittaranjan S Yajnik, Richard A Oram (2020) Type 1 diabetes genetic risk score is discriminative of diabetes in non-Europeans: evidence from a study in India. ***Sci Rep.*** 10(1):9450
- Kinjal M Dave, Lovejeet Kaur, Karuna N Randhir, Savita S Mehendale, Deepali P Sundrani, Giriraj R Chandak, Sadhana R Joshi (2021) Placental growth factor and Fms related tyrosine kinase-1 are hypomethylated in preeclampsia placentae. ***Epigenomics***.13(4):257-269

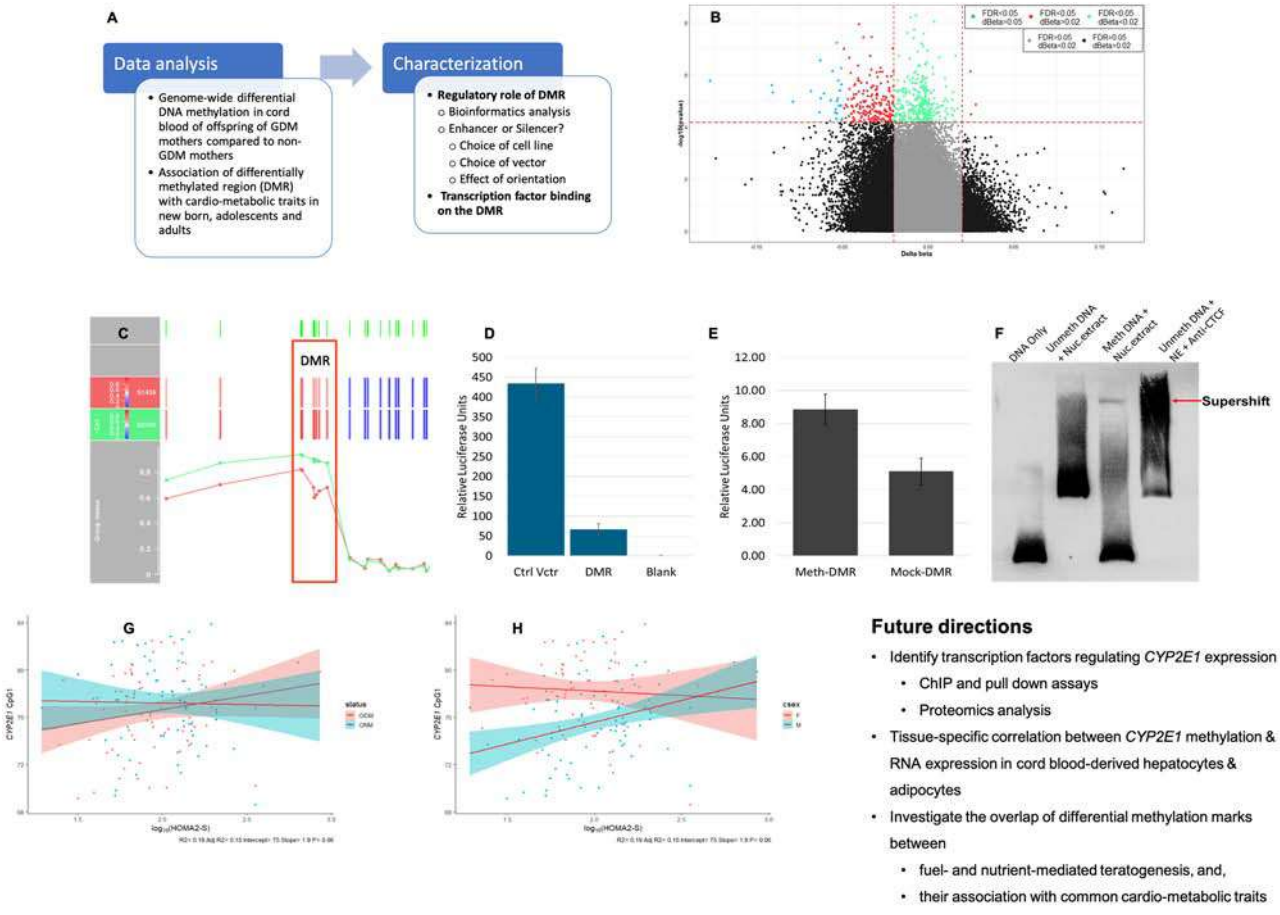
- Roopa Rajan, K P Divya, Rukmini MridulaKandadai, Ravi Yadav, Venkata P Satagopam, U K Madhusoodanan, Pankaj Agarwal, Niraj Kumar, Teresa Ferreira, Hrishikesh Kumar, A V Sreeram Prasad, Kuldeep Shetty, Sahil Mehta, Soaham Desai, Suresh Kumar, L K Prashanth, Mohit Bhatt, Pettarusp Wadia, Sudha Ramalingam, G M Wali, Sanjay Pandey, Felix Bartusch, Maximilian Hannussek, Jens Krüger, Ashwin Kumar-Sreelatha, Sandeep Grover, Peter Lichtner, Marc Sturm, Jochen Roeper, Volker Busskamp, Giriraj R Chandak, Jens Schwamborn, Pankaj Seth, Thomas Gasser, Olaf Riess, Vinay Goyal, Pramod Kumar Pal, RupamBorgohain, RejkoKrüger, Asha Kishore, Manu Sharma, Lux-GIANT Consortium (2020) Genetic architecture of Parkinson's Disease in the Indian population: Harnessing genetic diversity to address critical gaps in Parkinson's Disease Research. ***Front Neurol.*** 11:524

- Ayden Saffari, Smeeta Shrestha, PrachandIssarapu, Sara Sajjadi, Modupeh Betts, Sirazul Ameen Sahariah, Ashutosh Singh Tomar, Philip James, Akshay Dedaniya, Dilip K Yadav, Kalyanaraman Kumaran, Andrew M Prentice, Karen A Lillycrop, Caroline H D Fall, Giriraj R Chandak, Matt J Silver, EMPHASIS Study Group (2020) Effect of maternal preconceptional and pregnancy micronutrient interventions on children's DNA methylation: Findings from the EMPHASIS study. ***Am J Clin Nutr.*** 112(4):1099-1113

- Kalyanaraman Kumaran, Ghattu V Krishnaveni, Kumar Gavali Suryanarayana, Manohar Prabhu Prasad, Antonisamy Belavendra, Stephanie Atkinson, Ramaswamy Balasubramaniam, Robert H J Bandsma, Zulfiqar A Bhutta, Giriraj Ratan Chandak, Elena M Comelli, Sandra T Davidge, Cindy-Lee Dennis, Geoffrey L Hammond, Prabhat Jha, K S Joseph, Sadhana R Joshi, Murali Krishna, Kang Lee, Stephen Lye, Patrick McGowan, Pablo Nepomnaschy, Vivek Padvetnaya, SaumyadiptaPyne, Harshpal Singh Sachdev, Sirazul Ameen Sahariah, Nalini Singhal, Jacquetta Trasler, Chittaranjan S Yajnik, Janis Baird, Mary Barker, Marie-Claude Martin, Nusrat Husain, Daniel Sellen, Caroline H D Fall, Prakesh S Shah, Stephen G Matthews (2021) Protocol for a cluster randomised trial evaluating a multifaceted intervention starting preconceptionally-Early Interventions to Support Trajectories for Healthy Life in India (EINSTEIN): a Healthy Life Trajectories Initiative (HeLTI) Study. ***BMJ Open.*** 11(2):e045862

We have earlier shown that epigenetic regulation (DNA methylation) of candidate genes like FTO, TCF7L2, PPARD leads to their dysregulated expression and explains part of "Missing Heritability" for type 2 diabetes, a non-communicable disease. Under the Developmental Origins of Health and Diseases, we have demonstrated a 'Dual Teratogenesis' model that predicts future risk of non-communicable diseases combining 'Nutrient-mediated Teratogenesis (vitamin B12)' and 'Fuel-mediated Teratogenesis (glucose)' through maternal nutrition, especially during pregnancy. Using Gestational diabetes as the model for fuel-mediated teratogenesis, we identified a novel differentially methylated region (DMR) in CYP2E1 in the newborns of gestational diabetes mothers compared to those born to normal mothers. We showed that CYP2E1 DMR is a silencer and its methylation influences its interaction with CTCF and expression levels. Methylation levels of CYP2E1 DMR were also positively associated with insulin sensitivity in the newborns and at adolescence and adulthood. CYP2E1 is known to strongly influence both hepatic and peripheral insulin resistance, thus, altered CYP2E1 methylationin the offspring due to maternal glucose exposure may increase future risk of obesity and diabetes and has the potential for further use as a biomarker.

Under the CSIR-Sickle Cell Anaemia (SCA) Mission, we have screened lakhs of children in Chhattisgarh and Maharashtra and provided genetic testing, prenatal diagnosis, counselling and treatment to families. We have designed a cost-effective blood-based PCR for rapid diagnosis and designed a web portal to include patient details for genotype-phenotype analysis. We have developed robust methods to characterise the plasma proteome to identify robust biomarkers for SCA.



A. Experimental workflow of the project.

B. Volcano plot showing differentially methylated CpGs between offspring of Gestational diabetic (GDM) and normal mothers. Vertical red lines signify CpGs with 2% methylation differencewhereas the horizonal line indicates CpGs passing the 5% FDR cut-off.

C. Graphical representation of CYP2E1 differentially methylated region (DMR) where red and green lines indicate mean methylation in offspring of GDM mothers and control mothers respectively.

D. Luciferase assay of the CYP2E1 DMR, cloned in pGL4.13 vector, shows that the DMR acts as a silencer.

E. Luciferase assay of the CYP2E1DMR cloned in pGL4.13 vector shows that DNA methylation of the DMR reduces its silencing activity.

F. Electromobility shift assay (EMSA) shows that CTCF binding to the CYP2E1DMR is dependent on the methylation status of the DMR.

G. CpGs located within the DMR show gender-specific association with insulin sensitivity (HOMA-S). Red and green areas represent methylation status in females and males respectively.

H. The strong association between CYP2E1 DMR and HOMA-S continues in adolescents and adults.

G UMAPATHY

Understanding Species Extinction and Conservation Physiology

From left to right: Vinay Teja, S.Manu, Mihir Trivedi, Vinod Kumar, G.Umapathy, Gopi Krishnan, Aamer Sohel, Manisha Roy, Divyasree Karne

Research interests

- Species extinction in human dominated landscape
- Non-invasive hormone monitoring
- Pregnancy and stress assessment in wild and captive animals
- eDNA and genomics in biodiversity monitoring and assessment

Selected recent publications

- D. Chharang, S. Choudhary, V. Kumar, S. Sharma, P.C. Sharma, S. Saini, G. Umapathy (2020) Effect of dietary inclusion of live microbial cultures on faecal glucocorticoid metabolites in safari Asian elephants. ***Indian Journal of Animal Research.*** doi: 10.18805/ijar.B-4124

- Mihir Trivedi, Shivakumara Manu, Sanjaay Balakrishnan, Jihosuo Biswas, N. V. K. Asharaf & Govindhaswamy Umapathy (2021) Understanding the phylogenetics of Indian Hoolock gibbons – *Hoolock hoolock* and *H. leuconedys*. ***International Journal of Primatology.*** 42: 463–477

- Kumar, V.; Buragohain, S.; Deka, P.J.; Narayan, G.; Umapathy, G (2021) Non-invasive reproductive hormone monitoring in the endangered pygmy hog (*Porcula salvania*). ***Animals.*** doi.org/10.3390/ani11051324

To understand the impact of extrinsic factors on adrenocortical function as a measure of stress in tigers, we studied faecal glucocorticoid metabolite (fGCM) concentrations of tigers housed at different locations, and free ranging tigers in natural tiger reserves. We found no significant difference in fGCM concentrations between captive, re-wilded, and free-ranging tigers except for one site. Factors such as sex and season were not significant drivers of fGCM concentrations.

The pygmy hog is one of the world's rarest suids. In this study, we examined reproductive hormones in captive pygmy hogs using a non-invasive method by collecting 785 fecal samples from five females and two males for 12 months from a conservation breeding centre. We could detect pregnancy and estimate gestation period (153.25 days). We also found strong seasonal patterns in the birth rate, with most of the births occurring between May and June. The results of the study can directly help in monitoring the reproductive status of reintroduced hogs both in the wild and in conservation breeding programs in India.

Gibbons are the only apes in India but their phylogeny remains unclear because of recent reports on suspected presence of another species of gibbons (Eastern) besides the Western Hoolock gibbons in North Eastern India. Biological samples were collected from both the populations and phylogenetic analysis was carried out using partial D-loop and COI markers. Our results showed that all Indian populations belong to Western Hoolock! This study directly helps in conservation management and breeding of this species.

Hoolock gibbons, male and female (left panel) and putative Eastern Hoolock gibbons, male and female

HITENDRA K PATEL

Plant-Pathogen Interactions and Plant Breeding

From left to right (First row): Hitendra Kumar Patel, Raju Madnala, Kranthi Brahma, Vinoth Kumar K, Md. Jamaloddin, Donald James
(Second row): Bipin Kumar, Kamal Kumar Malukani, Rajkanwar Nathawat, Sohini Deb, Vishnu NM, Komal Awalellu, Gokulan CG
(Third row): Roshan MV, Shailaja, Namami Gaur, Palash Ghosh, Rennya PR, Mani Deepika M, Deepak Niranjan

Research interests

- Rice functional genomics
- Plant-pathogen interactions
- Marker-assisted selection in plant breeding

Selected recent publications

- Kamal Kumar Malukani, Ashish Ranjan, Shiva Jyothi Hota, Hitendra Kumar Patel, Ramesh V Sonti (2020) Dual activities of receptor like kinase OsWAKL21.2 induce immune responses. ***Plant Physiology.*** 183(3) - 1345-1363

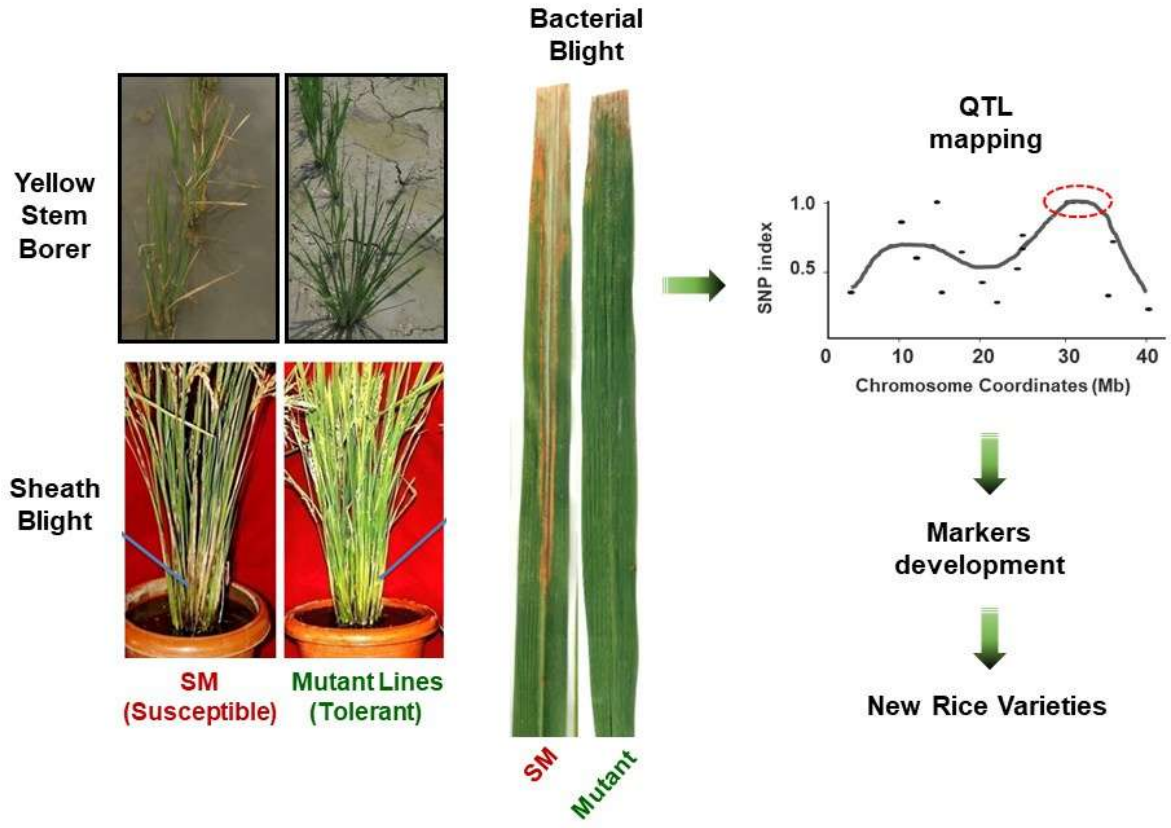
- Sohini Deb, Palash Ghosh, Hitendra K Patel, Ramesh V Sonti (2020) Interaction of the Xanthomonas effectors XopQ and XopX results in induction of rice immune responses. ***The Plant Journal.*** 104(2) - 332-350

- Emile Gluck-Thaler, Aude Cerutti,....., Hitendra Kumar Patel, Ramesh V Sonti, Claude Bragard, Jan E Leach, Laurent D Noël, Jason C Slot, Ralf Koebnik, Jonathan M Jacobs (2020) Repeated gain and loss of a single gene modulates the evolution of vascular plant pathogen lifestyles. ***Science Advances.*** 6(46) - eabc4516

In the rice functional genomics project, Samba Mahsuri and Improved Samba Mahsuri mutant lines with important agronomic traits including higher yield and biotic and abiotic stress tolerance have been identified. With an aim to identify the genomic region(s) that contribute to the important agronomic traits, we use a method called Bulked Segregant Analysis (BSA) in combination with Next-Generation Sequencing (NGS) technology and subsequent analysis. The analysis revealed candidate regions/quantitative trait loci (QTL) in the rice genome which provide tolerance to a serious pest of rice called Yellow Stem Borer (YSB). Using marker-trait analyses, a number of markers that are closely associated with the trait were identified.

Further, RNA-Seq was used to decipher the mechanism of tolerance. Certain secondary metabolism pathways were identified to be enriched in the tolerant line upon YSB infestation. Currently, we are aiming to identify more closely linked markers so as to use them as potential markers for breeding programmes.

Similarly, we have identified multiple QTL intervals that could be associated with enhanced tolerance to a serious fungal disease of rice called Sheath Blight (ShB) from two different lines. Presently, the development and validation of markers are in progress. Studies on mechanism of tolerance to three biotic stresses (YSB, ShB, and BB) are also ongoing.



Phenotypes of the representative lines and workflow. Three independent lines that were identified with enhanced tolerance to YSB, ShB, and BB showing clear phenotypic differences from the wildtype plant. The scatter plot represents the identification of QTL intervals and further steps include the development and application of markers for generating new rice varieties with desired phenotypic traits.

IMRAN SIDDIQI

Plant Reproductive Biology

From left to right, standing: Kaladhar Bethoju, Survi Mahesh, Imran Siddiqi, Vishakha Bharadwaj, Aswan Nalli, Chandan Kumar, Avinash Singh, Keith Frank, Bhaskar
Seated: Anand Singh, Sai Kiran, Sivakumar Prakash, Jayeshkumar Davda, Ginkuntla Saikiran, Arkasaradhi Gope

Research interests

- Developmental biology of plant reproduction
- Control of plant meiosis and gametogenesis
- Plant epigenetics
- Apomixis and plant breeding technologies

Selected recent publications

- Majumdar Parinita, Karidas Premananda, Siddiqi Imran, and Nath Utpal (2020) The ubiquitin-specific protease TNI/UBP14 functions in ubiquitin recycling and affects auxin response. ***Plant Physiology.*** 184:1499-1513

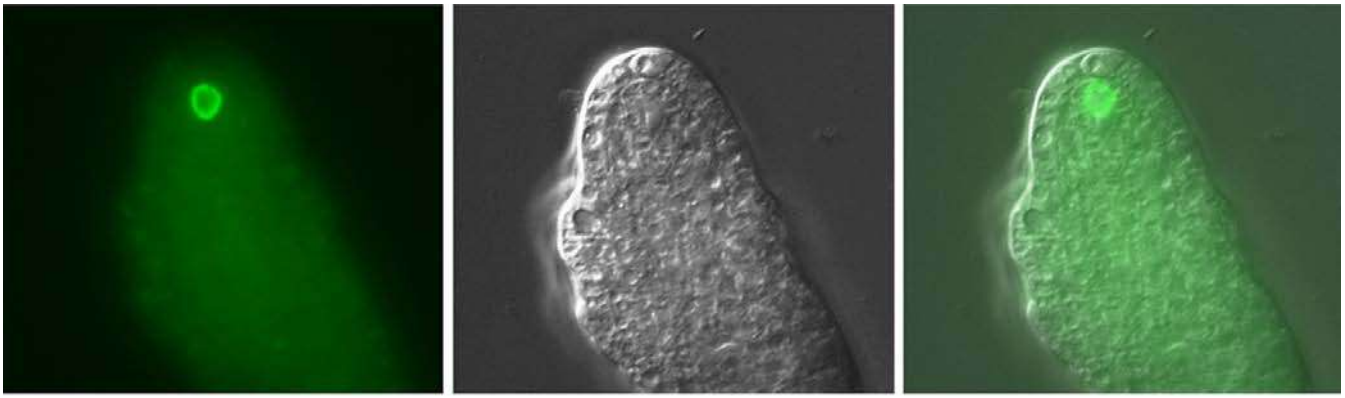
- Mahesh S, Bethoju K, Nalli A, Frank K, and Siddiqi I (2021) Functional analysis of a conserved domain in SWITCH 1 reveals a role in commitment to female meiocyte differentiation in *Arabidopsis*. ***Biochemical Biophysical Research Communications.*** 551:121-126

We have examined the role of the *DYAD/SWI1* gene in control of plant meiosis and shown that DYAD acts as a lineage determinant required for commitment to female meiosis. We have identified a novel plant-specific domain in *DYAD*, which we called the SMAM domain based on its presence in the functionally characterized genes (*SWITCH1*, *MALE STERILE 1*, *AMEIOTIC 1*, and *MALE MEIOCYTE DEATH 1*), and studied its domain conservation and evolution. We have shown that the function of the SMAM domain is conserved in *DYAD/SWI1* orthologs and that it has diverged in paralogs.

In continuing studies of the *SKR* gene for defining its pathway of action we have characterized and mapped two suppressors of *SKR* and performed genome wide expression analysis of a suppressor strain. The results provide support for a role for SKR in control of protein homeostasis.

The timing of fertilization after germination of pollen varies widely depending upon the plant species. An important question in plant fertilization biology is what are the cell cycle states of plant gametes before and at the time of fertilization. Previous studies have attempted to examine this issue in *Arabidopsis* using image cytometry based on DNA content. We have found that image cytometry based on quantitation of fluorescence can give widely variable results depending upon a number of factors. We are, therefore, reexamining this question using cell cycle stage specific reporter expression and markers of DNA synthesis.

In collaboration with the laboratories of Raphael Mercier and Rajeev Kumar (INRA Versailles, MPI Cologne), we are studying the control of monopolar centromere orientation in meiosis and have identified genes required for monopolar orientation. We are studying the mechanism of these genes and testing pairwise combinations for protein-protein interactions.



DYAD:GFP expression in the female meiocyte in an *Arabidopsis* ovule

JAHNAVI JOSHI

Systematics, Historical Biogeography & Diversification in the Tropical Forests

From left to right: Pooja Pawar, Bharti Dharapuram, Nehal Gurung, Jahnavi Joshi, Abhishek Gopal, Pragyadeep Roy, Mihir Kulkarni, Aditi

Research interests

- Molecular phylogenetics and systematics
- Macroecology & macroevolution
- Soil arthropods & tropical forests

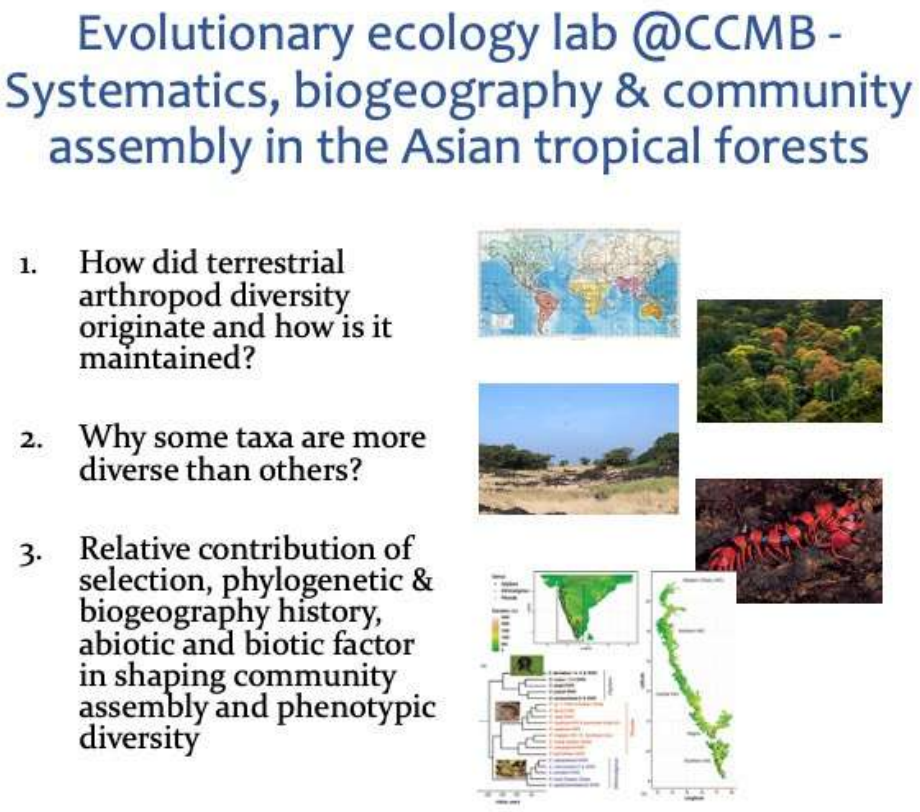
Selected recent publications

- Rohit Naniwadekar, Abhishek Gopal, Navendu Page, Sartaj Ghuman, Vivek Ramachandran, Jahnavi Joshi (2021) The critical ecological role of an endemic, large-bodied frugivore on a small tropical island. ***Ecology and Evolution***. 11,1399-1412.

Tropical forests are storehouses of biodiversity. Identifying the ecological and evolutionary drivers of these diversity patterns continues to be of interest to ecologists and evolutionary biologists. In the Asian tropics, new species of animals and plants continue to be discovered. Our lab aims at 1) systematic documentation of tropical diversity in an integrative taxonomic approach, 2) identifying the underlying geological, evolutionary and ecological processes that govern the diversity patterns and 3) identify the processes that govern the assembly of species in these forests.

Over the past one year we have reviewed and synthesised literature on an integrative taxonomy with special reference to its prevalence and scope for biodiversity in India. We also provide a guide for best practices and a workflow for integrative taxonomy. Lastly, we argue for the need for a national strategy for taxonomy and systematic research with an outline on how to achieve this (Joshi and Agarwal, 2021).

We also examined the spatial patterns of phylogenetic diversity and endemism in the Western Ghats (WG) using ancient predatory arthropods. We observed a decreasing latitudinal gradient in taxonomic and phylogenetic diversity in the WG and high phylogenetic endemism in the southern and northern WG. Our findings support expectations from the latitudinal diversity gradient in the WG and the southern WG refuge hypotheses. Our results from soil arthropods highlight the need to use phylogeny and distribution data while assessing diversity and endemism patterns in the WG (Bharti et al., 2021).



JYOTSNA DHAWAN

Molecular programs of quiescence in adult stem cells and skeletal muscle regeneration

From left to right (Bottom): Jyotsna Dhawan, Gunjan Purohit, Prabhavathy Devan, Lamuk Zaveri, Debarya Saha, Swetha Sundar, Sujoy Deb, Ananga Ghosh, A.S. Priti, Puja Singh, Devesh Bahety, Anviti Vasisht, Saher Chawla, Shinny Sunny, Manjit Rana

Research interests

- Control of cellular quiescence and its relationship to stem cell function
- Adult stem cells and skeletal muscle regeneration
- Epigenetic, transcriptional and post-transcriptional mechanisms in quiescence
- Secreted and mechanical signals in control of cell fate

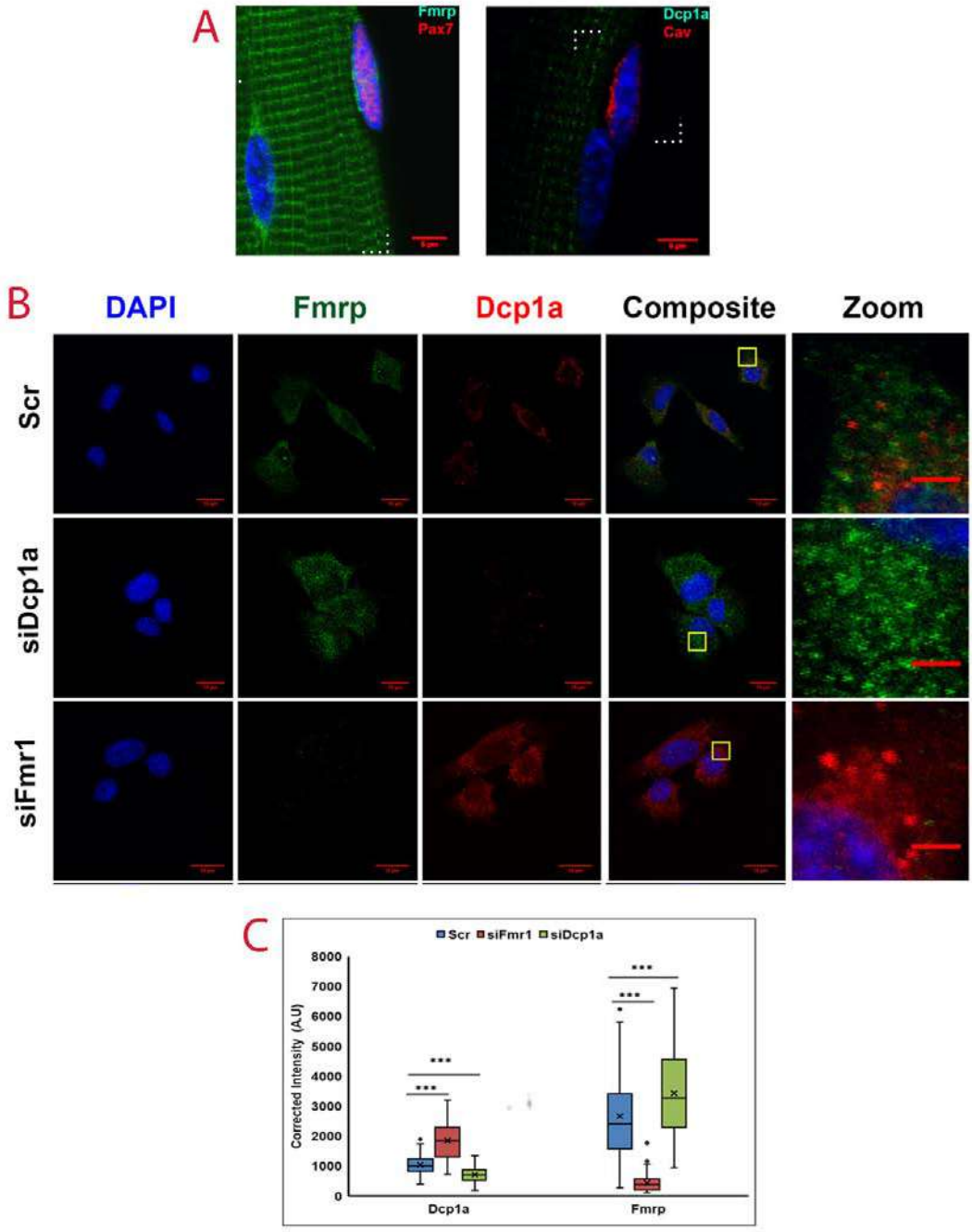
We are interested in the mechanisms that regulate cellular quiescence in adult muscle stem cells (MuSC). One of our current projects is summarized below:

mRNP granules in quiescent muscle stem cells

During muscle regeneration, quiescent MuSCs use distinct pathways to repair damaged myofibers or to self-renew. Earlier we had found that transcriptional and epigenetic regulators distinguish quiescence from differentiation. We have now investigated the contribution of post-transcriptional control via mRNP granule proteins Fragile X Mental Retardation Protein (Fmrp), a translational repressor and Decapping protein 1a (Dcp1a), a mediator of mRNA turnover.

Fmrp and Dcp1a are differentially enriched in quiescent MuSC vs myofibers (Fig A), and reciprocally enriched in quiescent vs. activated MuSC, suggesting stage-specific roles. Fmr1 knockout mice showed reduced myofiber caliber *in vivo* and MuSC proliferation *ex vivo*, consistent with a role for Fmrp in muscle homeostasis.

Changes in mRNP puncta *in vivo* are recapitulated *in vitro*. Fmrp is enriched in non-translating mRNP complexes abundant in G0 myoblasts, while Dcp1a puncta are lost in G0, suggesting stabilized and repressed transcripts. Knockdown of Fmrp led to decreased proliferation, poor reactivation & lower cyclin expression, while Dcp1a knockdown led to increased cell proliferation, rapid reactivation & higher cyclin expression. However, knockdown of either Fmrp or Dcp1a led to compromised differentiation. We also found cross-regulation: suppression of Fmrp enhanced accumulation of Dcp1a puncta, whereas knockdown of Dcp1a led to increased Fmrp in puncta (Fig B, C). Ongoing studies are focused on mechanisms of cross-regulation and impact on G0.



mRNP granules in muscle stem cells

A Fmrp and Dcp1a are differentially enriched in quiescent MuSC vs. myofibers in vivo
B Cross regulation of Fmrp and Dcp1a expression and granule assembly demonstrated in knockdown studies in cultured myoblasts
C Cross regulation of mRNP granule proteins quantified by confocal imaging

KARTHIKEYAN VASUDEVAN

Ecology and Conservation of Endangered Species

From left to right (top row): Alka Sahu, Karthikeyan Vasudevan, Yashwant Singh, Ravi Singh, Javaid Hameed (bottom rom): Afsar Soghra, K. Rajyalakshmi, Sripuram Srinivas, Siddharth Bhatia, Avni Blotra, Gayathri Sreedharan, Harika Katakam

Research Interests

- Disease ecology – understanding dynamics of chytridiomycosis in amphibian populations
- Conservation biology - studying reproductive ecology of a long-lived riverine specialist reptile - gharials (Gavialis gangeticus)
- Toxinology of venoms – understanding envenomation in humans by snakes and address human-snake conflict

Selected recent publications

- Ashish Jha and K. Vasudevan (2020) Demographic history of fragmented yellow-throated bulbul, *Pycnonotus xantholaemus* population in Deccan Peninsula, India. ***Endangered Species Research.*** doi.org/10.3354/esr01062
- Ashish Jha and K. Vasudevan (2020) Environmental niche modelling of globally threatened yellow-throated bulbul, *Pycnonotus xantholaemus* for conservation prospects in the Deccan Peninsula, India. ***Current Science.*** doi: 10.18520/cs/v119/i11/1815-1823

- Mutnale, M., G.S.N. Reddy and K. Vasudevan (2021) Bacterial community in the skin microbiome of frogs in a coldspot of Chytridiomycosis infection. ***Microbial Ecology***. doi.org/10.1007/s00248-020-01669-5

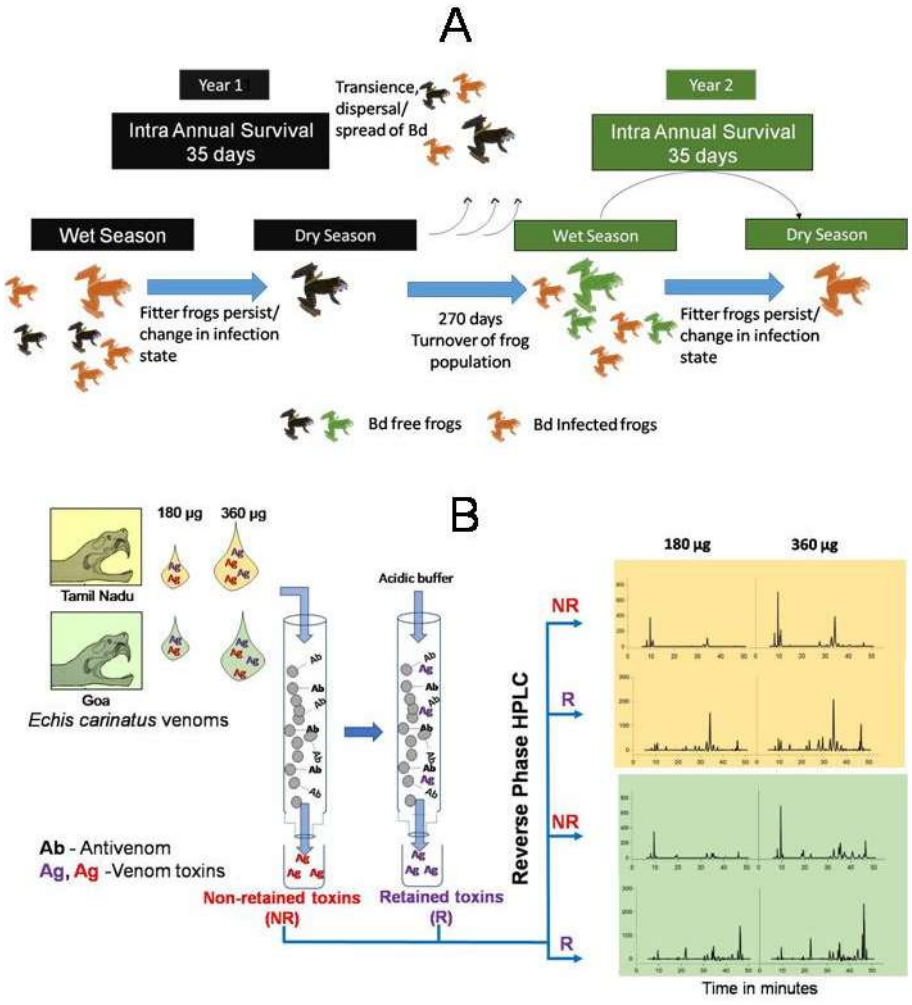
Sreedharan, G., Vasudevan, K. (2021) Chytridiomycosis in Asian amphibians, a global resource for *Batrachochytrium dendrobatidis* (Bd) research. ***Journal of Indian Institute of Science.*** doi: 10.1007/s41745-021-00227-3

Chytridiomycosis in indian amphibians

Chytridiomycosis is an emerging infectious disease that has impacted amphibians globally. It is caused by the fungal pathogen *Batrachochytrium dendrobatidis* (Bd). The disease has caused extinctions of over 90 amphibian species globally but its impact has not been severe in Asia. Such areas are referred to as a 'coldspot' of Bd infection and the factors that mediate host resilience or pathogen attenuation are not well-understood. Extensive surveys carried out earlier by our lab revealed that Bd infections in amphibians are under reported due to ineffective diagnostic assays. Our objectives was to develop effective frog population monitoring techniques, diagnostic assays for Bd so that the pathogen could be monitored. We designed a new primer pair using nuclear 5.8S rRNA and partial ITS-2 of Bd. The new primers were equally effective in detecting Bd in frogs, caecilians and salamanders. Bd prevalence corrected for false negatives shot up from 11% to 86% for samples collected between 2018-20 in the frog populations at Tillari Conservation Reserve.

Efficacy of polyvalent antivenom for snake bites

Clinicians report poor efficacy of Indian polyvalent antivenom (PAV) as more than 20 vials of PAV are required for treatment of a victim. We tested, if PAV efficacy is compromised due to insufficient antibodies against some venom toxins. We used third-generation antivenomics to reveal bound and unbound venom toxins of the Saw-scaled viper (Echis carinatus) venom from Goa (ECVGO) and Tamil Nadu (ECVTN). We used different amounts of venom and passed them through mini-columns containing ~5 mg antivenom bound to CNBr beads. The non-retained (unbound) and retained (bound) toxins were identified using reverse-phase HPLC and tandem mass spectrometry. Low molecular weight toxins - Short disintegrins (5.3kDa) and DIS domain of P-II SVMP from ECVGO and ECVTN showed poor binding with antivenom. The unbound toxins identified from this study could be targeted to improve the effectiveness of antivenom.



A - Pictorial representation of the role of frog life-history strategies in Bd pathogen dynamics in-situ, which was studied; B - Pictorial representation of experimental framework used in the study to assess the immunorecognition capacity of Indian polyvalent antivenom against venom toxins from two populations of Saw-scaled viper

KRISHNAN H HARSHAN

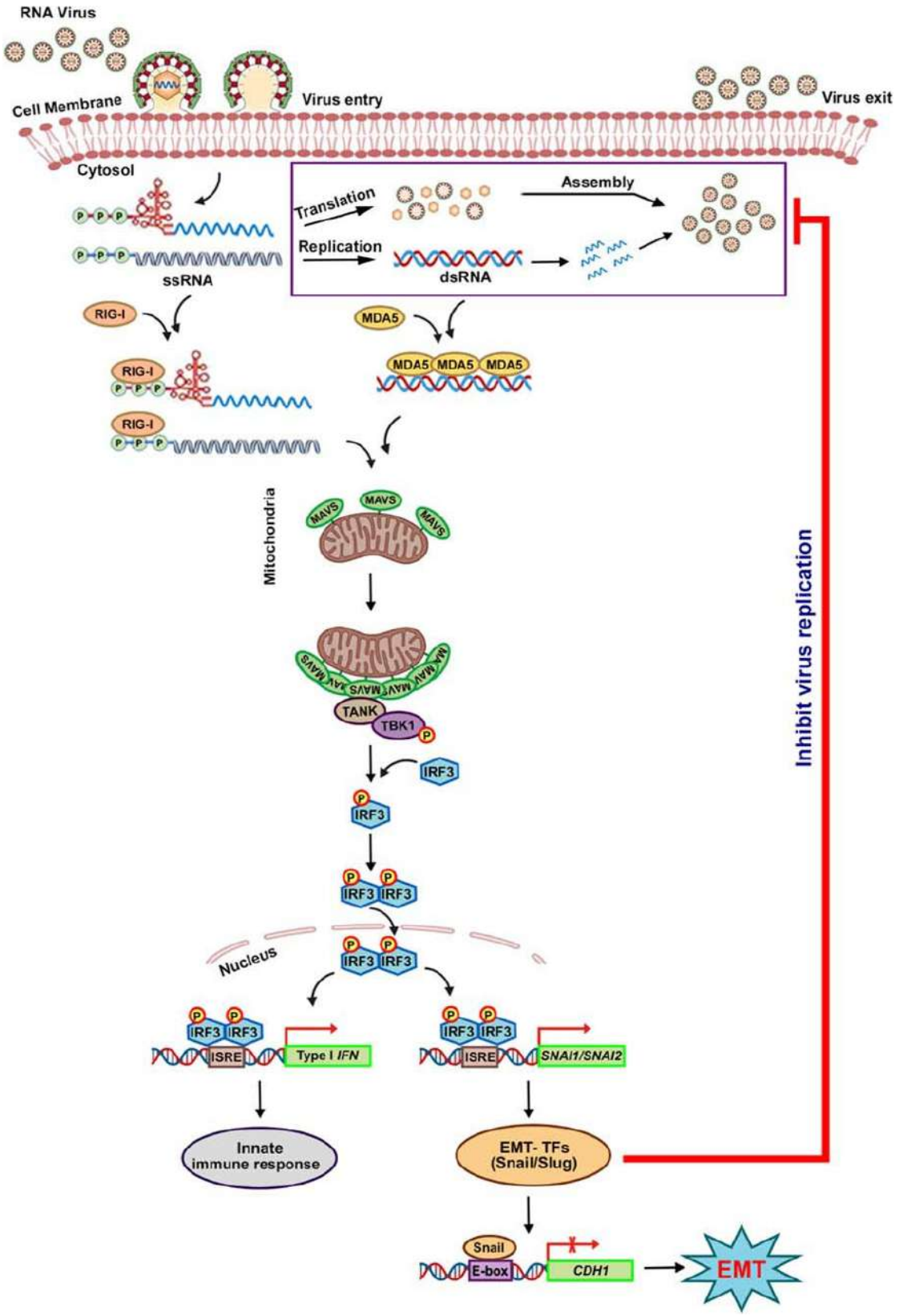
Host-Virus Interactions: Molecular Perspectives

From left to right: Sai Poojitha, Dixit Kumar, Prangya Sahoo, Karthika Nair, Divya Gupta, Anuhya Chowdhari, Sauhard Shrivastava, Krishnan Harshan, Amit Kumar, Mohan Singh, Vishal Sah, Haripriya Parthasarathy

Research interests

- Molecular Virology
- Host-virus interaction
- RLR pathway
- Innate antiviral response

The focus of our laboratory is the host response to human RNA viral infections such as Dengue and Coronavirus. The RIG-I like receptor (RLR) pathway is a major innate immune response pathway in mammals, that recognizes double stranded RNA intermediates of replication in RNA viruses. Activation of type-I interferons (IFN) is the outcome of such response that is mediated through a key mitochondrial membrane-associated protein, MAVS. Beyond the sketches of these responses, deeper details of these regulations in various cell types are still missing. In one of our recent findings, we identified that epithelial-mesenchymal transition (EMT) is caused by a broad range of viruses and EMT-TFs are activated as part of RLR signalling that promotes antiviral state in a strong way. Various viral proteins are known to interfere with IFN signalling, neutralizing the pathway at multiple nodes. Our laboratory has been studying the delayed response of the RLR pathway following SARS-CoV-2 infection in epithelial cells using infectious SARS-CoV-2 particles. Of particular interest is understanding the molecular mechanisms by which some of the recently evolved variants of the virus, such as Alpha- and Delta variants are able to replicate by evading the host innate immune system. Since host factors are key to the success of viral infection, their differential manipulation by distinct variants is an important aspect in these studies.



Molecular mechanism for activation of activation of EMT-TFs during RNA viral infections: After the virus entry into the cell either through endocytosis or fusion, the viral genome is sensed by RLRs, RIG-I, and MDA5, which transmits signals to MAVS localized on mitochondria, leading to oligomerization of MAVS. This recruits TANK and TBK1 (TANK binding kinase 1) onto oligomerized MAVS, resulting in activation of TBK1 by TANK through phosphorylation at S172. Phosphorylated TBK1 activates IRF3 through a series of phosphorylations at the C-terminus of IRF3, resulting in dimerization and subsequent nuclear translocation of IRF3, leading to transcriptional activation of SNAI1 and possibly SNAI2 as in the case of Type I IFN promoter activation. Snail and Slug, on the one hand, elevates ISGs and, on the other, represses E-cadherin, resulting in EMT. Elevated antiviral genes by Snail and Slug restrict viral replication, thereby controlling the spread of infection.

KUMARASWAMY REGALLA

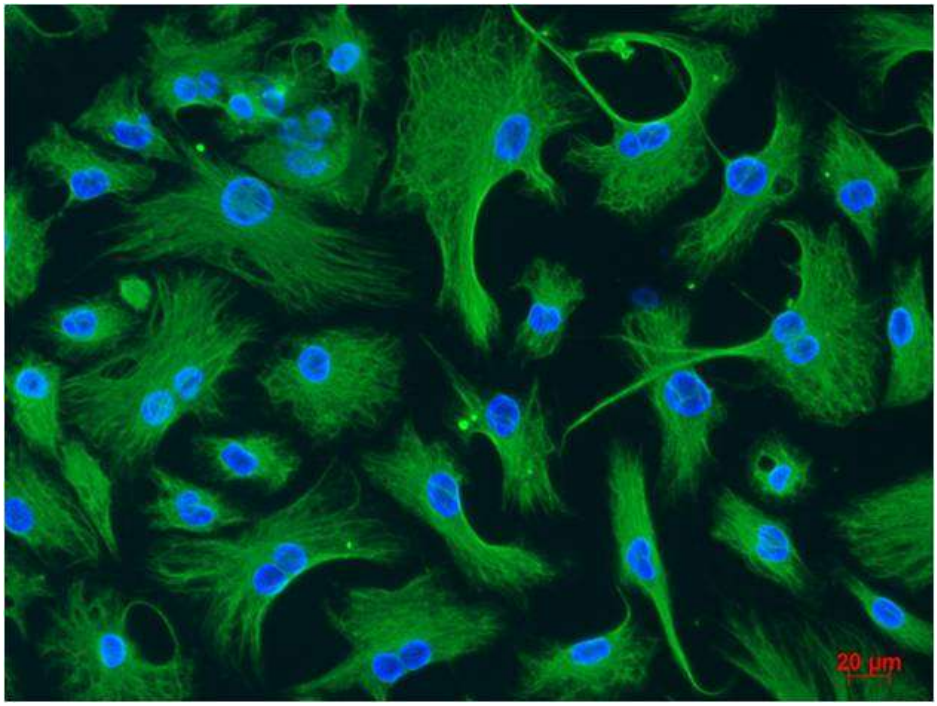
Cardiovascular Biology

From left to right: Priyanka Pant, Abishek Bharadwaj, Kumarswamy Regalla, Disha Nanda, Garima Slathia

Research interests

- Cardiovascular biology
- Non-coding RNAs in animal models

Heart diseases are the leading cause of death worldwide. In India, about 40% of all deaths in urban areas and 30% in rural areas are attributed to cardiovascular diseases. Recently, interest in non-coding RNAs as therapeutic targets for chronic diseases is increasing. In our lab we are investigating the role of non-coding RNAs in cardiac health and disease using *in vitro* and *in vivo* animal models. We identified specific long non-coding RNAs (lncRNAs) that that influence onset of cardiac hypertrophy, fibrosis and failure. We also found a lncRNA that takes part in the progression of Abdominal Aortic Aneurysm. We found that expression of these specific lncRNAs is regulated by transcription factors that are previously known to play pathological roles in cardiovascular diseases.



Mouse primary cardiac fibroblasts stained with Vimentin (and DAPI) to test the purity of isolation

K THANGARAJ

Evolutionary and Medical Genetics

From left to right: Lomous Kumar, Purushotham V, Narmadha, G. Mala, Nipa Basak, Pratheusa Machha, S. Deepa Selvi Rani, K. Thangaraj, Rajan Kumar Jha, Jaydeep AB, Sagnik Dhar, Sudhakar, Sunil Kumar Tripathi, Haneef
Inset images (top to bottom): Sunitha Kundur, Nitin Tupperwar, Agyaya Pratap, Jagamohan Chhatai, Deepak Kumar Kashyap

Research interests

- Evolutionary and medical genetics
- Origin and affinities of modern human
- Genetic basis of cardiovascular diseases, mitochondrial disorders, male infertility and sex determination

Selected recent publications:

- Dhandapany PS, Kang S, Kashyap DK, Rajagopal R, Sundaresan NR, Singh R, Thangaraj K, Jayaprakash S, Manjunath CN, Shenthar J, Lebeche D (2021) Adiponectin receptor 1 variants contribute to hypertrophic cardiomyopathy that can be reversed by rapamycin. ***Science Advances.*** 7:eabb3991
- Nizamuddin S, Dubey S, Singh S, Sharma S, Machha P, Thangaraj K (2021) CYP2C9 Variations and Their Pharmacogenetic Implications Among Diverse South Asian Populations. ***Pharmgenomics Pers Med.*** 14:135-147
- Deepha S, Govindaraj P, Sankaran BP, Chiplunkar S, Kashinkunti C, Nunia V, Nagappa M, Sinha S, Khanna T, Thangaraj K, Taly AB, Gayathri N (2021) Clinico-pathological and Molecular Spectrum of Mitochondrial Polymerase γ Mutations in a Cohort from India. ***J Mol Neurosci.*** doi: 10.1007/s12031-020-01765-8
- Sudhakar DVS, Jaishankar S, Regur P, Kumar U, Singh R, Kabilan U, Namduri S, Dhyani J, Gupta NJ, Chakravarthy B, Vaman K, Shabir I, Khadgawat R, Deenadayal M, Chaitanya A D, Dada R, Sharma Y, Anand A, Thangaraj K (2020) Novel NR5A1 Pathogenic Variants Cause Phenotypic Heterogeneity in 46,XY Disorders of Sex Development. ***Sex Dev.*** 13:178-186
- Danda S, Mohan S, Devaraj P, Dutta AK, Nampoothiri S, Yesodharan D, Phadke SR, Jalan AB, Thangaraj K, Verma IC, Danda D, Jebaraj I (2020) Founder effects of the homogentisate 1,2-dioxygenase (HGD) gene in a gypsy population and mutation spectrum in the gene among alkaptonuria patients from India. ***Clin Rheumatol.*** 39:2743-2749
- Lasagna E, Ceccobelli S, Cardinali I, Perini F, Bhadra U, Thangaraj K, Dababani RC, Rai N, Sarti FM, Lancioni H, Ige AO (2020) Mitochondrial diversity of Yoruba and Fulani chickens: A biodiversity reservoir in Nigeria. ***Poult Sci.*** 99:2852-2860

Paramasivam A, Meena AK, Venkatapathi C, Pitceathly RDS, Thangaraj K (2020) Novel Biallelic NSUN3 Variants Cause Early-Onset Mitochondrial Encephalomyopathy and Seizures. ***J Mol Neurosci.*** 70: 1962-1965

Koshy PJ, Sudhakar DVS, Anupama SH, Mathew M, Parthasarthy R, Thangaraj K, Yaqoob MM, Abraham G (2020) Novel Homozygous FAN1 Mutation in a Familial Case of Karyomegalic Interstitial Nephritis. ***Indian J Nephrol.*** 30:283-285

Selected highlights of our group's research findings are as follows:

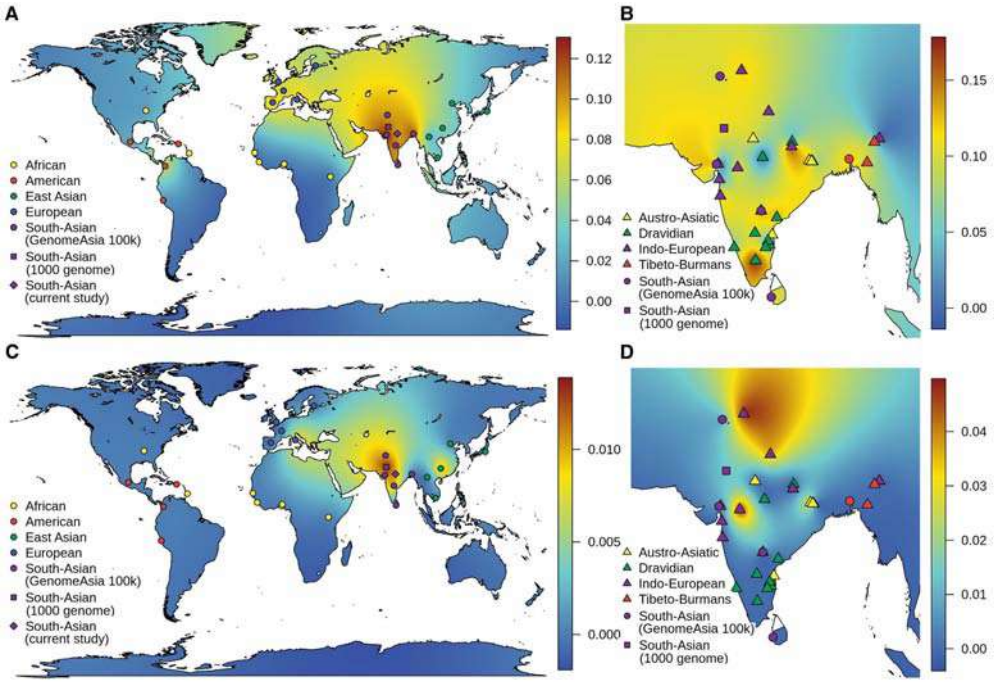
We have analysed 110 Roman Catholics from Goa, Kumta and Mangalore using genetic markers, and found that the Roman Catholics have close affinity with the Brahmins (Hum. Genet., 2021).

Recently a study has identified 50kb segment introgressed from Neanderthals that increases risk for COVID-19, and is present among 16% and 50% people of European and South Asian descent, respectively. However, we found that the polymorphism present in the 50kb introgressed segment did not show any significant correlation with the infection and fatality ratio in India (Sci. Rep., 2021).

Mutations in several genes are associated with hypertrophic (HCM) and dilated (DCM) cardiomyopathies. We sequenced the β-MYH7 in 137 DCM patients and 167 ethnically matched healthy controls, and found 27 variations, of which seven were novel and rare (8.0%). Further, we found that the missense mutations disrupts a critical network and may contribute to DCM (Can. J. Cardiol., 2021).

In another study, using Next-Generation Sequencing methods, we identified novel variants in adiponectin receptor 1 (ADIPOR1) as potential pathological risk factors for HCM. Biochemical studies showed that ADIPOR1 variants dysregulate glucose and lipid metabolism and cause cardiac hypertrophy through the p38/mTOR and/or ERK pathways (Sci. Adv., 2020).

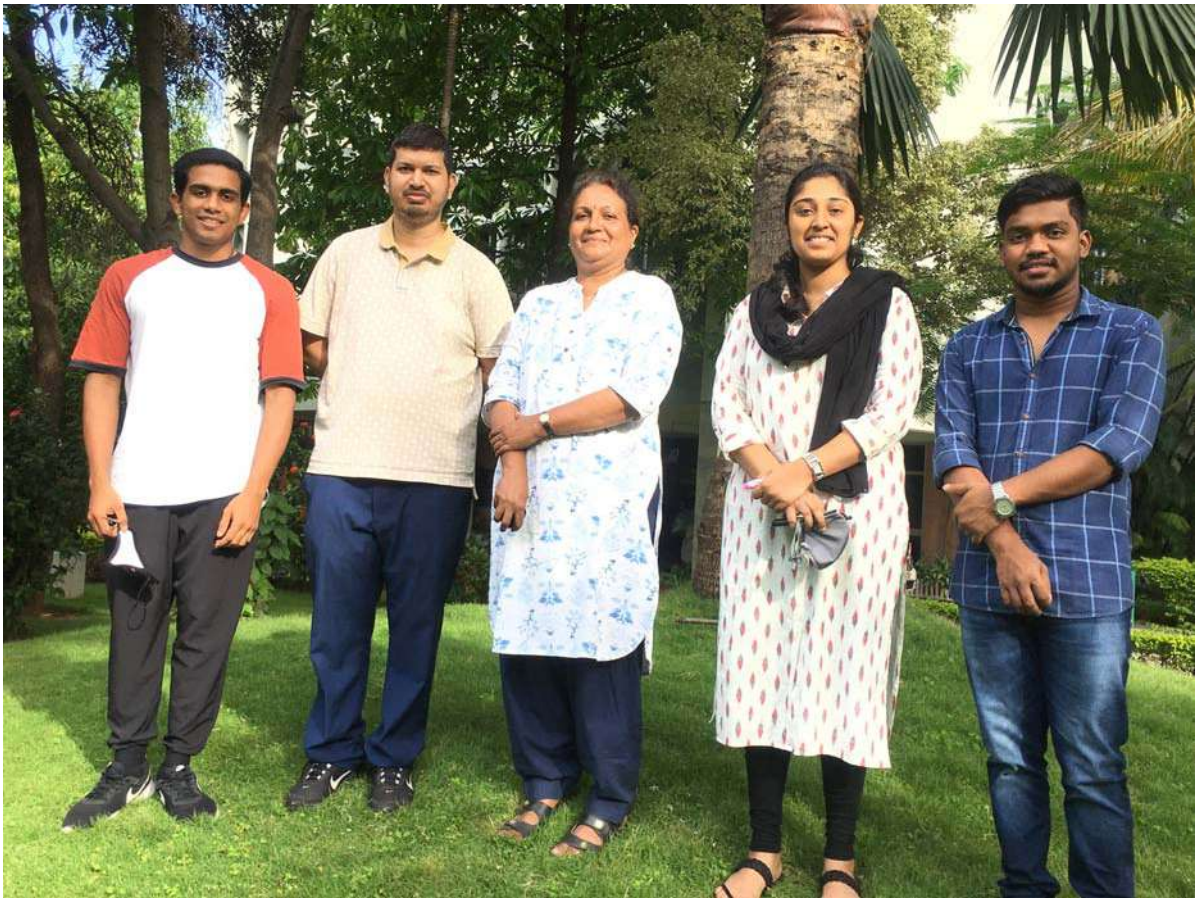
Cytochrome-P450-2C9 (CYP2C9) metabolizes a wide range of drugs. We investigated CYP2C9 variations in 1278 individuals from 36 Indian populations and along with 478 other South Asian populations, and observed a high frequency of CYP2C9∗3 (~13%) and CYP2C9∗3/∗3 (~1%) (Figure 1) that are associated with therapeutic responses (Pharmgenomics Pers Med., 2021).



Geospatial frequency distribution of CYP2C9∗3 and CYP2C9∗3/∗3. Genotypic and allelic frequency was interpolated with kriging method, and density map generated to explore geospatial frequency distribution. A and C represents the allelic (CYP2C9∗3) and genotypic (CYP2C9∗3/∗3) distribution in world-wide population, while B and D represents distribution within South Asian populations. In B and D, all samples from current study and 1000 genome project, present in HWE, were used in interpolation and, represented as triangular and circle, respectively. It is evident in geospatial frequency map that South Asian populations have high frequency of CYP2C9∗3 and showing high heterogeneity within sub-continent. Same is true for CYP2C9∗3/∗3.

LEKHA DINESH KUMAR

Wnt Signalling, Cancer, and Biomarker Discovery



From left to right: Rohan Ponangi, Rohitesh Gupta, Lekha Dinesh Kuamr, Aisha Shigna, Ankit Singh

Research interests

- Role of Wnt deregulators in the initiation and progression of colon cancer
- MicroRNAs as biomarkers for detection of different subtypes of breast cancer and leukemias
- Discovery of biodrug and its targeted delivery using RNA interference and nanotechnology
- Mechanisms of drug resistance

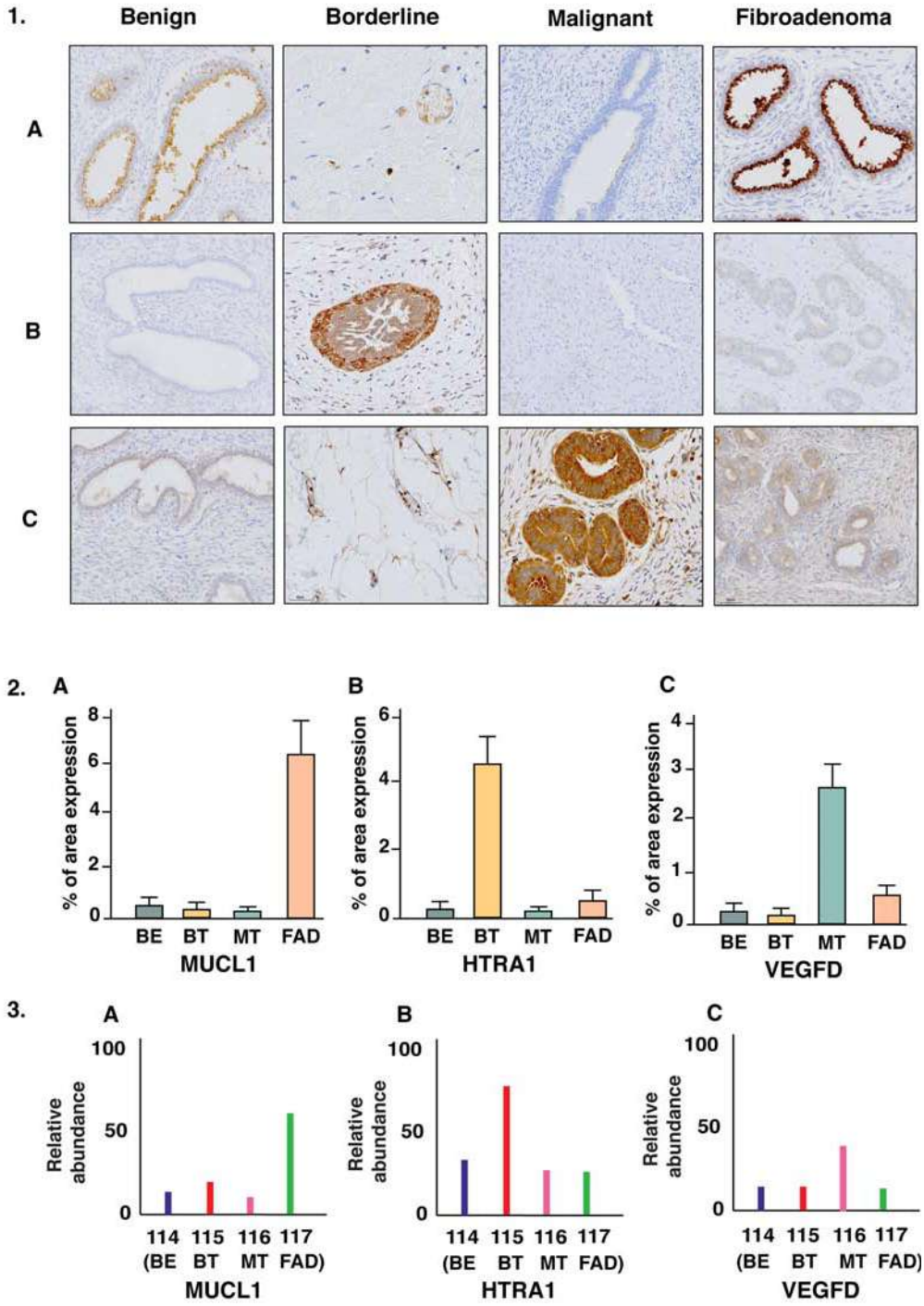
Selected recent publications

- Rekha Nair, Vinod kumar Verma, Syed Beevi, Abdul Rawoof, Liza Alexander, Ramanjaneya Prasad, Kusuma Kumari, Prashant Kumar, Lekha Dinesh Kumar (2020) MicroRNA signatures in blood or bone marrow distinguish subtypes of pediatric Acute Lymphoblastic Leukemia. ***Translational Oncology.*** 13 - 100800
- Archana Katoch, Debasis Nayak, Mir Mohd. Faheem, Aviral Kumar, Promod Kumar Sahu, Ajai Prakash Gupta, Lekha Dinesh Kumar, Anindya Goswami. Natural podophyllotoxin analog 4DPG attenuates EMT and colorectal cancer progression via activation of checkpoint kinase 2. ***Cell Death Discovery.*** 7:25
- Aviral Kumar, David S. Nayakanti, Kiran K. Mangalaparthi, Veena Gopinath, Nandyala Venkat Narsimha Reddy, Krishna Govindan, Geeta Voolapalli, Prashant Kumar and Lekha Dinesh Kumar (2021) Quantitative proteome profiling stratifies fibroepithelial lesions of the breast. ***Oncotarget.*** 12:507-518

Patents

- Biomarkers useful for detection of grades of human breast cancer. Dinesh Kumar Lekha, Verma Vinod Kumar, Appukuttan Nair Rekha, Jem Prabhakar, Katoor Jayasree. Patent no. 2852384 (in CA) and 2018202963 (in AU divisional)

Fibroepithelial lesions (FELs) of the breast are a group of biphasic tumors that are highly heterogeneous and include well-defined fibroadenomas (FADs) and phyllodes tumors (PTs). PTs are rapidly growing tumors which can often be misdiagnosed leading to multiple diagnostic complications and invasive procedures. The current grading system remains unreliable in differentiating these tumors owing to histological heterogeneity and lack of appropriate markers to monitor the sudden and unpredictable malignant transformation of PTs. Thus, there exists an imminent need for a marker-based diagnostic approach to augment the conventional histological platform. Recent advances in mass spectrometry-based proteomics platforms have revolutionized the feasibility of unbiased protein identification and quantification at greater depths. To this end, we employed iTRAQ based quantitative proteomics of FELs to extensively characterize the proteomic alterations across these tumors to identify potential biomarkers to distinctly identify these overlapping tumors. Among the differentially expressed proteins, we identified three candidate biomarkers such as MUCL1, HTRA1, and VEGDF uniquely expressed in FAD, borderline, and malignant PTs respectively. The present work also shed light to a brief mechanistic framework of PTs aggressive nature and present potential biomarkers to differentiate overlapping FELs. The high- throughput quantitative proteomic analysis suggested that FAD and PTs form distinct cluster away from borderline and malignant though there exists marked differences between them. Interestingly, over-expression of extracellular matrices (ECM) related proteins and epithelial mesenchymal transition (EMT) markers in borderline PTs led us to hypothesize a model of deposition and degradation leading to ECM remodelling and EMT acquisition triggering its malignant transformation.



(1) Immunohistochemical staining of MUCL1, HTRA1 and VEGFD which are uniquely over expressed in FAD (A), BT (B) and MT (C) respectively. (2) Percentage of area expression of MUCL1, HTRA1 and VEGFD in FAD (A), BT (B) and MT (C) respectively.
(3) Relative abundance of MUCL1, HTRA1 and VEGFD in FAD (A), BT (B) and MT (C) respectively as seen in proteomic data.

MANDAR V DESHMUKH

Molecular Basis of Evolutionary Divergence in RNAi Initiation

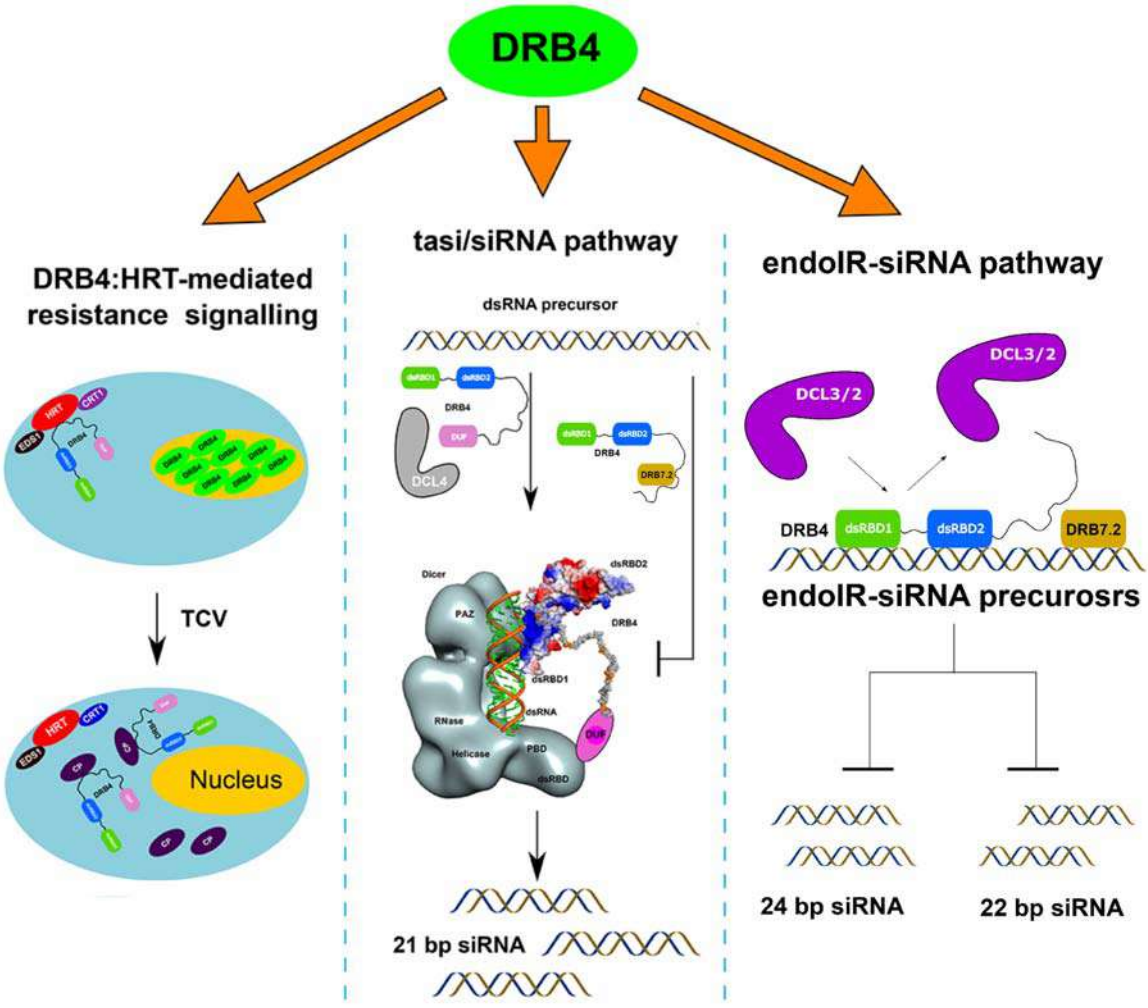
From left to right (Top row): Upasana Rai, Sneha Paturi, Ramdas Aute, and Jaydeep Paul
(Central row): Mandar V Deshmukh and Debadutta Patra
(Bottom row): Priti Chanda Behera
(Background): 600 MHz NMR Spectrometer

Research interests

- Role of RNA-binding gene regulatory proteins
- Structure, inter-domain orientations, and dynamics to decipher the initiation of the non-coding RNA-mediated gene regulation in various species

The RNAi pathway depends on a complex between Dicer, the initiator dsRNA, and a dsRNA-binding protein (dsRBP). In response to evolutionary selection pressure and developmental requirements, higher eukaryotes have developed an adaptable RNAi-based gene regulation pathway triggered by non-coding RNA. The ability of organisms to change the key components of the RNAi machinery is remarkable. The evolutionary divergence in the RNAi pathway appears as custom-made alterations in Dicer and dsRBP domain architecture and recruitment of uneven numbers of Dicers and dsRBP. Why organisms modify key enzymes and proteins in the RNAi initiation despite an identical outcome is elusive. We hypothesize that the RNAi initiation is a convoluted dynamic process tailored for evolutionary advantages to organisms.

To understand the origin and necessity of the evolutionary divergence in RNAi, we have defined the functional roles of RDE-4 in *Caenorhabditis elegans* and DRB4 in *Arabidopsis thaliana*. We are exploring the structure-function relationship in five DRBs in *Arabidopsis thaliana* using solution structure, biochemistry, and dynamics studies. Our results imply a fine balance in conserved and highly homologous systems that are tuned to alter the fate of the small RNA-mediated gene silencing. Surprising heterogeneity in the structure and function of dsRBPs suggests that the process of RNAi initiation is unique for each organism and depends on the step-wise assembly of the Dicer, dsRBP, and the trigger small RNA. Evolutionary differences in the key RNAi components imply that higher eukaryotes have tailored their RNAi pathway uniquely to adapt to environmental stress and to improve immune response.



A model for the multifarious activity of DRB4 in various scenarios depicting its central role in the tasi/siRNA pathway in *Arabidopsis thaliana*

MANJULA REDDY

Bacterial Cell Wall Synthesis and its Regulation

From left to right, starting from top: Manjula Reddy, Balaji Venkataraman, Nilanjan Som, Pavan Kumar, Raj Bahadur, Shambhavi Garde, Moneca Kaul, Vaidehi Rajguru, Suraj Kumar, Bhargavi Krishna Sree, Krishna Chaitanya, Devesh Bahety, GSN Reddy, M B Madhavi, Krishna Leela J, S Venugopal, P Hanumantha Rao

Research interests

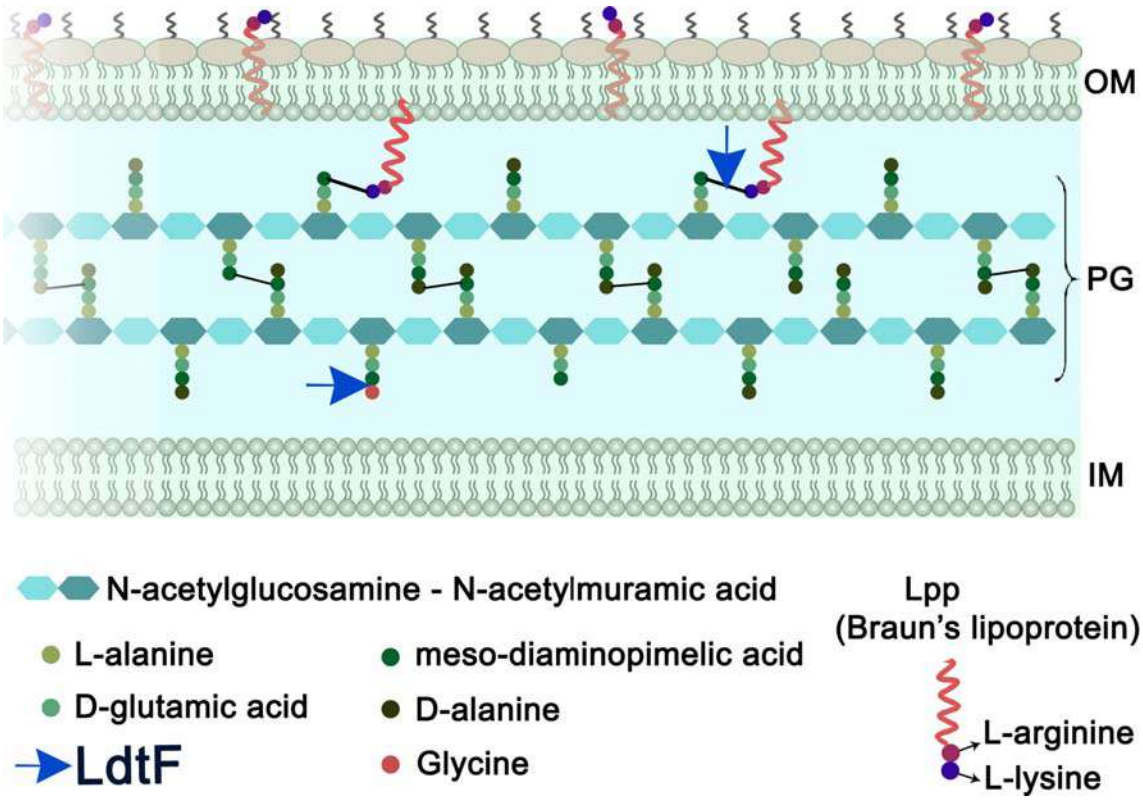
- Bacterial cell wall synthesis and its regulation

Selected recent publications

- Shambhavi Garde, Pavan Kumar Chodisetti, Manjula Reddy (2021) Peptidoglycan: Structure, Synthesis and Regulation. ***EcoSal Plus.*** doi: 10.1128/ecosalplus.ESP-0010-2020

Gram-negative bacterial cell envelopes are made up of an outer membrane (OM), an inner membrane (IM) that surrounds the cytoplasm, and a periplasmic space between the two membranes containing peptidoglycan (PG or murein). PG is an elastic polymer that forms a mesh-like sacculus around the IM protecting cells from turgor and environmental stress conditions. In several bacteria including *Escherichia coli*, the OM is tethered to PG by an abundant OM lipoprotein, Lpp (or Braun lipoprotein) that functions to maintain the structural and functional integrity of the cell envelope. Since its discovery Lpp has been studied extensively and although L,D-transpeptidases, the enzymes that catalyse the formation of PG–Lpp linkages have been earlier identified, it is not known how these linkages are modulated.

Using genetic and biochemical approaches, we have recently shown that LdtF (formerly yafK), a newly-identified paralog of L,D-transpeptidases in *E. coli* is a murein hydrolytic enzyme that catalyses cleavage of Lpp from the PG sacculus. LdtF also exhibits glycine-specific carboxypeptidase activity on muropeptides containing a terminal glycine residue. LdtF was earlier presumed to be an L,D-transpeptidase; however, our results show that it is indeed an L,D-endopeptidase that hydrolyses the products generated by the L,D-transpeptidases. To summarize, we describe the discovery of a murein endopeptidase with a hitherto unknown catalytic specificity that removes the PG–Lpp cross-links suggesting a role for LdtF in regulation of PG-OM linkages to maintain the structural integrity of the bacterial cell envelope.



Diagrammatic representation of the cell envelope of *E. coli*: Cell envelope consists of three layers- outer membrane (OM), peptidoglycan (PG) and inner membrane (IM). PG is stapled to the OM by Lpp or Braun lipoprotein (red helix) which exists in bound or free form. In the bound form, the N-terminal end of Lpp is anchored to the OM whereas the C-terminal lysine (purple circle) is covalently attached to an mDAP residue (dark green) of the PG stem peptides. The free form of Lpp spans the OM and is exposed to the surface. LdtF is identified in this study as an endopeptidase which cleaves PG-Lpp cross-links and also as a glycine-specific carboxypeptidase.

MEGHA KUMAR

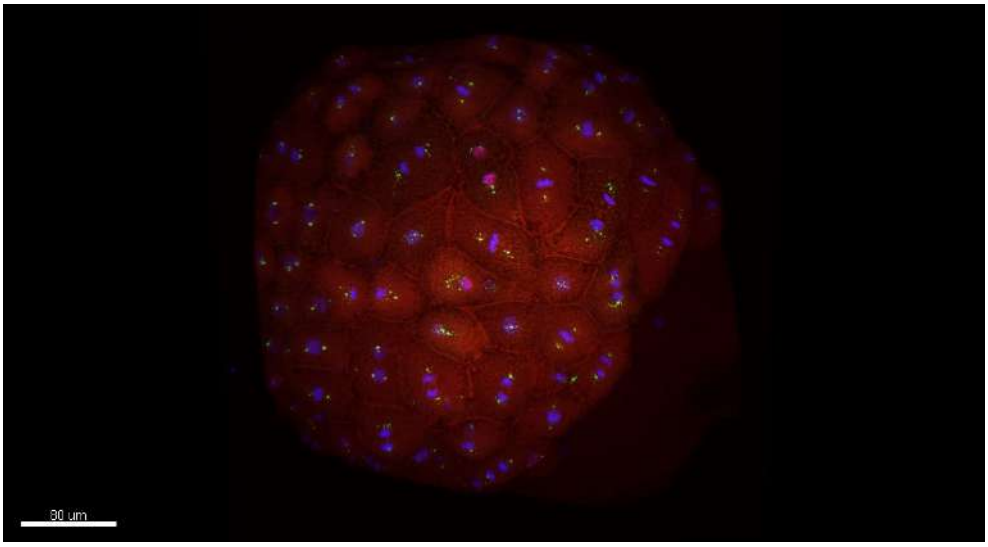
Cell and Developmental Biology

From left to right: Suraj Zade, Sulagna Mukherjee, Sayoni Chatterjee, Tuhina Prasad, Megha Kumar, Sharada Iyer

Research interests

- Cell and developmental biology
- Ecotoxicology and embryotoxicity

Cell division is a fundamental cellular process involved in embryonic development and mitotic aberrations result in disorders such as microcephaly, aneuploidy syndromes and embryonic lethality. We study the molecular mechanisms regulating cell division to understand the basis of these developmental disorders. We use zebrafish as the model system to study cell division dynamics during embryonic development using imaging, genetic manipulation and high throughput genetic screens. Our group is also interested in ecotoxicology and embryo toxicology. In one of our projects, we aim to assess the impact of common industrial byproducts on embryonic development. Our long-term goal is to elucidate the molecular mechanisms which form the basis of developmental defects upon exposure to these industrial byproducts.



3 hour old zebrafish embryo showing different phases of mitosis. Each embryonic cell shows DNA (blue), microtubular network (red) and spindle poles (green)

MEGHNA KRISHNADAS

Community and Functional Ecology

From left to right: Ashish Nambiar, Leela Prasad, Vikhyath Premugh, Lavanya Vanga, Meghna Krishnadas, Rishiddh Jhaveri, Vinayak Saini, Rajaditya Das, Sharath, Malvika Kamath

Research interests

- Community ecology
- Trait ecology
- Global change
- Forest dynamics
- Species coexistence
- Plant-soil feedback

Selected recent publications

- Meghna Krishnadas, Anand M Osuri (2020) Environment shapes the spatial organization of tree diversity in fragmented forests across a human-modified landscape. ***Ecological Applications Online.*** doi.org/10.1002/eap.2244

- Ghazala Shahabuddin, Rajkamal Goswami, Meghna Krishnadas, Tarun Menon (2021) Decline in forest bird species and guilds due to land use change in the Western Himalaya. Global Ecology and Conservation. 25: e01447

- Meghna Krishnadas and Simon Maccracken Stump (2021) Dispersal limitation and weaker stabilizing mechanisms mediate loss of diversity with edge effects in forest fragments. ***Journal of Ecology.*** 109(5) - 2137-2151

We seek to understand the processes that allow species to coexist and thus maintain diversity in ecological communities. Why are some species common but most species rare? What makes rare species persist? Further, in a world overwhelmingly shaped by humans today, we want to know how human influence impacts the mechanisms that maintain diversity. To this end, we combine ecological theory, experiments and observational field research with advanced statistical models. In particular, we use functional traits — heritable characteristics that mediate species' response to different conditions — to understand patterns and processes that shape biodiversity in different ecosystems. We use plant communities as model systems, but the concepts apply across many ecological communities. Currently, lab members are exploring the following questions:

1. Impact of changing rainfall patterns on seedling performance at forest edge vs. interior
2. Trait-mediated distribution and performance of forest tree seedlings along gradients of light and water availability
3. Environmental context-dependence in plant-soil feedback (impact of plant microbiome on performance)
4. Role of plant traits in mediating response of seedlings to density-dependent herbivory by insects
5. How host-pathogen interactions shape abundance of generalist vs. specialist pathogens

M M IDRIS

Bio-mechanisms of Regeneration

From left to right: M Kodieswaran, Sarena Banu, Mohammed Idris

Research interests

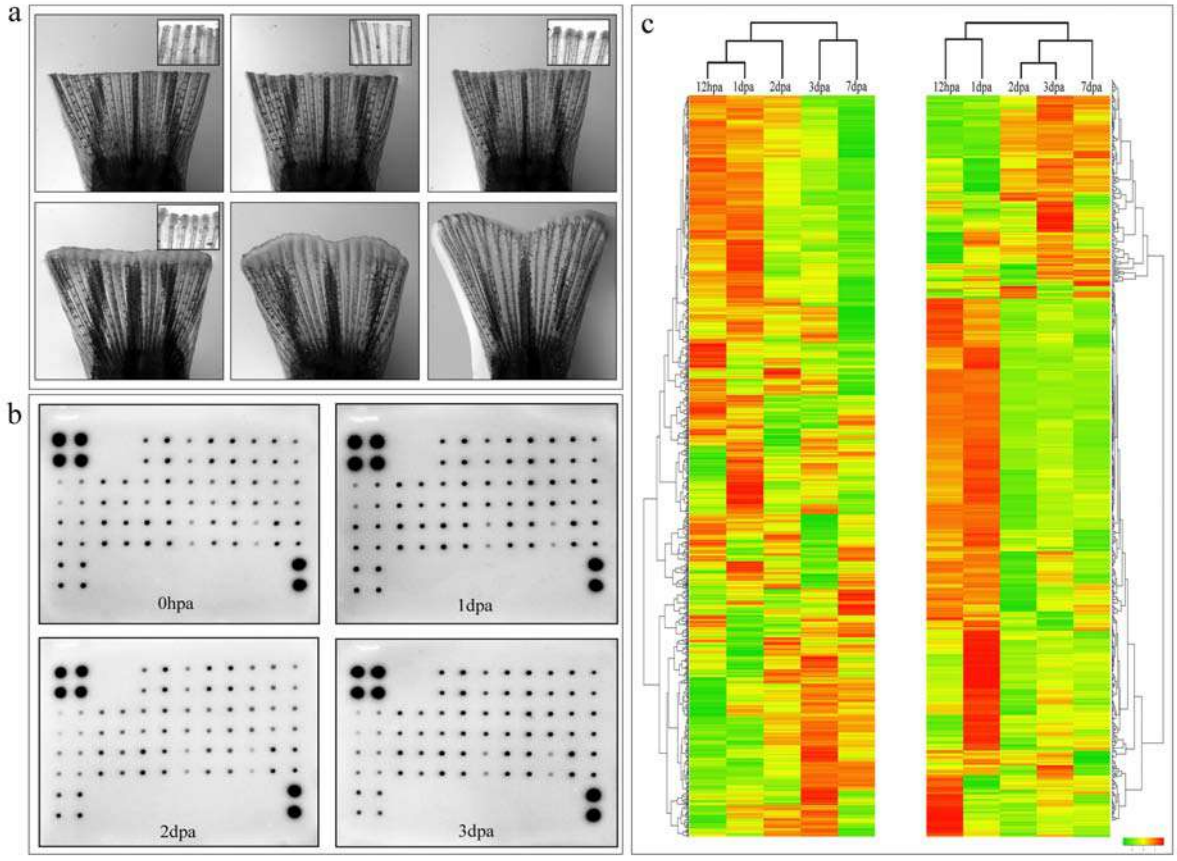
- Understanding the biomechanism of tissue and organ regeneration in alternate model animals.
- Understanding the molecular perspective during wound healing and regeneration in zebrafish model system.
- Development of Primary reference standard and impurities for Biologics and Generation of DNA Barcode for herbal plants.
- Understanding the SARS-CoV-2 infection in host human.

Selected recent publications

- Mir Quoseena, Sowmya Vuppaladadium, Shahid Hussain, Sarena Banu, Swarna Bharathi, Mohammed M Idris (2020) Functional role of annexins in zebrafish caudal fin regeneration - A gene knockdown approach in regenerating tissue. ***Biochimie.*** 175: 125-31
- Sai Pawan Nagumantri, Sarena Banu, Mohammed M Idris (2021) Transcriptomic and proteomic analysis of Hemidactylus frenatus during initial stages of tail regeneration. ***Scientific Reports.*** doi.org/10.1038/s41598-021-83283-0

Our group works on understanding the molecular and genetic aspects involved in tissue and organ regeneration in alternate model animals like zebrafish, geckos, ascidians and echinoderms. Understanding the bio-mechanisms of regeneration and the association of various genes (or proteins) in the regenerating environment is of high significance, as it might help us engineer non-regenerating systems into regenerating systems for therapy and healing. Epimorphic regeneration of zebrafish caudal fin tissue is complex and complete. A total of 1408 genes and 661 proteins were found differentially regulated during regeneration of zebrafish caudal fin tissue based on high throughput transcriptomics and iTRAQ based quantitative proteomics analyses. PRMT, SLC, Interleukin, HOX, neurotransmitter and several novel genes were found to be associated with regeneration for its differential regulation during the mechanism. Based on the network and pathway analysis it was found that the differentially regulated genes and proteins were found allied with cell cycle control of chromosomal replication, nervous system development and cellular development, growth and proliferation pathway. This study has mapped a detailed insight of the gene/protein changes in regenerating tissue more effectively.

Our group also works on the development of primary reference standards for biopharmaceuticals, monograph development and DNA barcode development for medicinal plants as per the requirement of Indian Pharmacopeia Commission. Till date we have analyzed a couple of therapeutic proteins and developed a methodology for its assay of protein impurities and synthesis of their reference standard. Also we have developed DNA barcode-based monograph for 20 different herbal drugs. Our group is also involved in understanding the role of innate immunity in humans during SARS-CoV-2 infection.



a. Regeneration of zebrafish caudal fin tissue post amputation b. Antibody array profile of cytokine during zebrafish caudal fin tissue regeneration. c. Heat map expression profile of genes and proteins associated with regeneration.

MUKESH LODHA

Mechanism of Epigenetic Inheritance in Plants

From left to right: Mukesh Lodha, Akanksha Garhewal, Preethi Jampala, Sai Deep

Research interests

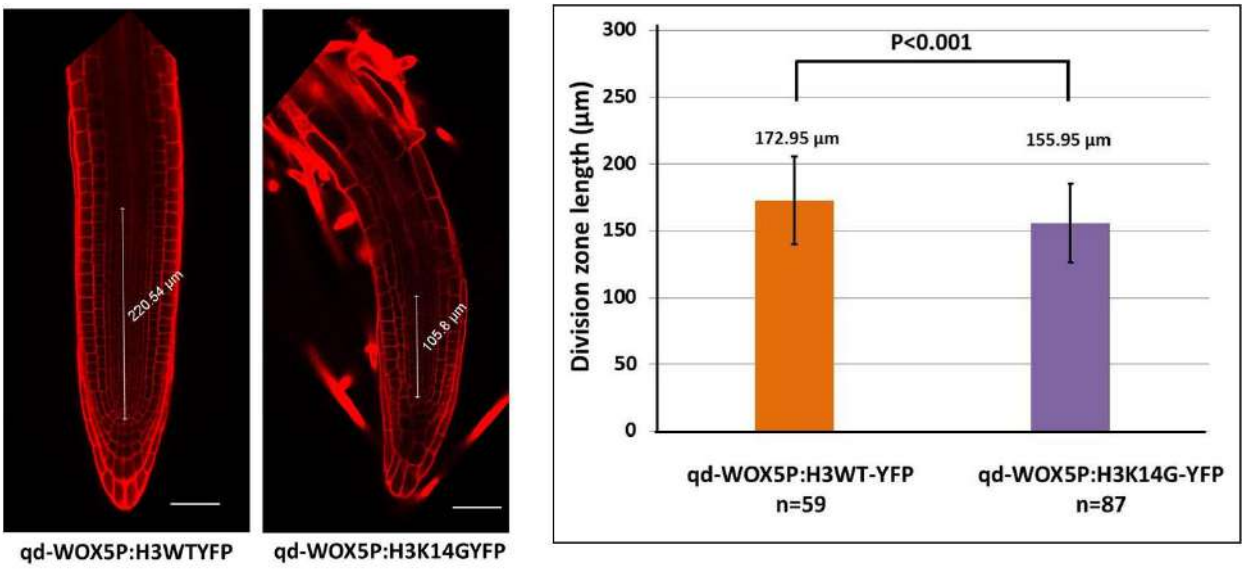
- Plant epigenetics
- Plant developmental biology

Epigenetic information is heritable during mitotic and meiotic cell divisions but it is not encoded in the genetic material. It is stable in the absence of initial trigger. A large share of our understanding of epigenetics is achieved through developmental genes.

Our group is using one of the important developmental regulators, SHOOT MERISTEMLESS (STM) as a tool to understand epigenetic regulation in plants. It is a homeodomain transcription factor and plays important role in shoot meristem stem cell regulator and determining factors in leaf complexity. In simple and compound leaf species STM is expressed in the shoot apical meristem and is downregulated in leaf primordia. In simple leaf species this downregulation is maintained throughout the leaf development. In compound leaf species like *Cardamine hirsuta*, tomato and pea, STM downregulation occurs in leaf primordial but is not maintained. STM reactivation in developing leaves is necessary for compound leaf formation.

We have identified the cis-regulatory element which recruits Polycomb in the proximal promoter of *Arabidopsis* STM and Trithorax complex in the distal part of the *Arabidopsis* STM promoter which recruits it to the locus. It turned out that the distance between Polycomb and Trithorax recruiting conserved cis-regulatory motifs is larger in simple leaf species than in compound leaf species and this distance is crucial in determining leaf complexity.

In the context of *Arabidopsis* root development, we have identified lysines 23 and 14 of histone H3 segregate asymmetrically and are preferentially kept in the root stem cells. Acetylation on these residues is important in this asymmetric segregation which is important in proper root development. Loss of acetylation by chemical treatment or mutations in the amino acid residues lead to malformation of the root.



Histone H3 K14 Acetylation is an Epigenetic Factor which is Important in Root Development in Arabidopsis thaliana. Propidium iodide stained Arabidopsis root apices of plants with wild type or K14 mutated histone H3 (left panel). Quantitative estimation of root meristem lengths in plants with wild type or K14 mutated histone H3 (right panel).

N NAGESH

Structure and Interaction of G-Quadruplex DNA

From left to right: Sindhuja, Sowjanya, Ira Bhatnagar, Narayana Nagesh, C B Tripura Sundari, Truptimayee, Afna Safia, Arushi

Research interests

- Biochemistry
- Biophysics
- Bio-organic Chemistry
- Medicinal Chemistry
- Chemical Biology
- G-quadruplex DNA
- DNA - small molecular interactions # innovative and socially relevant research activity

Selected recent publications

- Mohanraj Sadasivam , Arunkumar Sakthivel , Nagesh Narayana, Shekhar Hansda, Murugan Veerapandian, Subbiah Alwarappan, Pandiaraj Manickam (2020) Magnetic bead-amplified voltammetric detection for carbohydrate antigen 125 with enzyme labels using aptamer-antigen-antibody sandwiched assay. ***Sensors & Actuators: B. Chemical.*** 312, 127985-127991

- Jeshma Kovvuri, Burri Nagaraju, C. Ganesh Kumar, Sunitha Rani Routhu, Jitendra Gour, Kishore Mullagiri, Narayana Nagesh and Ahmed Kamal (2020) Amberlite IR-120H Catalyzed synthesis of 1,3-Diphenylpyrazole-chromenoquinolin-6-one compounds and their biological evaluation. ***American Journal of Medicinal Chemistry.*** 2(1), 2-16

- Kesari Lakshmi Manasa, Sowjanya Thatikonda, Dilep Kumar Sigalapalli, Arpita Sagar,Gaddam Kiranmai,Arunasree M Kalle, Mallika Alvala,b Chandraiah Godugu, Narayana Nagesh, and Bathini Nagendra Babu (2020) Design and synthesis of β-carboline linked aryl sulfonyl piperazine derivatives: DNA topoisomerase II inhibition with DNA binding and apoptosis inducing ability. ***Bioorganic Chemistry.*** doi.org/10.1016/j.bioorg.2020.103983

- Kesari Lakshmi Manasa, Sanam Swetha Yadav and Narayana Nagesh (2020) The β-carboline alkaloids in cancer therapy- recent advancements in this area. ***IOSR Journal Of Pharmacy And Biological Sciences.*** 15 (3): 1-27

- Kesari Lakshmi Manasa, Sowjanya Thatikonda, Dilep Kumar Sigalapalli, Sowmya Vuppaladadium, Ganthala Parimala Devi, Chandraiah Godugu, Mallika Alvala, Narayana Nagesh, and Bathini Nagendra Babu (2020) Design and synthesis of substituted (1-(benzyl)-1H-1,2,3-triazol-4-yl)(piperazin-1-yl)methanone conjugates: Study on their apoptosis inducing ability and tubulin polymerization inhibition. ***RSC Medicinal Chemistry.*** 11(11):1295-1302

- Lakshmi Manasa K, Swetha Yadav S, Srikanth D, Narayana Nagesh and Mallika Alvalaa (2020) Recent insights into β-Carboline alkaloids with anticancer potential. ***Modern Approches in Drug Design.*** 3(1)

- Ramya Tokala, Surbhi Mahajan, Gaddam Kiranmai, Dilep Kumar Sigalapalli, Sravani Sana, Stephy Elza John, Narayana Nagesh, Nagula Shankaraiaha (2021) Development of β-carboline-benzothiazole hybrids via carboxamide formation as cytotoxic agents: DNA intercalative topoisomerase IIα inhibition and apoptosis induction. ***Bioorganic Chemistry,*** 106:10448

- Kumbhare, Ravindra M.; Padma, Singu; Chilakamarthi , Ushasri; Mahadik, Namita S., Bhamidipati, Keerti, Valipenta, Narasimhulu, Mokale, Santosh; Narayana, Nagesh (2021) Benzimidazole-1,2,3-triazole hybrid molecules: Synthesis and study of their interaction with G-quadruplex DNA. ***RSC Medicinal Chemistry,*** 106, 104481

We are interested in studies involving G-quadruplex DNA stabilization by small molecules and its interaction with metals, macromolecules. Besides this, we are also enthusiastic to understand the mechanism of modified, novel organic and inorganic complexes in enhancing anti-cancer/pro-apoptotic activity among cancer cells and reducing cancer cell proliferation both under *in vitro* and *in vivo* conditions, using the latest molecular biology assays and techniques. Further, we are interested in involving ourselves in innovative and socially relevant scientific research activity which will be useful to Indian population.

PAVITHRA L CHAVALI

Cellular and Developmental Biology

From left to right: Rajashree Ramaswami, Soumya Bunk (discontd), Pavithra Chavali, Dhruv Kumar Shakyawar, Sourav Ganguli, Shashank Saxena, Aswathy Krishnan (co-supervisory student)

Research interests

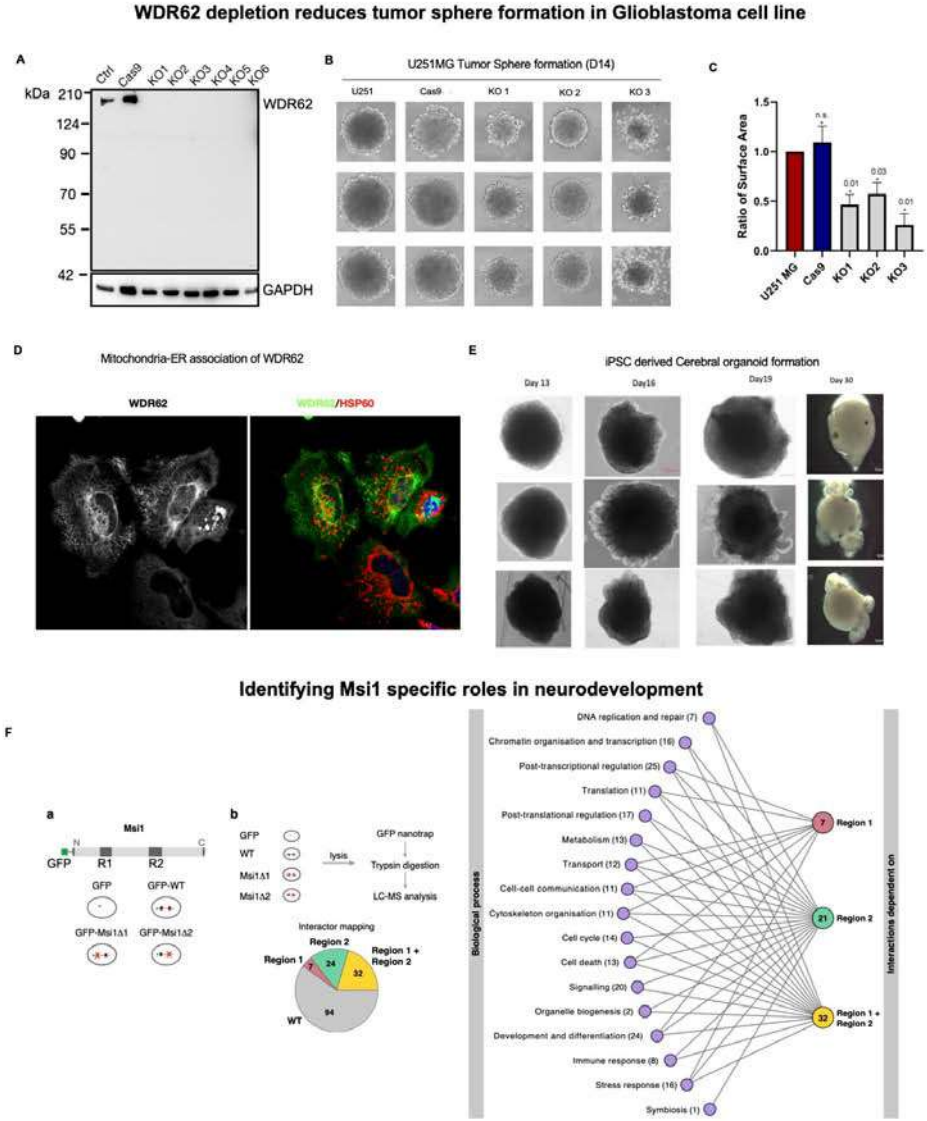
- Spatio temporal regulation of neurodevelopmental proteins.
- Developmental mechanisms exploited in developmental diseases.
- Use of 3D organoids as a model for disease progression.

Selected recent publications

- Mamta Verma , Mohd Imran K Khan , Rajashekar Varma Kadumuri , Baskar Chakrapani , Sharad Awasthi , Arun Mahesh , Gayathri Govindaraju , Pavithra L Chavali , Arumugam Rajavelu , Sreenivas Chavali , Arunkumar Dhayalan (2021) PRMT3 interacts with ALDH1A1 and regulates gene-expression by inhibiting retinoic acid signaling. ***Communications Biology.*** 4(1) - 109 4(1):109

Our group focusses on understanding cell cycle regulatory mechanisms underlying normal development and disease manifestation. Currently, we investigate the molecular functions of a major microcephaly gene *WDR62* and a stem cell RNA binding protein Musashi1. We have identified a novel subcellular localisation of WDR62 during interphase and identify that the WDR62 knock-outs display defects in cell division as well as dysregulated sub-cellular organelle homeostasis, due to its regulation of chaperones.

Furthermore, knock down of WDR62, results in formation of smaller tumorspheres in gliomas. We are now co-culturing tumor spheres with cerebral brain organoids to identify the pathogenic mechanisms. For Musashi1, we have generated mutants expressing deletion 1 and 2 and have identified unique interacting partners dependent on these regions. We are now characterising the role of these mutants in RNA binding and its role in gene expression program during brain development.



A. Immunoblot depicting absence of WDR62 protein in the knock outs generated in U251 MG cells B. Representative images of tumor sphere formation in U251 MG Parental, Cas9 Control and 3 different WDR62 knock-out cells taken at day 14. C. Quantification of the tumor sphere sizes normalised too the parental U251 MG cells. Graph depicts data from 3 independent experiments. D. Confocal depicting interphase localisation of WDR62 (Green) and HSP60 (red). E. Bright field images depicting the formation of brain organoids from iPSCS F. Depiction of differential protein interactors between the wild type and the mutant Musashi1 based on AP MS experiments.

P CHANDRA SHEKAR

Early Embryonic Development in Mouse

From left to right: Debabrata Jana, Simran Kumari, Mansi Srivastava, Daiva Kumari, Hanuman Kale, Purnima Sailasree, P Chandra Shekar, Vishnu V Vijay, Hiral Shah, Niharika Tiwary

Research interests

- Cross-regulation of pluripotency factors and signaling pathways in determining cell fate choices.
- Molecular basis of state transition and lineage restrictions in stem cells of early embryos.
- Understanding principles of self-organization of stem cells into embryo-like structures.
- To study the mechanism regulating metabolic transitions during the state transition of stem cells.

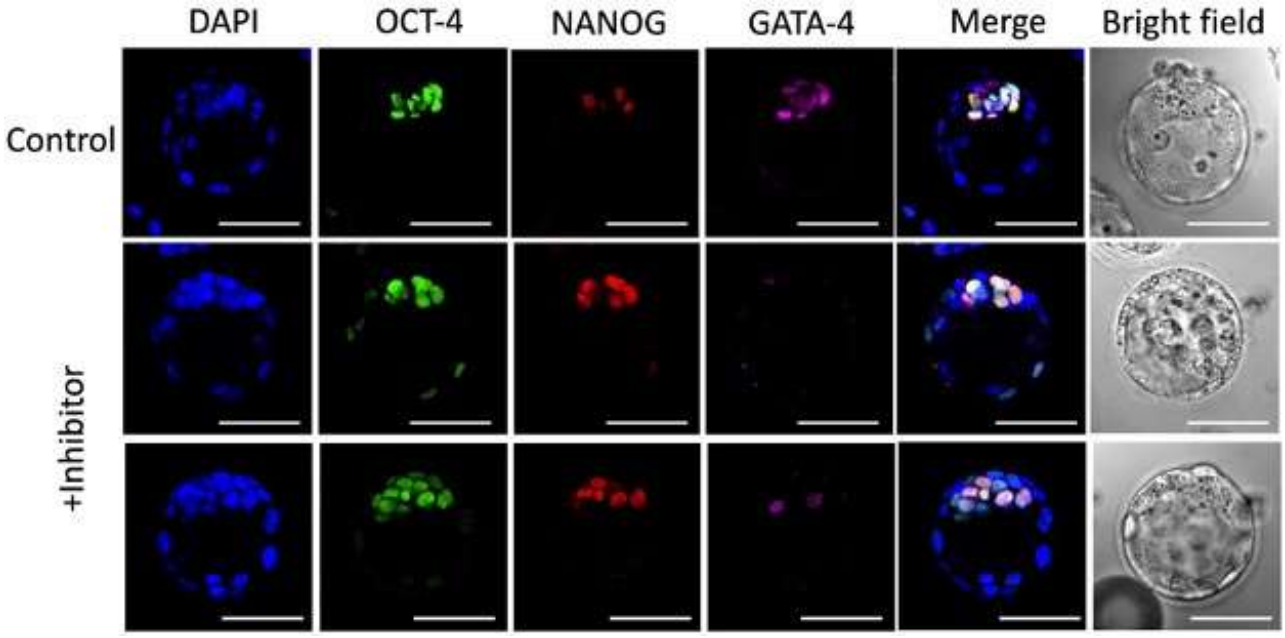
Selected recent publications

- Jamwal VS, Vishnu VV, Domreddy A, Parekh Y, Kumar BK, Shekar PC, Singh S (2020) Generation of iPSC from fetal fibroblast cells obtained from an abortus with type-I tri-allelic variants. ***Stem Cell Res.*** doi: 10.1016/j.scr.2020.101963

- Vishnu VV, Bh. Muralikrishna, Verma A, Nayak SC, Sowpati D T, Radha V, Shekar PC (2021) C3G Regulates STAT3, ERK, Adhesion Signaling, and Is Essential for Differentiation of Embryonic Stem Cells. ***Stem Cell Reviews and Reports.*** 17 - 1465–1477

The blastocyst is an important developmental stage of all placental mammals. It contains extra-embryonic layers - trophectoderm and primitive endoderm, which support the development of the embryo proper. Primitive endoderm is a monolayer of cells formed towards the coel of the blastocyst. The outermost layer of cells of inner cell mass form primitive endoderm by loss of Nanog and expression of Gata6. It is not known how Nanog expression is lost in outer cells leading to the formation of a single layer of primitive endoderm. We have used embryoid body models and developed a novel 3D cell sorting assay to study this phenomenon. Our experiments show that mechanical signal is essential for this cell fate choice. We show that the outer cells trigger differential mechanical signals due to basal-apical polarity which induce signaling cascade. This signaling cascade affects NANOG protein stability and inhibits its transcription resulting in loss of NANOG in the outermost layer of cells. The loss of NANOG allows the establishment of *Gata6* expression in the outer cells leading to defining a single layer of primitive endoderm.

From a small molecule screen, we developed a method to self-organize ESCs to blastocyst-like structures called "blastoids" from ESCs. We show that they not only exhibit molecular features of blastocyst but also can implant and induce decidualization in mice. We show that under our culture condition of self-organization, transient induction of 2-cell stage embryonic network is triggered. This is essential for resetting the developmental potential to totipotent state permitting self-organization into blastoids.



The inhibition of the mechanical signaling cascade by a small molecule inhibitor during early blastocyst development affects the formation of primitive endoderm. The primitive endoderm is well-developed in control embryos as shown by the expression of GATA4. In the presence of the small molecule inhibitor of the mechanical signaling cascade, the formation of Primitive endoderm is affected as shown by either very few or complete loss of GATA4 expressing cells.

PURAN SINGH SIJWALI

Roles of the Ubiquitin Proteasome System and Autophagy in Malaria Parasite Biology and Pathogenesis

From left to right (Top row): Renu, Abhipsa, Srinivas, Amisha, Manish
(Middle row): Nivya, Kanika, Puran, Murrel, Somesh
(Bottom row): Priyanka, Zeba, Gayathri, Deepak

Research interests

- Degradation pathways, like autophagy and ubiquitin proteasome system, involved in organelle disposal, cell division and hemoglobin catabolism during the development of malaria parasites

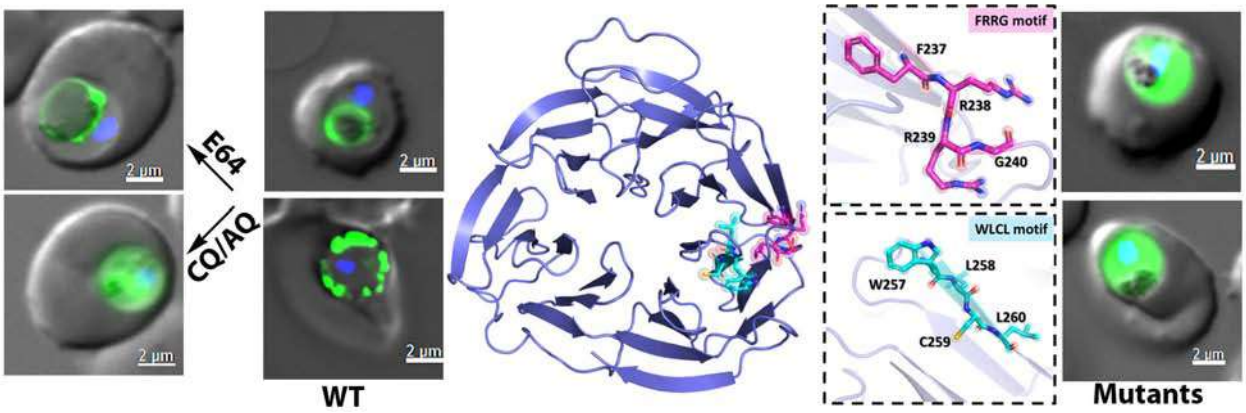
Selected recent publications

- Vikas R. Gaikwad, Uttam B. Karale, Gokulapriya Govindarajalu, Navin Adhikari, E. Vamshi Krishna, Vagolu Siva Krishna, Sunil Misra, Dharmarajan Sriram, Puran Singh Sijwali, Haridas B.Rode (2020) Synthesis and efficacy of pyrvinium-inspired analogs against tuberculosis and malaria pathogens. ***Bioorganic & Medicinal Chemistry Letters.*** doi.org/10.1016/j.bmcl.2020.127037

- Manish Bhattacharjee, Navin Adhikari , Renu Sudhakar, Zeba Rizvi, Divya Das , R Palanimurugan , Puran Singh Sijwali (2020) Characterization of *Plasmodium falciparum* NEDD8 and identification of cullins as its substrates. ***Scientific Reports.*** doi: 10.1038/s41598-020-77001-5

Autophagy, a lysosome-dependent degradative process, does not appear to be a major degradative process in malaria parasites and has a limited repertoire of genes. To better understand the autophagy process, we investigated *Plasmodium falciparum* Atg18 (PfAtg18), a PROPPIN family protein, whose members like *Saccharomyces cerevisiae* Atg18 (ScAtg18) and human WIPI2 bind PI3P and play an essential role in autophagosome formation. Wild type and mutant PfAtg18 were expressed in *P. falciparum* and assessed for localization, the effect of various inhibitors and antimalarials on PfAtg18 localization, and identification of PfAtg18-interacting proteins. PfAtg18 is expressed in asexual erythrocytic stages and localized to the food vacuole, which was also observed with other *Plasmodium* Atg18 proteins, indicating that food vacuole localization is likely a shared feature.

Interaction of PfAtg18 with the food vacuole-associated PI3P is essential for localization, as PfAtg18 mutants of PI3P-binding motifs neither bound PI3P nor localized to the food vacuole. Interestingly, wild type ScAtg18 interacted with PI3P, but its expression in *P. falciparum* showed complete cytoplasmic localization, indicating additional requirement for food vacuole localization. The food vacuole multi-drug resistance protein 1 (MDR1) was consistently identified in the immunoprecipitates of PfAtg18 and *P. berghei* Atg18, and also interacted with PfAtg18. In contrast to PfAtg18, ScAtg18 did not interact with MDR1, which, in addition to PI3P, could play a critical role in localization of PfAtg18. Chloroquine and amodiaquine caused cytoplasmic localization of PfAtg18, suggesting that these target PfAtg18 transport pathway. Thus, PI3P and MDR1 are critical mediators of PfAtg18 localization.



***Plasmodium* Atg18 localizes to the food vacuole. Homology modelling of *Plasmodium* Atg18 indicated that it adopts a beta-propeller structure and contains two PI3P-binding motifs: FRRG and WLCL. The wild type (WT) protein localizes to the food vacuole that is analogous to the lysosome. The localization is altered when parasites are treated with E64 or quinoline class of antimalarials (CQ/AQ) or the motifs are mutated (mutants).**

PURNIMA BHARGAVA

Epigenetic Mechanisms of Gene Regulation

Purnima Bhargava

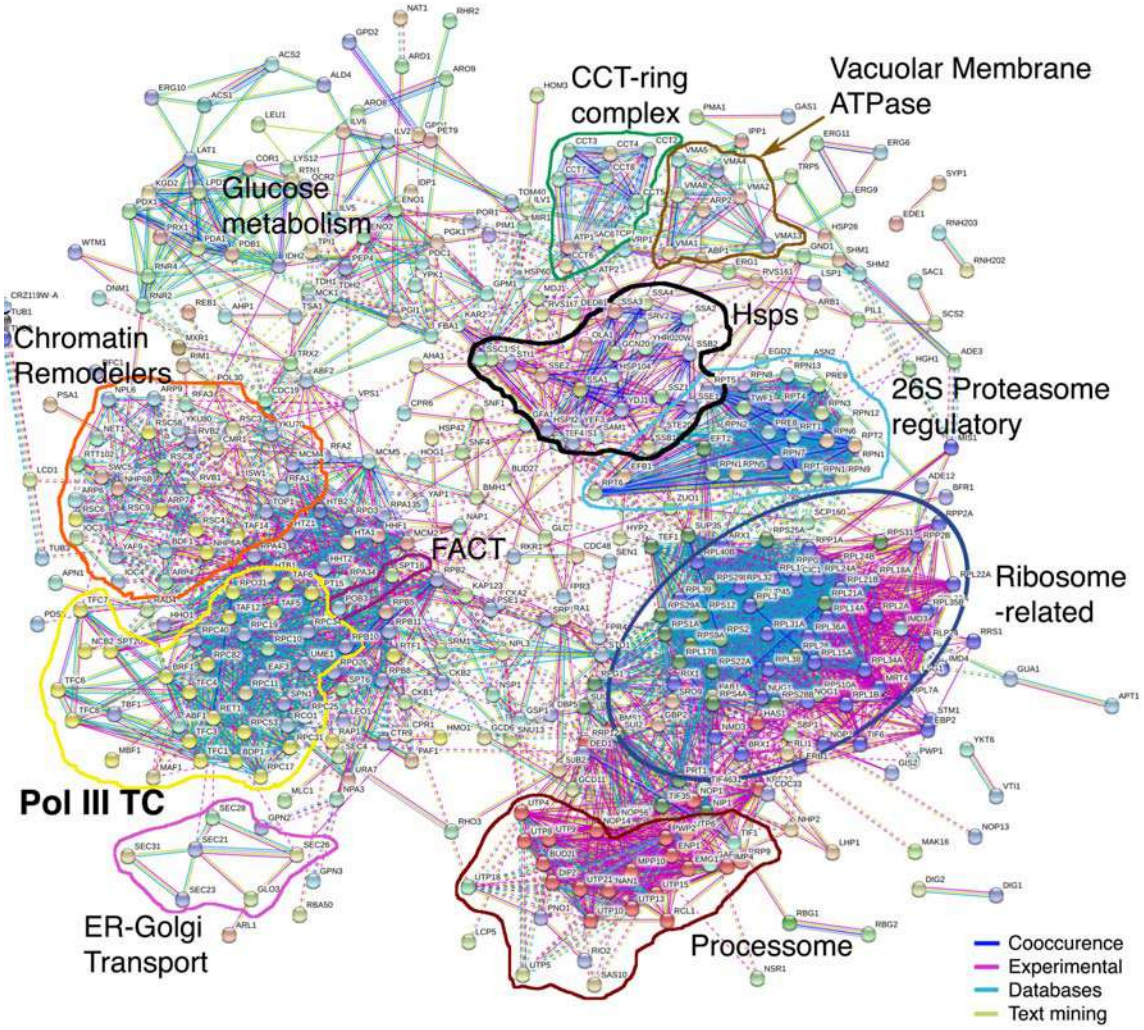
Research interests

- Transcription by yeast RNA polymerase III
- Epigenetic regulatory mechanisms
- Determinants of nucleosome positioning
- Gene regulation under stress conditions

Selected recent publications

- Shukla, A., Bhalla, P., Potdar, P. K., Jampala, P. and Bhargava, P. (2021) Transcription-dependent enrichment of the yeast FACT complex influences nucleosome dynamics on the RNA polymerase III-transcribed genes. ***RNA.*** 27:273-290

Since stress is a very important component of day-to-day life, our current research is focused on stress management by cells. We use budding yeast as a model system. Transcription by RNA polymerase III (pol III) is regulated under stress conditions. Our efforts to map the roles of several transcription factors of pol II found in the interactome of pol III transcription complex, revealed novel extra-transcriptional activities associated with them. One of such factors, the FACT (Facilitates Chromatin Transcription) complex is found to work as a general stress-sensor during this year. FACT complex is required for the transcription elongation through the nucleoosmes on the pol II-transcribed ORFs. Our genome-wide ChIP-seq data found a subtle dynamics of the FACT subunit Spt16 occupancy, specifically on the pol II-transcribed ESR (Environmental Stress Response) genes. In comparison, Spt16 occupancy on the pol III-transcribed genes shows changes under different stress conditions and influences the chromatin structure on all of the genes. Spt16 is not essential for basic transcription but the highest level of the FACT subunit Spt16 at the 3' gene-ends is transcription-dependent. Pol III delivers Spt16 to the downstream (DS) nucleosome at the gene terminator with the end of each transcription cycle from where it is lost along with pol III under nutrient starvation-induced transcriptional repression. The association of DS enrichment of Spt16 with traversing of the genes by pol III and not merely pol III presence gives Spt16 a direct approach to sense the transcription status and influence the gene expression via nucleosome dynamics.



STRING network analysis of the Pol III TC (transcription complex) interactome reveals a network of the several macromolecular complexes with specialized functions.

RAGHUNAND R TIRUMALAI

Physiology and Pathogenic Mechanisms of *Mycobacterium tuberculosis*

From left to right (Front row): Kokavalla Poornima, Shiela Chetri, Sapna Shandilya (Back row): Raghunand Tirumalai, Korak Chakraborty, Ravi Prasad Mukku, Muskan Gupta

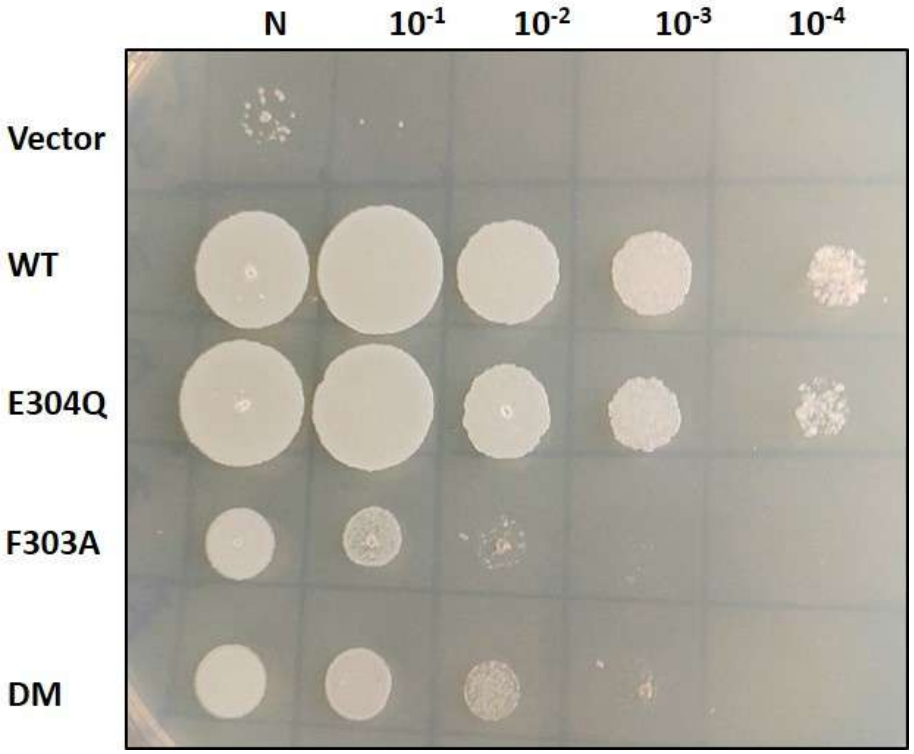
Research interests

- Characterising events at the host-pathogen interface,
- Identification of bacillary virulence factors,
- Identifying novel antibiotic resistance mechanisms

in *Mycobacterium tuberculosis*

Mycobacterium tuberculosis (M.Tb) has a complex lipid cell wall, largely composed of mycolic acids and long-chain fatty acids that play a crucial role in maintaining the integrity and permeability of the cell wall. This complex lipid structure has a role in abrogating the process of phagosome-lysosome fusion and establishment of infection. The *M.tb* desaturase A1 (DesA1) catalyses the introduction of position-specific double bonds during the biosynthesis of mycolic acids, a crucial step in the synthesis of a diverse range of mycolic acids. We have previously shown that *M.tb* DesA1 is a calcium-binding protein, belong to the βγ-crystallin family of proteins. To analyse the role of calcium-binding in DesA1 structure and function, we performed a chemical protein unfolding assay to assess the stability of the protein in the presence and absence of calcium.

Our results show that calcium-binding imparts structural stability to DesA1. To further confirm our results, we introduced mutations at key residues in the identified calcium-binding motif. A complete loss of calcium-binding was observed in the mutant F303A, whereas the mutants E304Q and F303AE304Q showed reduced binding. All three mutants either failed to complement, or showed a reduced ability to complement the growth phenotype of a conditional *M. smegmatis* desA1 deletion mutant strain, indicating a stringent requirement for these residues in DesA1 function. In addition, F303A and F303AE304Q showed increased sensitivity to isoniazid, a first-line anti-tuberculosis drug, emphasising the critical importance of calcium in the functioning of DesA1 and its role in maintaining cell wall integrity.



Complementation of a conditional M. smegmatis desA1 deletion mutant strain with wild type M.tb desA1 and its point mutants. DM - Double mutant, N - Neat

RAJAN SANKARANARAYANAN

Structural Biology

From left to right (Standing): Vinitha, Kezia, RajKanwar, Ankit, Aravind, Mallesh, Jotin, Akshay, Noopur, Biswajit (Sitting): Dinesh Babu, Sudipta, Koushick, Santosh, Bapin Kumar, Sankaranarayanan, Mukul, Pradeep, Aditya, Rukmini, Sakshi, Shobha, Priyadarshan, Lalitha, Sambavi

Research interests

- Mechanistic basis and functional relevance of proofreading mechanisms in the cell for translation quality control
- Lipid metabolite-producing enzymes called FAALs, with a special emphasis on FAAL-like proteins recently identified by us in opisthokonts

Selected recent publications

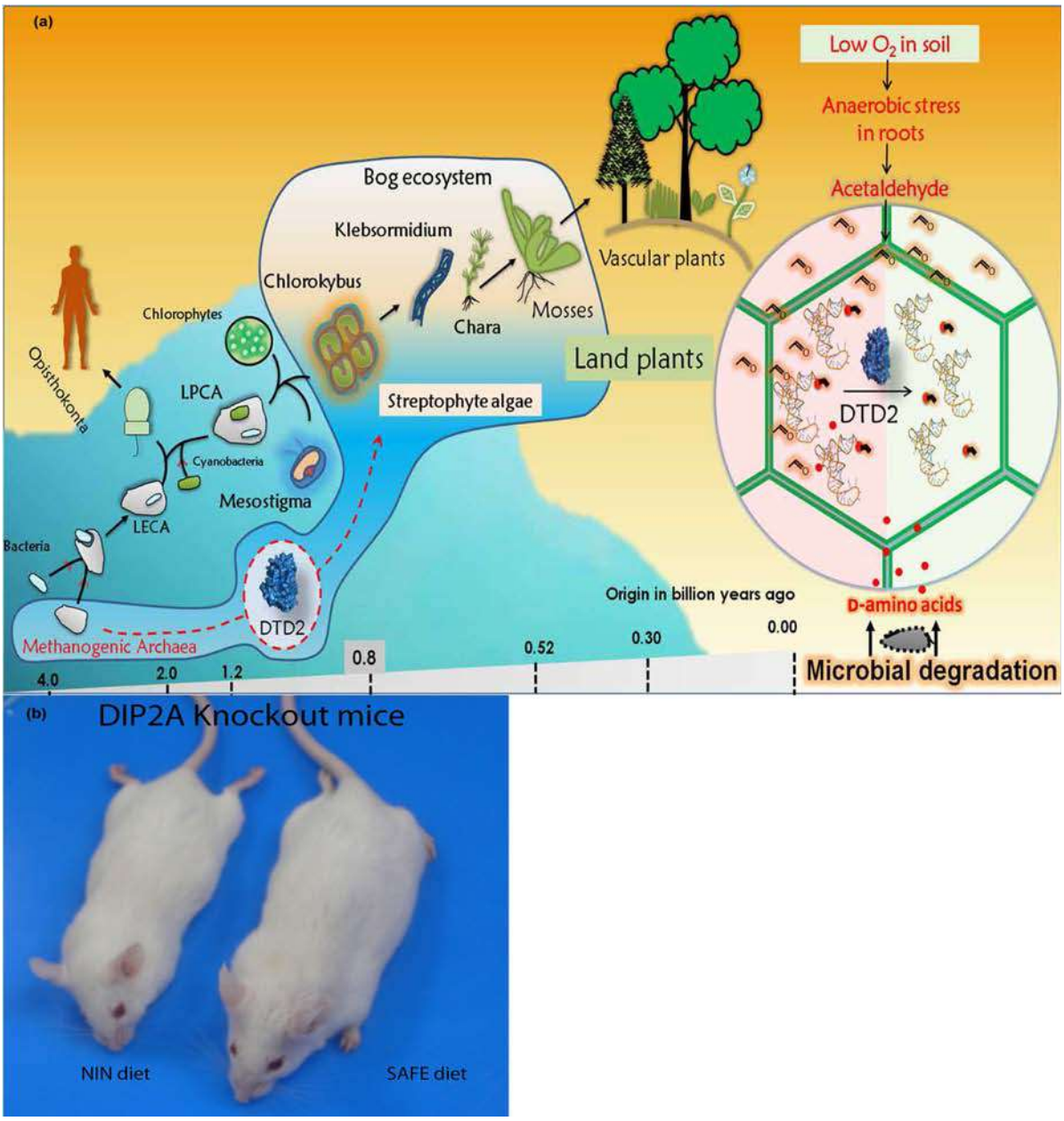
- Mazeed M, Singh R, Kumar P, Raman B, Kruparani, SP, Sankaranarayanan R. (2021) Recruitment of Archaeal DTD is a Key Event Toward the Emergence of Land Plants. ***Science Advances***. 7 : eabe8890 DOI: 10.1126/sciadv.abe8890
- Kuncha SK, Venkadasamy VL, Amudhan G, Dahate P, Kola SR, Pottabathini S, Kruparani SP, Shekar PC, & Sankaranarayanan R. (2020) Genomic innovation of ATD alleviates mistranslation associated with multicellularity in Animalia. ***eLife***. 9:e58118.(Covered by elife Science Digest-June 18 2020: 'Proofreading to evolve')
- Kinatukara P, Subramaniyan PS, Patil GS, Shambhavi S, Singh S, Mhetre A, Madduri MK, Soundararajan A, Patel KD, Shekar PC, Kamat SS, Kumar S, Sankaranarayanan R. (2020) Peri-natal growth retardation rate and fat mass accumulation in mice lacking Dip2A is dependent on the dietary composition. ***Transgenic Res.*** 29(5-6)553-562

Our lab focuses on D-aminoacyl-tRNA deacylases (DTDs) that remove erroneously attached D-amino acids from D-aminoacyl-tRNAs, termed 'chiral proofreading'. In mouse and human cell lines, oxidative stress compromises the threonyl-tRNA synthetase proofreading of L-Ala mischarged on tRNA(Thr), a tRNA misselection error. Under these conditions, we identified that a structural homolog of DTD, Animalia-specific tRNA deacylase (ATD) provides functional redundancy to proofread L-Ala mischarged on tRNA(Thr). As oxidative stress is essential for development of multicellular organisms, the genomic innovation of ATD in the ancestors of Animalia, choanoflagellates, is a key evolutionary event. Currently, we are investigating the role of ATD in modulating tRNA fragments and its physiological consequence.

DTD1 performs chiral proofreading in Bacteria and Eukaryota and the role is played by DTD2 in Archaea, but Plantae are unique as they have both DTD1 and DTD2.

We identified that the sensitivity of DTD2 knockout plants to acetaldehyde is because acetaldehyde forms ethyl adducts with aminoacyl-tRNA. DTD2 protects the plants from acetaldehyde by decoupling N-ethyl-D-amino acids from N-ethyl-D-aa-tRNAs. Our finding suggests that acquiring DTD2 from Archaea, is a key event in the emergence and evolution of land plants [Figure(a)].

Fatty acyl-AMP ligases (FAALs) transfer fatty acids to 4'-phosphopantetheine arm of acyl-carrier protein instead of abundant Coenzyme-A. Currently, we are trying to delineate how FAALs reject chemically identical and abundant Coenzyme-A. Disco-interacting protein 2 (DIP2), a eukaryotic protein containing FAAL-like domains were characterized by generating DIP2A-/- mice in collaboration with Dr. Satish Kumar (CSIR-CCMB). These mice fed with TAG-rich diet (NIN-formulation) show stunted growth as neonates, while those fed with DAG-rich diet (Safe-formulation) show fat mass accumulation as adults (> 10 months) [Figure(b)].



a) Acquiring archaeal DTD2 is one of the essential events toward evolution of land plants to mitigate the toxicity created by confluence of anaerobic stress and D-amino acids. Model showing recruitment of DTD2 in streptophyte algae and its implications toward land plant evolution (LECA-last eukaryotic common ancestor, LPCA-last plant common ancestor).

b) The effect of TAG-rich diet (NIN-formulation) and DAG-rich diet (Safe-formulation) on the growth of DIP2A knockout mice.

RAKESH K MISHRA

Genome Organization and Epigenetic Regulation

From left to right (Top row): Rashmi Upadhyay Pathak, Runa Hamid, Rakesh Kumar Mishra, Ravina Saini, Sonu Yadav, Saketh Murthy
(Bottom row): Nikhil Hajirnis, Ashish Bihani, Soujanya M. S, Avvaru Akshay Kumar, K. Phanindhar, Ashmala Naz

Research interests

- Comparative and functional genomics of non-coding DNA
- Organization and regulation of Hox genes: evolutionary logic of animals body plan
- Epigenetic regulation and development

Selected recent publications

- P Saha, DT Sowpati, M Soujanya, I Srivastava, RK Mishra (2020) Interplay of pericentromeric genome organization and chromatin landscape regulates the expression of Drosophila melanogaster heterochromatic genes. ***Epigenetics & Chromatin.*** doi: 10.1186/s13072-020-00358-4

- R Sureka, R Mishra (2020) Identification of evolutionarily conserved nuclear matrix proteins and their prokaryotic origins. Journal of Proteome Research. 20 - 518-530

- D Puri, CVB Swamy, J Dhawan, RK Mishra (2020) Comparative nuclear matrix proteome analysis of skeletal muscle cells in different cellular states. ***Cell Biology International.*** 45 - 580-598

- Arumugam Srinivasan, Rakesh K Mishra (2020) Lessons on gene regulation learnt from the Drosophila melanogaster bithorax complex. ***International Journal of Developmental Biology.*** 64 - 151-158

- Shagufta Khan, Divya Tej Sowpati, Arumugam Srinivasan, Mamilla Soujanya and Rakesh K. Mishra (2020) Long-Read Genome Sequencing and Assembly of Leptopilina boulardi: A Specialist Drosophila Parasitoid. ***G3 (Bethesda).*** 10 - 1485-1494

- Shilpa Bisht, Sofia Banu, Surabhi Srivastava, Rashmi U Pathak, Rajeev Kumar, Rima Dada, Rakesh K Mishra (2020) Sperm methylome alterations following yoga-based lifestyle intervention in patients of primary male infertility: A pilot study. ***Andrologia.*** 52 - e13551

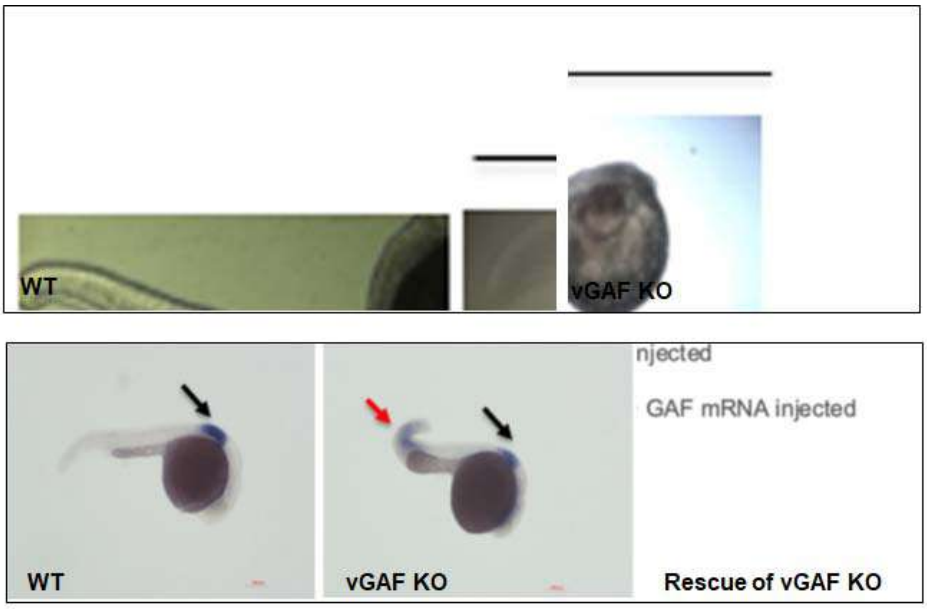
- Praveena L Ramanujam, Sonam Mehrotra, Ram Parikshan Kumar, Shreekant Verma, Girish Deshpande, Rakesh K Mishra, Sanjeev Galande (2021) Global chromatin organizer SATB1 acts as a context-dependent regulator of the Wnt/Wg target genes. ***Scientific Reports.*** 11 - 3385

- T Ponrathnam, R Saini, S Banu, RK Mishra (2021) Drosophila Hox genes induce melanized pseudo-tumors when misexpressed in hemocytes. ***Scientific Reports.*** 11 - 1-15
- S Banu, S Srivastava, A Mohammed, G Kushawah, DT Sowpati, Rakesh K Mishra (2021) Tissue-specific transcriptome recovery on withdrawal from chronic alcohol exposure in zebrafish. ***Alcohol.*** 91 - 29-38

Gene regulation is based on chromatin structure where organization of coding and non-coding elements of the genome plays an important role. A good example of such regulation is provided by the Hox cluster that shows a collinearity of gene expression pattern with the arrangement of genes in the cluster.

Our lab is interested in understanding how genetic information in the form of genomic sequence is interpreted by the developmental mechanisms. Taking specific example of vertebrate-GAF that interacts with the cis-regulatory elements in the HoxD complex of zebrafish and mouse, we show that key regulatory aspects of developmental gene regulation are conserved across the evolutionary landscape of bilaterians.

Genome is packaged in the nucleus where regulatory events take place but very little is understood about the origins of the nucleus. We analyzed the nuclear matrix (NuMat) of Drosophila and zebrafish to address this issue and identified number of NuMat proteins emerged before the evolution of the LECA. Such proteins are conserved across all eukaryotes, indicating their indispensable nature for nuclear function for over 1.5 billion years of eukaryotic history. Our analysis paves the way to understand the evolution nucleus through the complex internal nuclear architecture and its functions.



Role of vGAF in early development of zebrafish by modulating expression of *Hox* genes. Upper panel: CRISPR mediated knock out (KO) of vertebrate GAGA Factor (vGAF) leads to deformity of body axis. Lower panel: *Hoxd4* expression, as seen by RNA *in situ*, is drastically changed with ectopic expression in posterior part (red arrow) in cGAF KO animals leading to deformation of body axis phenotype. This mis-expression and the deformity phenotype of vGAF knock out is rescued by *GAF* mRNA.

R NAGARAJ

Host-defense Antimicrobial Peptides; Activity and Developing Future Therapeutic Agents

R. Nagaraj

Research interests

- Host-defense peptides; Their role in innate immunity
- Theoretical analysis of protein structures

Selected recent publications

- Jagannadham, M.V., Gayatri, P., Binny, T.M, Raman, B., Kameshwari, D. B., and Nagaraj, R (2020) Mass Spectral Analysis of Synthetic Peptides: Implications in Proteomics. ***J Biomol Techniques.*** doi.org/10.7171/jbt.2020-3201-001

Downregulation of defensin genes in SARS-CoV-2 infection

A total of 40 SARS-CoV-2 positive samples and 40 negative samples as controls for differential expression were selected from the same pool which tested negative to SARS-CoV-2 E and ORF gene. Eighteen defensin genes were selected for the study. They include both α- and β-defensin genes including isoforms. From these, 10 defensin genes showed expression at detectable limits in the selected masopharyngeal/oropharyngeal swab samples, which were further selected for the differential expression analysis. The β-defensin genes DEFB4A, 107B, 106B, 4B and 103A were found significantly down regulated based on differential analysis against control for SARS-CoV-2 infection. Genes corresponding to HD-5 and HD-6 were not affected as would be expected in nasopharyngeal/oropharyngeal samples. Of particular interest was the downregulation of both isoforms of the HBD-2 genes DEFB4A and DEFB4B. The downregulation of several defensin genes suggests that innate immunity provided by defensins is compromised in SARS-CoV-2 infection resulting in progression of the disease caused by the virus. Also, virus-mediated downregulation of defensin expression could result in augmented colonization of the uppermost airway by bacteria resulting in lung infection. Association of defensin genes with SARS-CoV-2 infection suggests that upregulating defensin gene expression could be an attractive therapeutic intervention. Defensin peptides that are part of the full-length human defensins HBD-1-3 that exhibit antimicrobial activities could also conceivably act as effective antiviral agents for therapies against SARS-CoV-2.

SANTOSH KUMAR

Receptor Signalling and Immune Response

From left to right (top): Sitanshu K. Sarangi, Ketaki Bhagwat, Etikala Apoorva (bottom): Santosh Kumar

Research interests

- Immunoreceptor signaling, using the tools of *in vitro* reconstitution, fluorescence imaging, and cellular biochemistry
- Lymphocyte responses in human diseases, using tools of single cell sequencing, genomics, and cellular biochemistry

Immunoreceptor signaling

Many receptors signal through Tyr-based motifs present in cytosolic tail. They exert positive or negative regulation for a proper balance of cellular responses. Immunoreceptor Tyr-based inhibitory motif (ITIM)-bearing, HLA-C-specific, inhibitory killer-cell Ig-like receptor (KIR) tightly controls the activation of human NK cells. Since inhibitory receptors co-cluster with activation receptors and exert inhibition locally, they were considered as co-receptors. In the initial models, ITIM phosphorylation depends on kinase involved in activation. Phosphorylated ITIMs recruit the protein tyrosine phosphatase SHP-1, which dephosphorylates the guanine nucleotide exchange factor Vav-1 leading to inhibition. KIR clusters and functions independently of actin. The clustering and inhibitory function of KIR is dependent on Zn2+. Zn2+ promotes polymerization of KIR into filaments. KIR prevents proximal activation steps before the initiation of the activation cascade. This proximal inhibition could inhibit signaling dependent on activation. Inhibitory signaling leads to phosphorylation of the small adaptor protein Crk. Receptor engagement with HLA alone is sufficient to induce Crk phosphorylation. Therefore, inhibitory receptors could signal independently of activation. Using tools of in vitro reconstitution and cellular biochemistry, we are studying how ITIM phosphorylation is controlled, and how SHP-1 and Crk operate to inhibit NK cell activities. We are also studying the role of Zn2+ in controlling receptor signaling and cytotoxic activities of NK cells.

Lymphocyte responses in *H. pylori* infection

H. pylori infection is often associated with chronic gastritis that could persist after antibiotic treatment. We are studying NK cell and T cell responses in *H. pylori* infection with an aim to understand the cellular and molecular basis of *H. pylori*-induced chronic gastritis.

SHRISH TIWARI

Sequence Analysis of Biomolecules

From left to right, starting from top: Deepti Rao, Shrish Tiwari, P. Ramesh, Tummala Nikhila Sai and Ruby Srivastava

Research interests

- Bioinformatics
- NGS sequence analysis
- *De novo* assembly
- Variant analysis
- Discovering genotype to phenotype correlation
- Analysis of rice genome

We are building a reference genome for Samba Mahsuri (SM). In this regard we have generated an assembly with ~40,000 scaffolds, using short reads from Illumina sequencing. Analysis of this assembly using various parameters, including N50 value, the BUSCO score that looks at the core set of genes in the family, the fraction of rice transcripts recovered in the assembly, seems to indicate this assembly is of good quality and near complete. We are in the process of mapping these scaffolds onto rice chromosomes.

We are working on an EMS mutant line of SM which has the phenotypes of early maturation and high yield. The MutMap approach is being used to identify the loci which could be responsible for these traits. In the MutMap approach stable EMS mutants, with a favourable agronomic trait, are crossed with wild-type parental line to get F1 generation. F1 is self-propagated to get F2 generation, which segregates for mutant and wild-type phenotype. The plants exhibiting the mutant phenotype are bulked and sequenced along with the parental plant. The aim is to identify a cluster of SNPs that is present in almost all the mutant plants. These loci are predicted to be responsible for the observed trait. We have generated the F2 generation for the mutant line we are working with and are in the process of phenotyping it.

We have also been involved in a project to build a comprehensive database of microRNAs involved in cancer. We have published a database of miRNAs involved in leukemia, along with their target genes and the pathways they may be involved in.

SONAL NAGARKAR JAISWAL

Developmental Biology

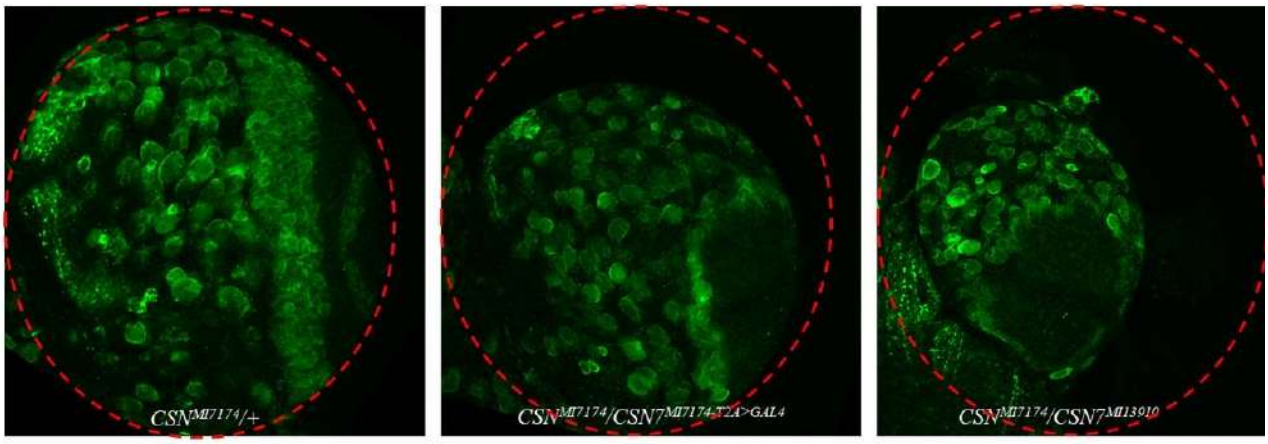
From left to right, starting from top: Sonal Nagarkar Jaiswal, Priyanka Pandey, Aishwarya K, Reshmi Varghese, Nandan J, Brinda Palliyana

Research interests

Mechanisms of

- neural stem cell self-renewal,
- quiescence and
- differentiation

To identify novel players involved in NSC maintenance, we utilized *Drosophila* neural stem cells (neuroblast, NB), and carried out genetic screens. Through these screens, we isolated several genes that are enriched in NB, and whose knock-down leads to brain defects. We are currently focusing on two candidates genes; *CSN7* and *CG32060*. We found that loss of these genes in developing *Drosophila* brains lead to small brains. Both are evolutionarily conserved and have been implicated in brain related disorders, however, their roles in brain development is not known. To identify their roles in brain development, we are primarily using NB as a model system and human NSCs (hNSCs) to find whether their functions are conserved in humans.



Loss of CSN7 leads to small brain phenotype. (A) Larval brains (72 hours ALH) from control (left) and CSN7 mutants (middle and right) exhibiting small brain phenotype. Brains are stained with anti-Miranda, a neuroblast marker.

SWASTI RAYCHAUDHURI

Proteotoxicity in Age-related Diseases

From left to right: Harshit Vaish, Pooja Gupta, Richa Singh, Subhasmita, Aanchal, Suparna Ghosh, Shemin Mansuri, Pallavi, Swasti Raychaudhuri

Research interests

- Proteostatic control on protein-complex biogenesis
- Cellular response to protein aggregation

Selected recent publications

- Shivali Rawat, Suparna Ghosh, Debodyuti Mondal, Valpadashi Anusha, Swasti Raychaudhuri (2020) Increased supraorganization of respiratory complexes is a dynamic multistep remodelling in response to proteostasis stress. ***J Cell Science.*** doi: 10.1242/jcs.248492

Proteostatic control on protein-complex biogenesis

The balance between specific and non-specific interactions between proteins governs the assembly of functional protein-complexes. Free subunits of protein-complexes are unstable, aggregation prone and rapidly degraded by the proteostasis machinery. We have recently found that respiratory complex (RC) subunits are increasingly engaged into improved supra-organizations during proteostasis-stress to safeguard their stability and function. Thus, fine-tuning of the assembly and degradation of RC-subunits determine mitochondrial bioenergetics. We hypothesize that the core and accessory RC-subunits play qualitatively and quantitatively different roles in this regulation. Currently, we are investigating:

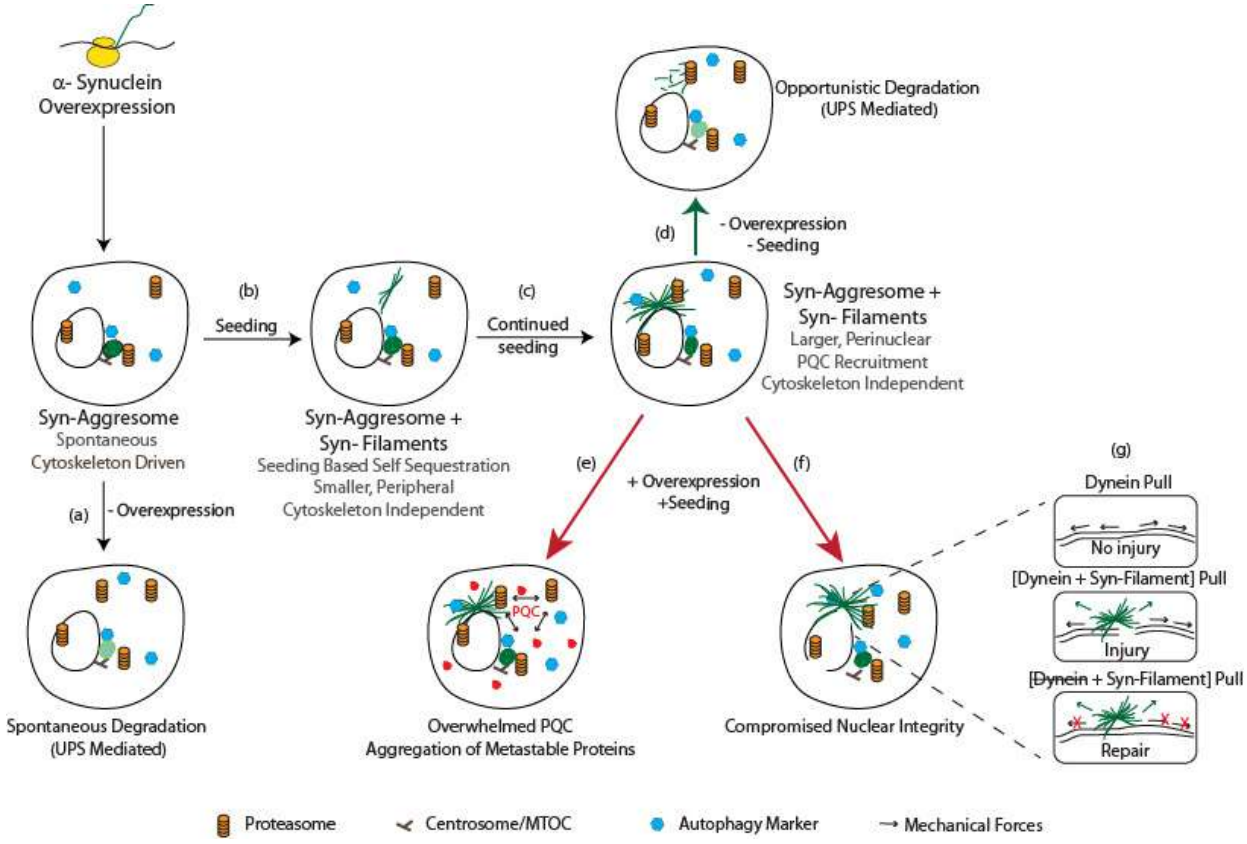
1. The turnover of individual RC-subunits and different RC-assemblies in different proteostasis-stress conditions
2. The sequence evolution of core and accessory subunits and the importance of evolved sequence signatures in mammalian RC-assembly and aggregation of the individual subunits

Cellular response to protein aggregation

Misfolded aggregation-prone proteins often sequester into perinuclear inclusion bodies called aggresomes for the purpose of ubiquitin-proteasome mediated degradation. Our recent work suggests that misfolding-prone α-Synuclein can be simultaneously deposited into perinuclear aggresome-like deposits (Syn-aggresomes) and perinuclear filamentous IBs (Syn-filaments) in same cells. We show that misfolded proteins accumulated in both these inclusions are UPS-degradable but over-grown Syn-filaments oversaturate cellular protein homeostasis and cause extensive damage to the nuclear envelope. In this background, we are investigating:

1. The cause and consequence of the perinuclear localization of α-Synuclein inclusion bodies
2. Why perinucleus is the preferred site for depositing misfolded protein aggregates for the purpose of quality control

In addition to these, we are involved in CSIR-Sickle Cell Anaemia mission mode project, analyzing the plasma proteome of patients.



Model depicting two distinct α-Synuclein inclusion bodies in the same cell offering unique homeostatic consequences: (a) Syn-aggresomes are formed spontaneously upon overexpression of α-Synuclein and assist UPS mediated degradation of the overexpressed protein. (b) Syn-filaments are induced by the addition of seeds in the same cells and are not recognized by PQC factors at early stage. (c) PQC components are recruited to over-grown perinuclear Syn-filaments. (d) Syn-filaments remain UPS-degradable upon withdrawal of seeds or after stopping α-Synuclein expression. (e) In case of continued polymerization, repurposing of PQC-factors to large Syn-filaments oversaturates proteostasis resulting in aggregation of other misfolding-prone proteins; in the current example FlucDM-mCherry (red). (f-g) Large Syn-filaments associate with nuclear envelope to weaken the lamina and dynein motor forces pull apart the nuclear lamina, resulting in extensive nuclear injury.

TUSHAR VAIDYA

Molecular Analysis of Host-Pathogen Interactions

From left to right: Satyajeet, Tushar Vaidya, Devi Prasad, Pradyumna, Ram Prasad

Research interests

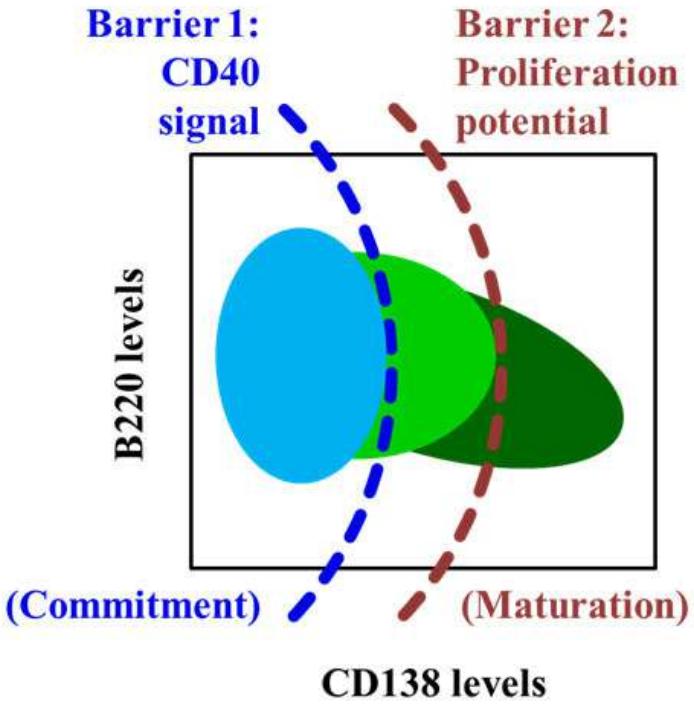
- Generation of immune memory in B lymphocytes
- Virulence mechanisms in *Leishmania*
- Machine Learning to understand regulation of Gene expression in *Leishmania*

Selected recent publications

- Satyajeet Salunkhe, Tushar Vaidya (2020) CD40-miRNA axis controls prospective cell fate determinants during B cell differentiation. ***Molecular Immunology.*** doi: 10.1016/j.molimm.2020.07.007

We study the role of CD40 mediated events (akin to T cell mediated help, *in vivo*) in the generation of immune memory in B lymphocytes. Previously we described how CD40 signal moves naïve B cells into an intermediate state that is neither naïve nor plasma cell. Our analyses of this intermediate "memory-like state" suggests that both CD40 signal and the proliferative status of the B cell are key determinants of B cell differentiation. Our experiments have also established the existence of a CD40-miRNA axis controlling determination of cell fate in B lymphocytes. Additionally, we have described how CD40 signaled B lymphocytes for homotypic aggregates in which cells at different locations are subjected to unequal doses of stimulants, leading to a hitherto unreported source of heterogeneity in cell fates.

Additionally, we are also investigating the regulation and function of key genes in in the protozoan pathogen, *Leishmania donovani*. We have categorized META1 as a potential drug target, given its involvement in virulence, secretory processes, and morphological integrity of *Leishmania*. We have also identified a pair of paralogs, DRG1 and 2 (Differentially Regulated Genes) which are evolutionarily highly conserved across Kinetoplastids, yet exhibit distinct gene expression and regulation, protein stability and cellular localisation. We have undertaken to machine-learn stable robust artificial-genetic-regulatory-networks (AGRN) based on known principles of gene-regulation and a Darwinian evolution for characterization of DRGs1&2; wherein, the regulation and function of DRG1 and DRG2 will be described by a consensus of clustering characteristics of genes in the learnt network.



Regulation of B cell differentiation. B cells undergo terminal differentiation to become plasma cells. During this process, they progressively accumulate CD138 and lose B220 from their surface. We identified that engaging CD40 signalling restricts the commitment to differentiate (light blue → light green), whereas, the proliferation potential of cells hinders the maturation of differentiation (light green → dark green).

VEGESNA RADHA

Signaling and Regulation of Cell Fate

From left to right: Tulasi, Murali, Gowthaman, Raghawan, Radha, Aswathy, Divya

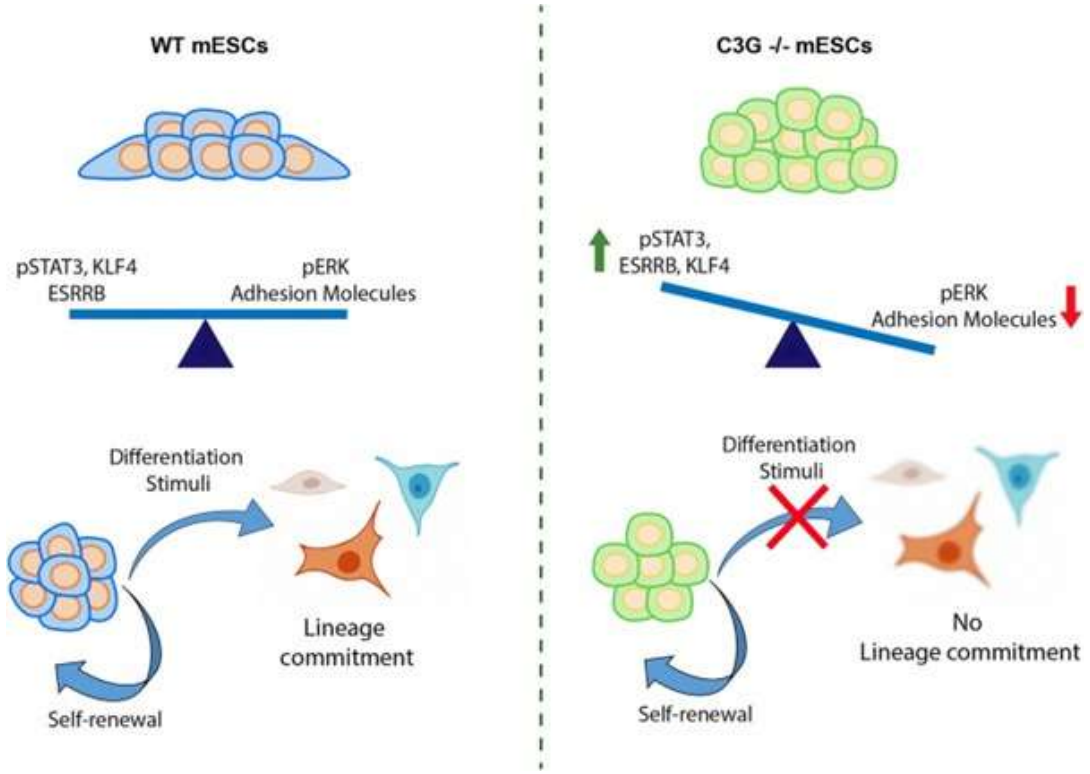
Research Interests

- Characterizing regulatory molecules of intracellular pathways leading to differentiation and cell death,
- Pathological situations due to their deregulation

Selected recent publications

- Sanjeev Chavan Nayak, Vegesna Radha (2020) C3G localizes to the mother centriole in a cenexin-dependent manner and regulates centrosome duplication and primary cilium length. ***J Cell Science.*** doi: 10.1242/jcs.243113
- Divya Sriram, Ramulu Chintala, B V V Parthasaradhi, Sanjeev Chavan Nayak, Indumathi Mariappan, Vegesna Radha (2020) Expression of a novel brain specific isoform of C3G is regulated during development. ***Scientific Reports.*** doi: 10.1038/s41598-020-75813-z
- Parvatam, S., Bharadwaj, S., Radha, V. (2020) The need to develop a framework for human-relevant research in India: Towards better disease models and drug discovery. ***J Biosciences.*** 45 - 144
- Sriram D, Dayma K, Devi AS, Raghawan AK, Rawat S, Radha V (2021) Complex formation and reciprocal regulation between GSK3beta and C3G. ***Biochim Biophys Acta Mol Cell Res.*** 868(5):118964

Over the past few years, we identified properties of RAPGEF1 (C3G) that explain its essential role in regulating cell fate decisions during embryonic development, as well as in adult tissues. During the year, we further analysed the functional consequence of reciprocal regulation between GSK3β, and RAPGEF1. Using mouse ES cells, we demonstrated that RAPGEF1 is essential for differentiation of these cells into the three embryonic lineages. Cells lacking RAPGEF1 show enhanced self renewal. Molecular analysis indicated that RAPGEF1 is essential for regulating STAT 5, ERK, and adhesion signaling (Figure). We also began work on understanding defective signaling caused by mutations in human RAPGEF1 that cause developmental defects (courtesy, Dr. Alexandre Raymond, Switzerland). Y485C mutation is associated with developmental delay, short stature, plagiocephaly, and Tetralogy of Fallot. Our experiments revealed that Y485 is a target site for phosphorylation by c-Abl, and the Y485C mutant is defective in its catalytic activity. We have initiated experiments using the zebrafish model system to understand the importance of RAPGEF1 for vertebrate development. Using an inhouse raised monoclonal antibody, we showed ubiquitous expression in embryos and adult tissues, and also detected a unique alternately spliced isoform expressed in the adult brain. Knockdown of RAPGEF1 expression using morpholinos showed CNS and eye development defects in 1 day old embryos. These findings enhance our understanding of the molecular control of early embryonic development in vertebrates, and explain why loss of RapGEF1 causes early embryonic lethality.



In murine embryonic stem cells (mESCs), RAPGEF1 (C3G) is essential for repressing molecules essential for self renewal (activation of STAT3 and expression of KLF4 and ESRRB), and activation of ERK, and adhesion signaling to enable lineage differentiation in the presence of differentiation stimuli. mESCs lacking C3G self-renew, and are unable to differentiate even in the presence of differentiation stimuli.

VENKAT CHALAMCHARLA

Transcription and Chromatin Regulation

From left to right: Mamta Nirmal, Annapoorna KP, Venkat Chalamcharla, Anubhav Bhardwaj, Harsh Kapoor, Sauvik DasNaskar

Research interests

- Regulation of transcriptional elongation and termination for gene control in non-dividing and dividing eukaryotic cells

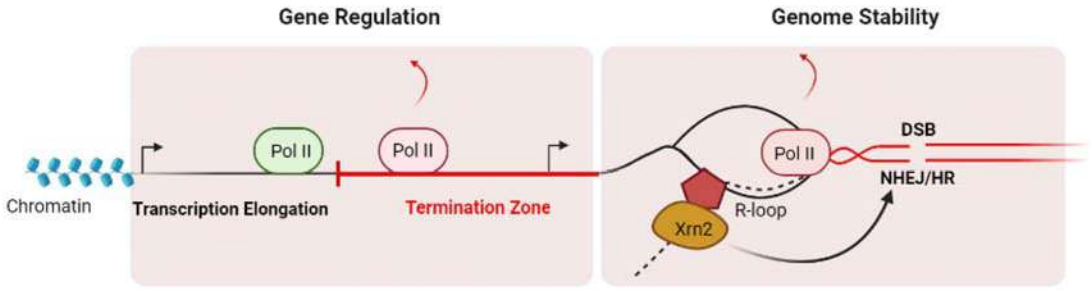
Transcription termination is a fundamental process that defines the end of the transcription unit. In eukaryotes, it has become clear that transcription termination by RNA Polymerase II (Pol II) has a critical role in gene regulation and genome maintenance. Although the Pol II termination process and the machinery occupy an increasingly important place in human health and disease, the underlying mechanisms remain poorly understood. Using the fission yeast *Schizosaccharomyces pombe* as a model organism, our current objectives are to understand:

1) how transcriptional exit (elongation-termination transition) is signalled at gene ends with canonical polyadenylation signals,

2) the roles of RNA and transcription termination in DNA double strand break repair, and

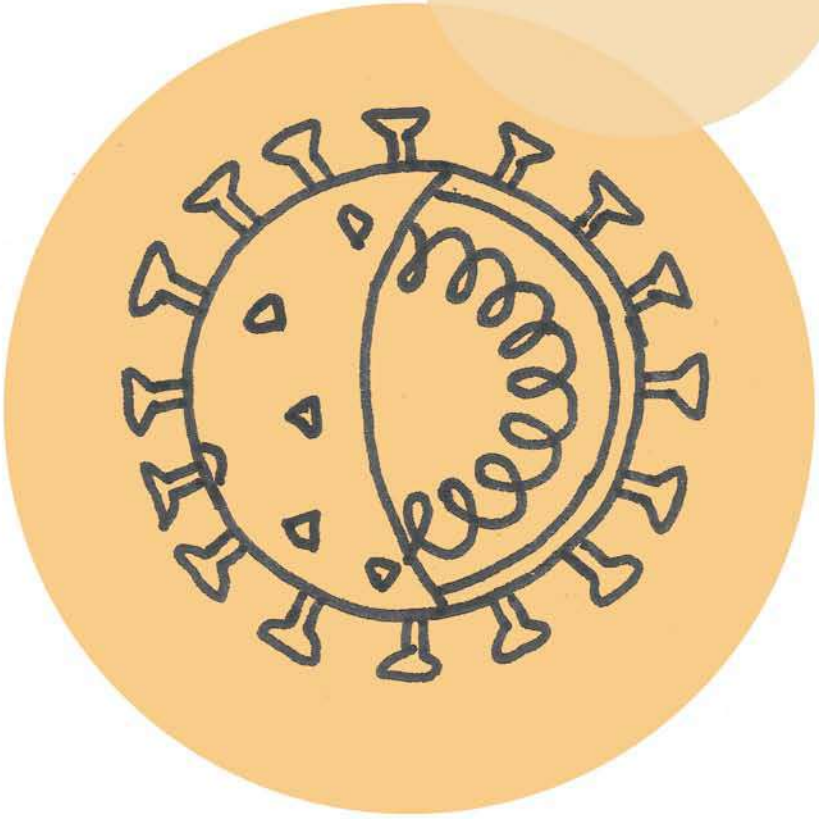
3) how transcription termination affects chromatin organization in eukaryotes.

To this end, we have identified a key determinant of the Cdk9-PP1 kinase-phosphatase switch that triggers Pol II termination, and advanced our understanding of how the termination factor Xrn2 influences non-homologous end joining (NHEJ) and homologous recombination (HR) repair pathway choice in proliferating *S. pombe* cells. Moreover, we have identified several transcriptional and chromatin regulators required for the long-term maintenance of the cellular quiescence (non-dividing, G0 phase) in *S. pombe*. Active maintenance of the quiescence gene expression program, and transcriptional reprogramming to prioritize cell growth in response to a wide range of mitogenic signals, governs the remarkable longevity of quiescent G0 cells. Advances in fundamental understanding of cellular quiescence will benefit several fields relevant to human health, such as stem cell biology and cancer biology.



Schematic representation of the transcription termination process as a regulator of gene expression and genome stability in eukaryotic cells. Pol II, RNA Polymerase II; Red arrow indicates the dissociation of Pol II from the chromatin template, R-loops, RNA-DNA hybrids, DSB, double strand break; NHEJ, non-homologous end joining; HR, homologous recombination.

1.1B COVID-19 Contributions

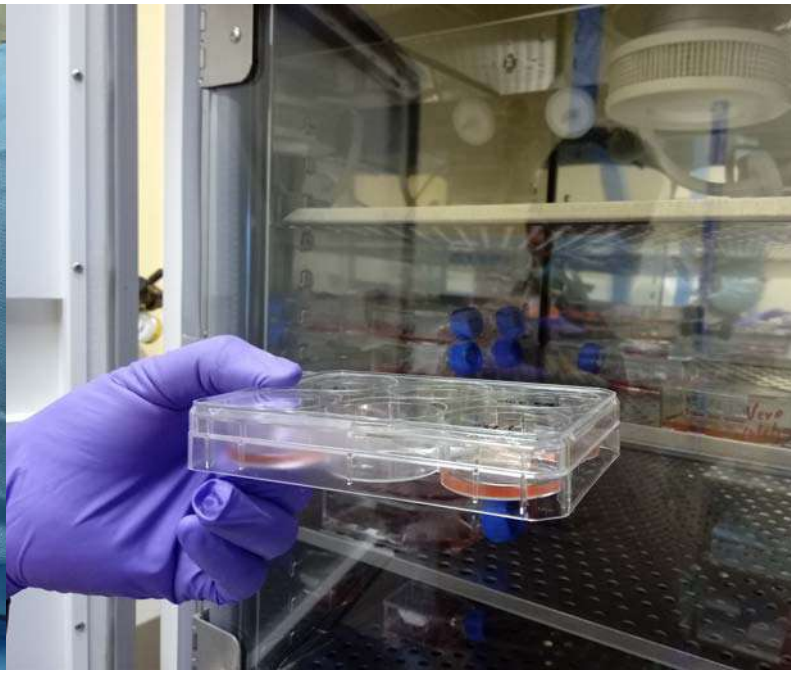


SETTING UP COVID-19 TESTING AND SARS-COV-2 CULTURING

Dhiviya Vedagiri, Divya Gupta and Krishnan H Harshan

By the end of March, 2020, CCMB set up the diagnostic facility to screen patient samples for COVID-19. I coordinated this with the assistance from Drs. Archana Siva and Karthik Bharadwaj. We set up the testing facility in the biosafety level-3 (BSL-3) lab of CCMB. A large number of student volunteers joined in this venture and CCMB became the first research institution in India to set up COVID-19 diagnostic facility. This successful initiative led to several other research institutions across the country establishing such diagnostic facilities, considerably assisting in the fight against COVID-19.

Following the setting up of diagnostic facility, our laboratory initiated the isolation and establishment of SARS-CoV-2 cultures from patient samples. We successfully did that in a short time and became the second lab in India to set up SARS-CoV-2 cultures. My laboratory then set up a platform to screen drug candidates against SARS-CoV-2 that was successfully employed by CCMB to test hundreds of potential molecules so far. We currently have established cultures of several variants of SARS-CoV-2 and use them for understanding fundamental biology of COVID-19 and also to develop various products by industry.



Left: SARS-CoV-2 diagnostics lab at CCMB
Right: SARS-CoV-2 cultures at CCMB

DRY-SWAB METHOD FOR RT-PCR - BASED COVID-19 DIAGNOSTICS: TECHNOLOGY DEVELOPMENT & COMMERCIALIZATION

Technical Team - Sai Uday Kiran, CG Gokulan, Santosh Kumar Kuncha, T Karthik Bharadwaj, Rakesh K Mishra
Commercial Team - Divya Singh, Archana B Siva

A RNA extraction-free dry swab method for RT-PCR based detection of SARS-CoV-2 has been developed by CSIR-CCMB, Hyderabad. This method does not require use of viral transfer medium (VTM) and also does not require RNA extraction step as compared to standard PCR test and, therefore, saves cost, time and, very importantly, is much safer for the healthcare workers involved in COVID-19 testing.

This method involves collection of a VTM less dry oropharyngeal / nasopharyngeal swab from suspect SARS-COV-2 patients. The swab is then transported to the lab wherein Tris-EDTA- Proteinase K buffer is added, and the sample is incubated for 30 minutes at room temperature. The sample is then subjected to heat inactivation at 98°C for 6 minutes. The extract is then used for RT-PCR. A schematic representation of the method is shown in Fig. 1.

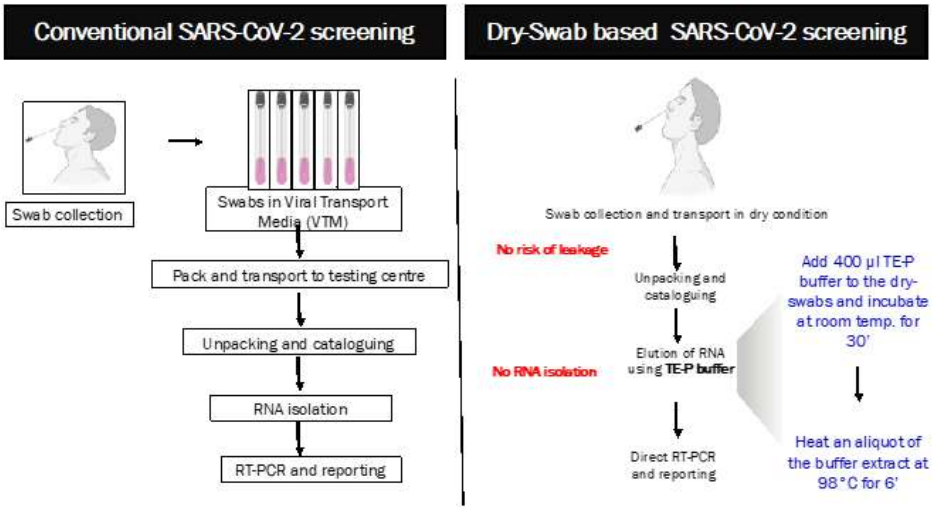


Fig 1. Schematic representation of the dry swab method vs the conventional VTM-based RT-PCR method

Post-ICMR approval, the dry swab technology/ know-how has been transferred so far to five Industry partners:

- Spice Health Limited, New Delhi
- Apollo Hospitals, Hyderabad
- Meril Diagnostics Limited, Vapi
- Capital Health Services India Pvt Ltd, Hyderabad
- Biosmart Technologies, Mumbai

On-site/hands-on and online trainings on the Dry-Swab technology have been conducted and more than 500 people have been trained.

The timeline for dry swab technology development & commercialization can be seen in Fig 2.

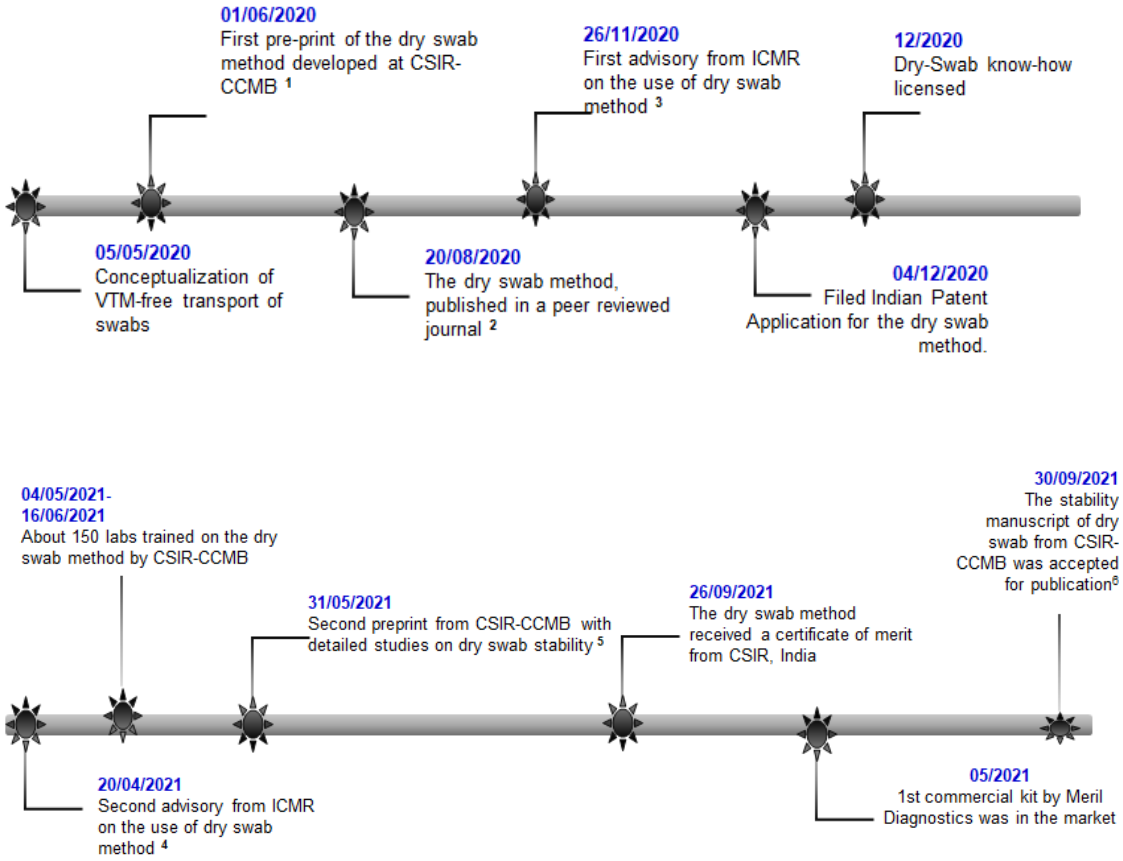


Fig 2: Timeline for dry swab technology development & commercialization

ANTIGEN DETECTION TESTS FOR SARS-COV-2

Vishnu Vijay, Chandra Shekar, Ch. Varalakshmi, Zareena Begum, D. Parthasaradhi, Vegesna Radha

Antigen Detection (AD) tests based on specific monoclonal antibodies are more rapid, less laborious and less expensive. They have been critical in the face of the global COVID-19 pandemic as they have immense application in diagnostics, and as a research tool. Using the expertise available at CCMB, we produced several mouse anti-SARS-CoV-2 monoclonal antibodies using purified recombinant Nucleocapsid (N) protein as antigen.

The clones were characterized, and they exhibit robust performance in direct as well as sandwich ELISA assays. Examination by western blotting indicated that these monoclonal antibodies can recognize the denatured N protein specifically, and also detect the native viral protein in vero cells infected with SARS-CoV2 (Fig. 1). In addition, the antibodies could be used to detect the presence of virus in infected cells by indirect immunofluorescence assays (Fig. 2). Due to their mouse origin, these monoclonals are compatible with the experimental immunoassay setups providing a useful tool for future research. They can be utilized also for development of serological standards for quantitative assessment of antibody titers *in sera*. The monoclonal antibodies against SARS-CoV-2 nucleocapsid proteins that have been produced, might form the basis for a future rapid point of care test.

Fig. 1

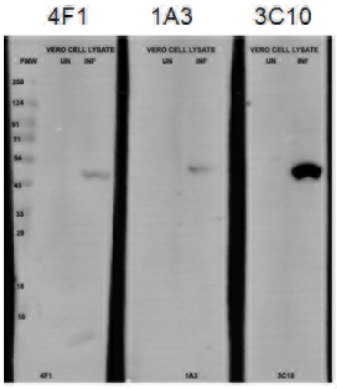


Fig. 2

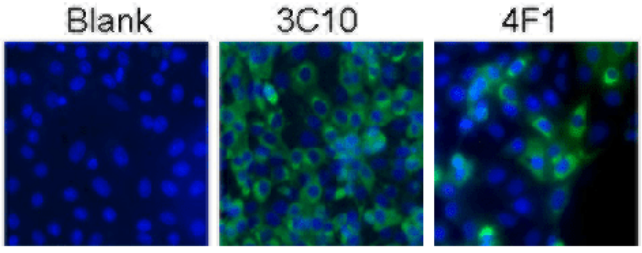


Fig 1. N-protein is detected specifically in lysates of Vero cells infected with the SARS-CoV-2 virus.
Fig 2. Vero cells infected with SARS-CoV-2

SEROLOGICAL TEST FOR COVID-19 EXPOSURE AT POPULATION LEVEL

Puran Singh Sijwali and Manjula Reddy

- Stable HEK293T cell lines expressing the nucleocapsid-strepII fusion protein were generated.
- Recombinant nucleocapsid-strepII was purified from the cytosolic fraction, with a typical yield of ≈100 µg/180 ml confluent culture (Figure 1).
- Successfully developed and validated a Nucleocapsid protein-based ELISA platform, which has been termed the CoviSET (COVID-19 Serology ELISA Test).
- CoviSET platform detected antibodies in 75% RT-PCR positive COVID-19 subjects and 41% healthy subjects (Figure 2).
- CoviSET ELISA plates can be stored at -30°C for at least 3 months without any loss of performance and the assay can be done in 3 hours.
- Nucleocapsid and spike S1 and S2 domains were also successfully expressed using E. coli expression systems.

CoviSET platform is available in the form of a kit, and the SOP has been shared with CCMB business cell for commercialization.

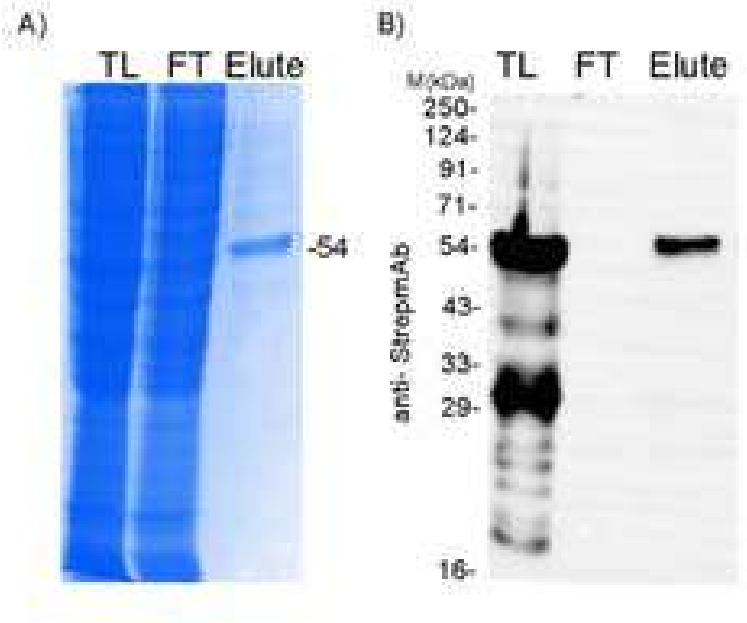


Fig 1. Production of recombinant nucleocapsid protein. The nucleocapsid protein was expressed in HEK293T cells. A) The coomassie-stained SDS-PAGE gel shows total cell lysate (TL), flow-through (FT) after incubation with the resin and elution sample (Elute) containing recombinant nucleocapsid at ≈54 kDa. B) The western blot with anti-StrepMAB shows reactivity with nucleocapsid protein in different lanes as mentioned in "A". The protein marker sizes are in kDa.

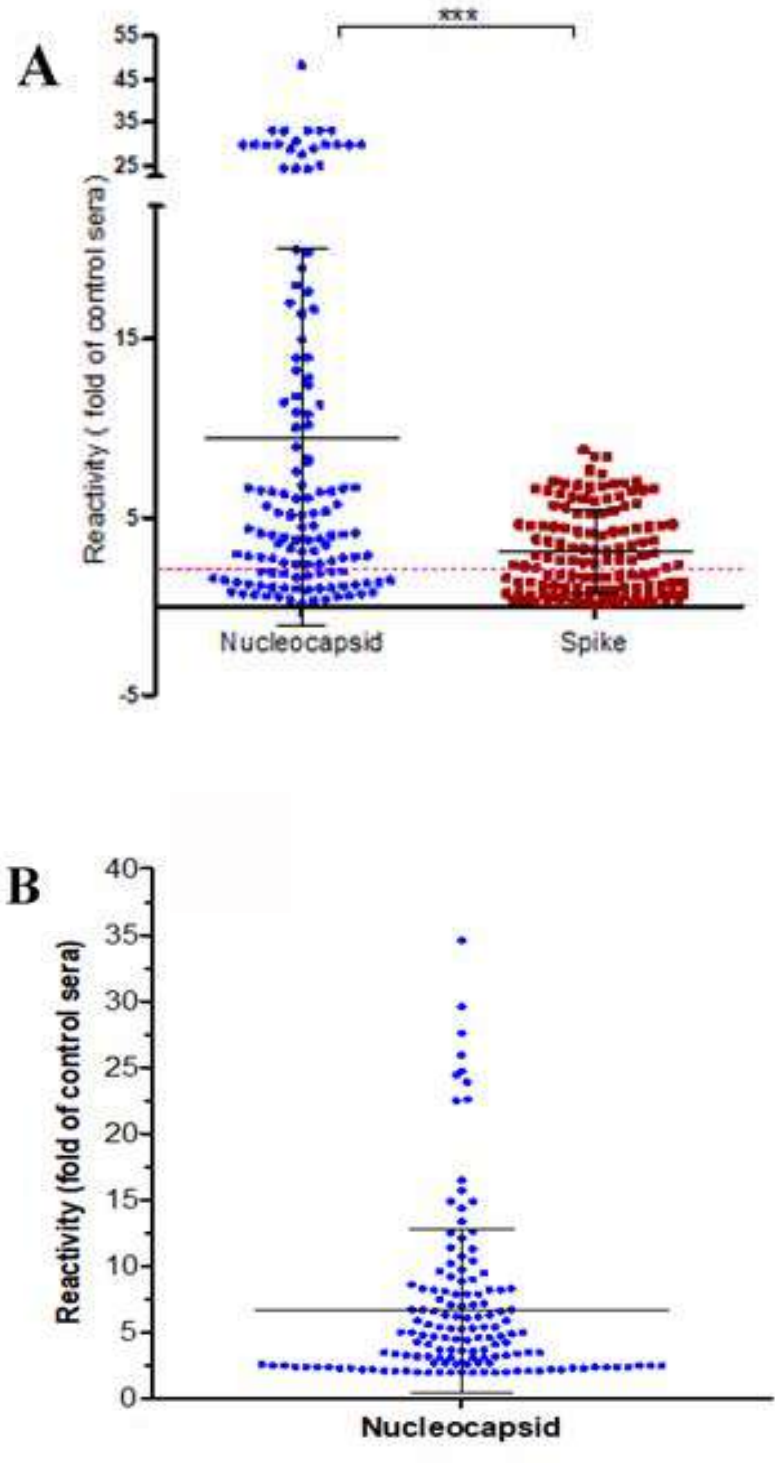


Fig 2. Serosurvey using the CoviSET platform. Plasma from RT-PCR positive subjects (A) and potentially exposed subjects (B) were assessed for the presence of antibodies to nucleocapsid and spike using the CoviSET platform. The figure "A" shows comparison of reactivity to nucleocapsid and spike proteins and figure "B" indicates prior exposure to SARS-CoV-2.

DEVELOPMENT OF AN INACTIVATED SARS-COV2 VACCINE FOR COVID-19 (ICOV2VAC)

Puran Singh Sijwali and Krishnan H Harshan

- Successfully developed a procedure to isolate and culture clinical isolates of SARS-CoV-2 in the laboratory, which is being used for characterization of different strains as well (Figure 1).
- Succeeded in developing a procedure to obtain pure inactivated SARS-CoV-2 preparation, which can be adapted to other SARS-CoV-2 strains (Figure 2).
- Developed a high-throughput microneutralization assay to determine neutralizing efficiency of antisera, which is being used to compare vaccination response in people and assess the neutralizing ability of antisera to emerging variants.
- Assessed immunogenicity of the inactivated SARS-CoV-2 preparation in mice and hamsters using five adjuvants. AddaVax and ASO3 were found to be comparable with alum in generating antibody response (Figure 3).

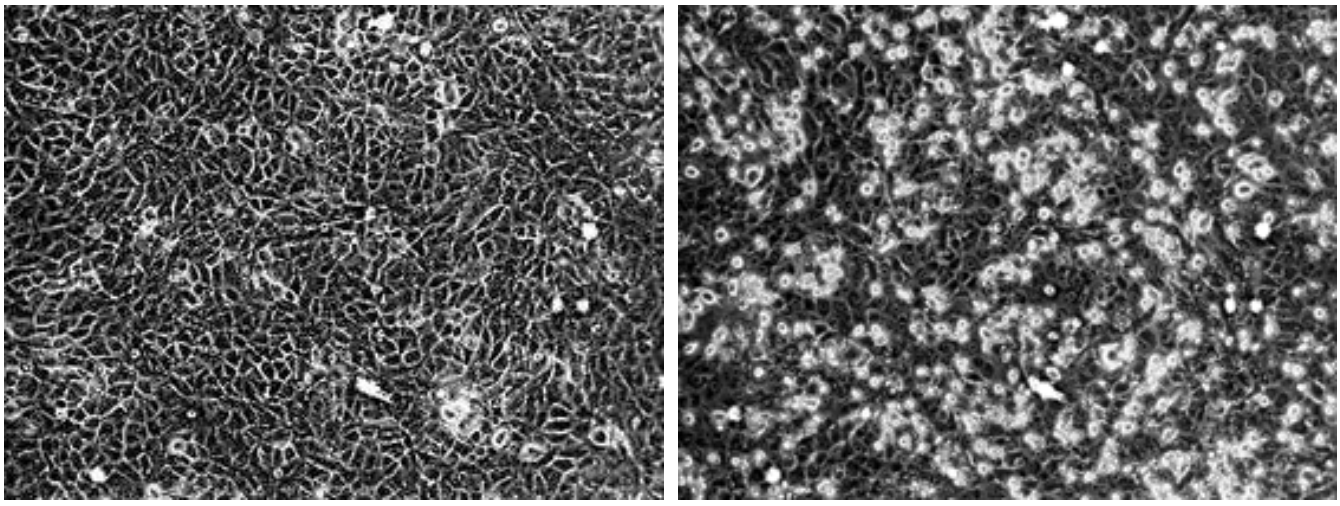


Fig 1. *In vitro* culture of SARS-CoV-2. Shown are the images of uninfected (left) and SARS-CoV2 infected (right) Vero cells. The shiny areas in the right image are of cells dying of infection.

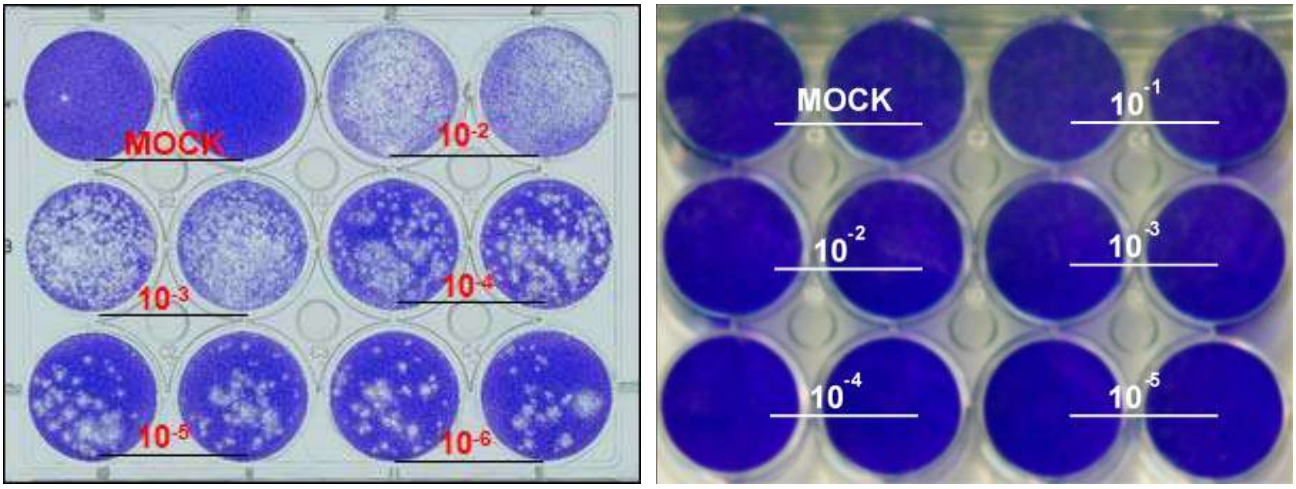


Fig 2. Inactivation of SARS-CoV-2. The infectious virus titer was measured by plaque forming assay. On the left is a representative plaque plate image where the clear zones are defined as plaques. Wells indicated with "MOCK" are of uninfected cells and the remaining wells contained the indicated dilution of the virus. Inactivation of virus by beta-propiolactone (BPL) renders virus unable to infect and make plaques as shown in the right image. MOCK represents uninfected cells and the remaining wells contained the indicated dilution of inactivated virus.

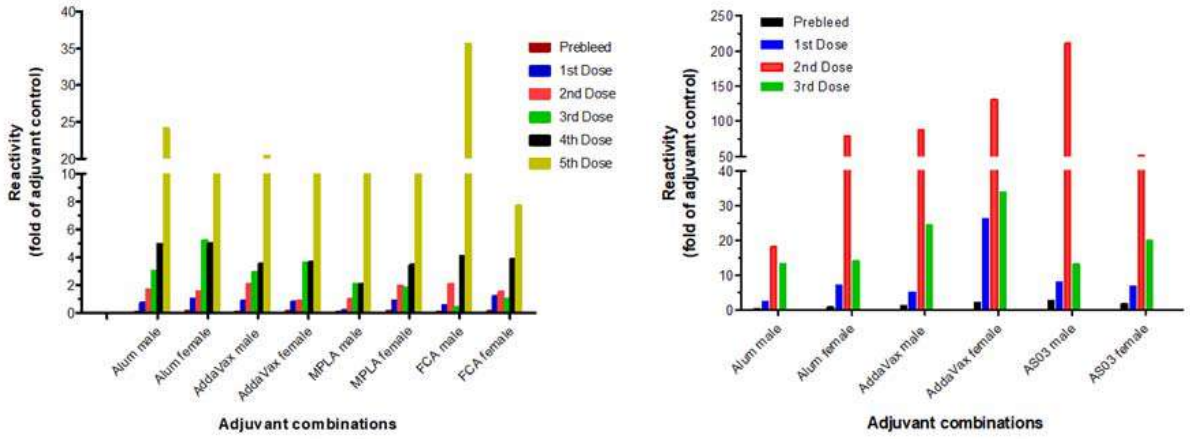


Fig 3. Antibody response in animals. Mice (top) and hamsters (bottom) were immunized with combinations of inactivated SARS-CoV2 and adjuvants (alum, addaVax, MPLA, ASO3 and FCA). Blood was collected before the 1st immunization dose (prebleed) and 10-12 days after each immunization dose. Antisera were assessed for reactivity against the inactivated SARS-CoV-2 by ELISA. Reactivity of antisera are shown as fold increase over the reactivity of respective adjuvant control.

DEVELOPMENT OF EQUINE IMMUNOGLOBULIN FRAGMENT F(AB')2 WITH HIGH NEUTRALIZING CAPABILITY AGAINST SARS-COV-2

Divya Gupta, Dixit Tandel, Haripriya Parthasarathy, Dhiviya Vedagiri, Vishal Sah and Krishnan H Harshan

While vaccines are effective in controlling the prospective infections, therapeutic agents are important in treating the infected individuals. Currently, there are no direct antivirals effective against SARS-CoV-2.

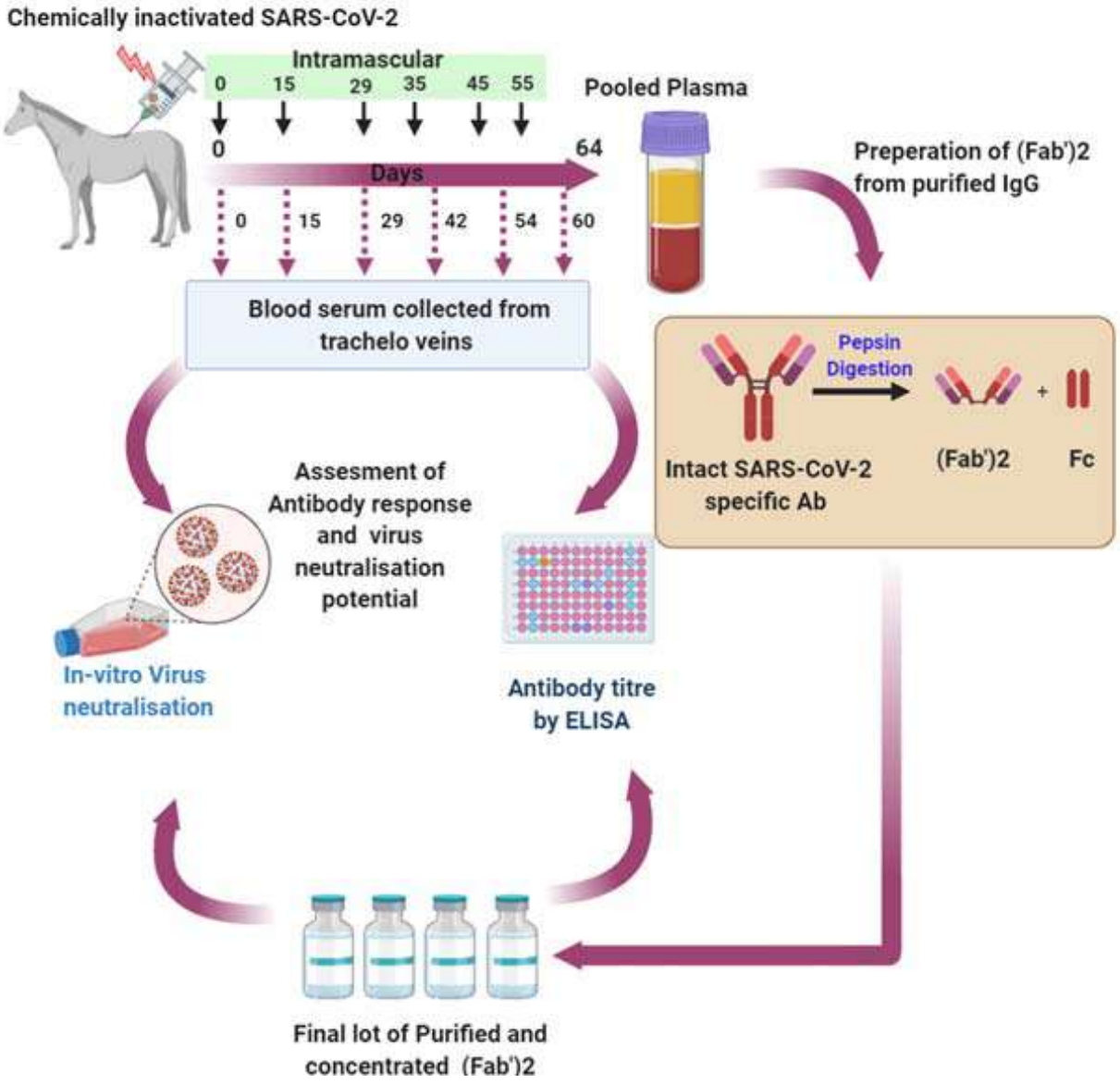
Passive immunotherapy by neutralizing antibodies can be an important tool in treating severe cases of COVID-19. Neutralizing monoclonal antibodies against specific epitopes of "Spike" are in the market, however are unaffordable to most patients. In addition, its efficacy against the emerging variants is debatable.

Equines have been considered a suitable host to generate antibodies against various antigens including infectious agents. Antibodies generated in equines against rabies and snake venom have been successfully used in patients. In this project, CCMB collaborated with VINS Bioproducts (VBS) and University of Hyderabad to generate purified equine F(ab')2 fragments of neutralizing antibodies against SARS-CoV-2 (Figure 1). Chemically inactivated whole SARS-CoV-2 isolated in CCMB were used to immunize equines at VBS to generate antisera that were further purified to generate F(ab')2 fragments.

The F(ab')2 fragments were subsequently tested for their SARS-CoV-2 neutralizing capacity in CCMB.

Our studies have demonstrated that equines hyper-immunized with these fragments elicit high antibody titers with a strong virus-neutralizing potential. *In vitro* microneutralization assays demonstrated high SARS-CoV-2 neutralization titers of F(ab')2 fragments (300CCID50) as high as 25,000. Upon interpretation, 1mL of the product at this titer is technically capable of inactivating over 107 viral particles in culture. The F(ab')2 efficiently cross neutralized other SARS-CoV-2 strains, demonstrating its efficacy against the emerging viral variants. Pharmacokinetic study of F(ab')2 in rabbits demonstrated approximate plasma half-life of 47 hours signifying the linear pharmacokinetics property.

In conclusion, this study demonstrates that virus-neutralizing antibodies raised in equines have high potential to be used as a treatment regimen in the form of effective passive immunotherapy to combat COVID-19. The product is undergoing clinical trials currently.



Schematic of the development of anti-SARS-CoV-2 specific F(ab')2 with High Neutralizing Capability from equines

PSEUDO-CAPSID OF SARS-COV-2 AS A POTENTIAL VACCINE CANDIDATE

Manjula Reddy

SARS-CoV2 is an enveloped virus with a host-derived lipid membrane. The viral capsid assembly of SARS-CoV2 requires a membrane glycoprotein, M and an envelope protein E, both of which are highly hydrophobic proteins embedded in the lipid membrane conferring curvature to the virion. It is earlier known that co-expression of M and E proteins allows formation of stable virus-like protein structures (pseudo-capsid). Based on this observation, we made attempts to make the pseudo-capsid of SARS-CoV-2 virus with recombinant M and E proteins.

We cloned the genes encoding both M and E proteins in various expression systems (bacterial, mammalian or insect cell). However, these proteins are not overexpressed in any of the systems tested above and further standardization is required to co-express these proteins. Using pseudo-capsid structures may offer higher immune protection compared to the single subunit vaccine because of their stability and structural resemblance to the live viral particles.

POST-VACCINATION MONITORING OF MEMORY IMMUNE RESPONSES AGAINST COVID-19

Santosh Kumar & Puran Singh Sijwali

India has been undergoing mass vaccination against COVID-19. Majority of vaccinated Indian population have so far received Covishield or Covaxin. How long the protection provided by these vaccines would last is unclear.

We are working to follow up the kinetics of SARS-CoV-2-specific antibody and T cell responses in individuals, who received any of the two vaccines, over a period of 2 years. The information generated from this study could reveal the parameters that govern vaccine efficacy, and could provide clues for further refinement and development of vaccines if needed.

CELL-BASED PLATFORM FOR TESTING ANTI-COVID DRUGS, FORMULATIONS/SOLUTIONS

B Kiran Kumar

CCMB is been actively involved in isolating and culturing SARS-CoV-2 from Indian patients. Using these viral isolates, we have established cell-based assays to screen potential antiviral compounds, nano formulations and sterilization solutions. In addition, we are also isolating and culturing SARS-CoV-2 variants circulating in the country. From the screening we have identified few potential targets showing antiviral activity against SARS-CoV-2. We have supported several academic institutions, CSIR labs, MSMEs and industries and extended our support to the ongoing drug discovery efforts/solutions.

Now, we are in the process of scaling up a medium to high-throughput antiviral screening facility at CCMB, which will augment our capacity. During this ongoing pandemic, we have tested the potential drug candidates against SARS-CoV-2 designed by several CSIR labs and industries, for their antiviral activity before initiating preclinical studies. This does not only fast track the ongoing drug discovery/solutions, but also helps in building expertise and infrastructure required for antiviral platforms.

MONITORING VIRAL EVOLUTION WITH GENOME SEQUENCING

Sofia Banu, Payel Mukherjee, Priya Singh, Surabhi Srivastava, Lamuk Zaveri, Divya Tej Sowpati

SARS-CoV-2 undergoes constant mutations like all other viruses. While most mutations are of little to no consequence, sometimes the virus accumulates a mutation that gives it an advantage over other strains. For example, early into the pandemic, a viral strain appeared containing the mutation D614G (the amino acid D at 614 position mutated into G) in its Spike protein. This mutation offered a transmission advantage to the virus compared to the original Wuhan version, and therefore successfully replaced the original virus across the globe. Other viral variants with advantages have appeared globally, such as the Alpha (first identified in the UK), Beta (identified in South Africa), Gamma (identified in Brazil), and most notoriously the Delta variant (first identified in India). Some of these variants transmit with higher efficiency, or can bypass existing immunity (both natural as well as vaccine-induced), or have a combination of both. Hence, tracking new variants is relevant for identifying and preventing outbreaks, and in the context of vaccines and therapeutics developed globally.

At CCMB, we have been tracking SARS-CoV-2 variants by sequencing viral samples to decipher spatio-temporal trends of viral spread and evolution (https://data.ccmb.res.in/gear19/). An approach to do this is by using primers that span the entire 30 kb viral genome, amplify using PCR, and then

sequence the amplified products on an NGS machine such as the Illumina or Oxford Nanopore platforms. The data is then compared against the reference viral genome and mutations are identified computationally. Finally, the genomes are analyzed in the context of other metadata such as host demographics, clinical outcomes and geographical and epidemiological factors. This enables us to identify the variants or mutations that are either gaining or losing prevalence, and therefore flag them effectively.

TESTING LARGE CATS FOR SARS-COV-2 IN ZOOS

Karthikeyan Vasudevan

SARS-CoV-2 infections in humans reportedly emerged from a cross-species pathogen transmission event that happened in Wuhan, China, in December 2019. There is also now a growing body of data indicating that the virus infects several companion animals and captive wild animal species, particularly big cats. Understanding susceptibility of animals to SARS-CoV-2 would help identify potential reservoirs and sources of infection that are of importance for animals and humans.

Tigers, African lions, snow leopards, puma and Asiatic lions have been infected with SARS-CoV-2 globally. Epidemiological and genomic studies of the pathogen from infected tigers and lions of Bronx zoo have shown that transmission of virus from human to captive big cats is possible. Based on these reports the Central Zoo Authority (CZA) advised collection of samples from captive big cats with suspected cases of infection by SARS-CoV-2 and be sent to designated institutions. In addition to the three recognized labs for animal testing, Centre for Cellular and Molecular Biology – Laboratory for Conservation of Endangered Species (CCMB-LaCONES) was recognized for testing of samples from zoos for SARS CoV-2.

Following this, CCMB scientists prepared guidelines for collection, preservation and transport of samples collected for SARS CoV-2 testing and related information for zoos. In August 2020, four samples from Asiatic lions that showed symptoms of respiratory distress in Nehru Zoological Park, Hyderabad were tested for SARS-CoV-2 and reports were shared with the zoo authorities for taking necessary steps. CCMB scientists further engaged with other recognized labs and CZA for testing wild animals to develop standardized methods for SARS-CoV-2 tests.

PUBLICATIONS ON SARS-COV-2 & COVID-19

- S Banu, B Jolly, P Mukherjee, P Singh, S Khan, L Zaveri, S Shambhavi, Rakesh K Mishra (2020) A distinct phylogenetic cluster of Indian severe acute respiratory syndrome coronavirus 2 isolates. ***Open Forum Infectious Diseases.*** doi: 10.1093/ofid/ofaa434

- S Karak, S Srivastava, RK Mishra (2020) Testing and surveillance strategies in the context of COVID-19 in India. ***Indian Chemical Engineer.*** 62 - 343-350

- Uday Kiran, C G Gokulan, Santosh Kumar Kuncha, Dhiviya Vedagiri, Bingi Thrilok Chander, Aedula Vinaya Sekhar, Suchitra Dontamala, Arakatla Lohith Reddy, Karthik Bharadwaj Tallapaka, Rakesh K Mishra, Krishnan Harinivas Harshan (2020) Easing diagnosis and pushing the detection limits of SARS-CoV-2. ***Biology Methods and Protocols.*** doi.org/10.1093/biomethods/bpaa017

- S Srivastava, S Banu, P Singh, DT Sowpati, RK Mishra (2021) SARS-CoV-2 genomics: An Indian perspective on sequencing viral variants. ***Journal of Biosciences.*** 46 - 1-14

- Somdatta Karak & Vegesna Radha (2020) Understanding the SARS-CoV-2 to manage COVID-19. ***Indian J Cardiovascular Disease in Women.*** 5(03) - 285-293

ADVISORIES ON SARS-COV-2 & COVID-19

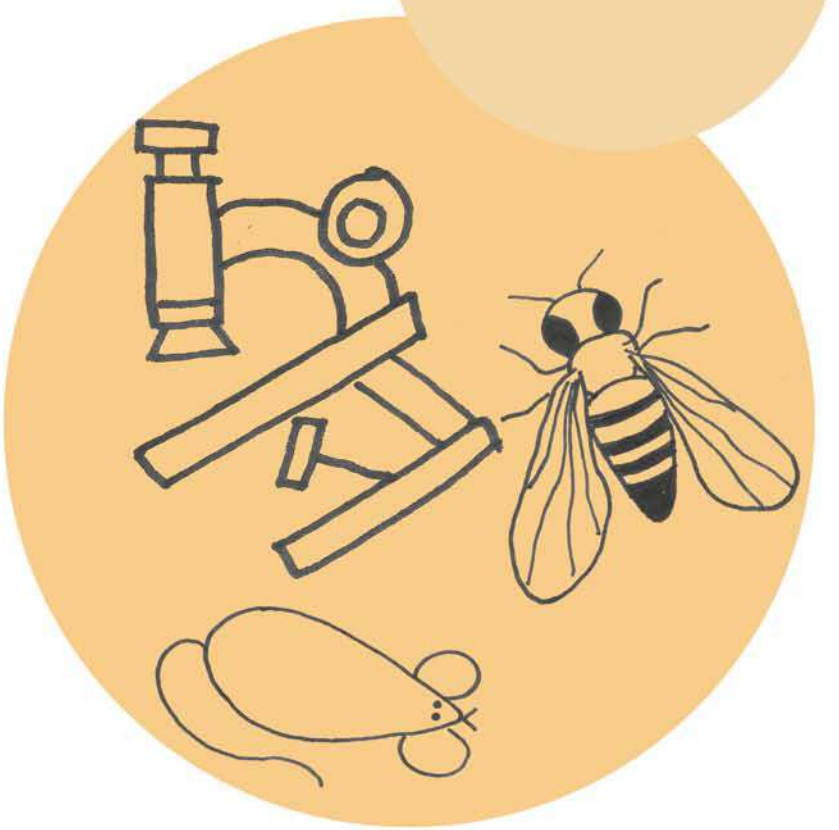
- https://www.icmr.gov.in/pdf/covid/techdoc/archive/Advisory_Dry_Swab_RNAExtraction_26112020.pdf

- https://www.icmr.gov.in/pdf/covid/techdoc/Advisory_Dry_Swab_RNAExtraction_20042021_.pdf

- http://covid-19.ccmb.res.in/advisory-on-fighting-coronavirus/

- Shibba Takkar, Maddury Jyotsna, Prerna Goyal, Anurag Chaudhary, Sujatha Vipperla, Yellapragada Hemalatha, Vandana Midha, Mary John, Amrutha Kakollu, Pooja Tandon, Suman Puri, Hari Anupama,Gagan Priya, Benzeeta Pinto,Vinitha P. Reddy, Monica M. Irukul (2020) Consensus Scientific Statement on Advisory Working Guidelines and Recommendations for the Female Population in COVID-19 Era by WINCARS. ***Indian J Cardiovascular Disease in Women.*** 5(03) - 75-194

1.1C Research Facilities



Advanced Microscopy and Imaging Facility (AMIF)

Atomic Force Microscope (AFM)

Nanonics Imaging Ltd (Multiview 1000) Atomic force microscope (AFM) is a high-resolution scanning probe microscope which gives a topographic image of the sample surface. From the height and distance profiles drawn on these images, the diameter of spherical structures can also be measured.

Working Principle: In the AFM probe a cantilever with glass tip is mounted onto a tuning fork which exerts a normal force onto the sample. The oscillation of the tuning fork, whose resonance is typically 30-40 kHz, is actuated and subsequently monitored for changes in frequency, amplitude, quality factor, and phase.

Samples that can be analyzed by AFM: Biological assemblies as diverse as multi subunit enzymes, viral capsids, bacteria, biofilms, molecular nets, nucleosomes, biological membrane components, protein aggregates, amyloids and organic/inorganic nanomaterials.

Left to right : Angothu Ramesh, Suman Bandari, Nandini Rangaraj, Chivukula Subbalakshmi, N Ravi Chakravarthi, Adicharla Harikrishna

Raman Spectroscopy and Raman Rapid Imaging Model: RENISHAW InVia Raman Microscope

In Raman spectroscopy, the sample is illuminated with a monochromatic laser beam (532 nm, 633 nm and 780 nm) and the Raman spectrum is obtained from the resultant inelastic scattered light intensity, as a function of frequency shifts. From the characteristic Raman frequencies, the chemical composition of a sample can be obtained.

Raman rapid imaging is done using Stream Line technique by acquiring data from different points on the sample to generate maps based on parameters of resulting spectra.

Samples that can be analyzed using Raman Microscope: Biofluids, fixed and live cells, thick tissue specimens, bacteria, plant materials, drugs, semiconductors, nanomaterials, polymers, proteins, organic and inorganic compounds.

Scanning Electron Microscope

Hitachi S3400N Scanning electron microscopy (SEM) uses a finely focused beam of electrons in order to produce a high resolution image of the surface structure of a sample by detecting the secondary electrons resulting from interactions of the electron beam with atoms at various depths within the sample.

Samples that can be analyzed using SEM: Nanomaterials, bacteria, normal and tumor cells, organic and inorganic materials, dental and bone implants among others.

It is also equipped with confocal, live-cell confocal, high resolution, super resolution and regular microscopes

Confocal Microscopes

Models: Leica TCS SP8, Zeiss LSM 880, Olympus FV 3000

Confocal microscope scans specimens in the XY-plane along with the Z-plane thus allowing data collection in 3D. The users are provided with additional computers and suitable software for data analysis while the main systems are being used for data acquisition. This facility uses inverted microscopes with various objectives and receives illumination from various laser lines (405, 458, 477, 488, 514, 532, 543, 561, 594 and 633 nm).

The systems are provided with facilities for scanning and analysis of single and multi- labeled samples combined with DIC, 3D reconstruction, kinetic analysis, ratio analysis, spectral analysis, Fluorescence Recovery after Photo bleaching (FRAP) and Fluorescence Resonance Energy Transfer (FRET).

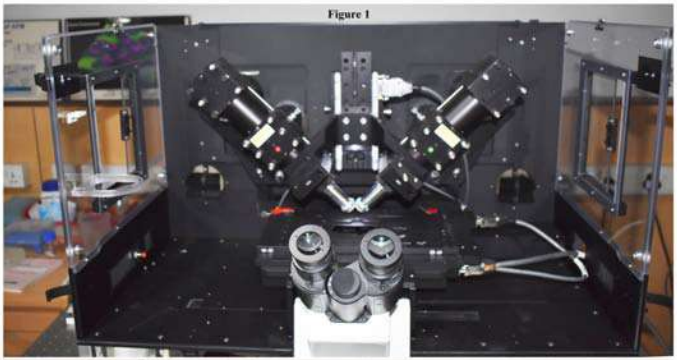
The Leica TCS SP8 is a classical confocal microscope. It has three PMT detectors and additional two highly sensitive hybrid detectors.

The Zeiss LSM 880 is a high resolution confocal microscope. In a classical confocal microscope, the pinhole is set at 1 AU which improves resolution by a factor of 1.06. The resolution can be further increased by making the pinhole smaller but the signal to noise ratio drops significantly. The Zeiss LSM 880 has a hexagonal microlens array that connects to a linear GaAsP detector which collects all light of an airy disk simultaneously. Each detector element functions as a single very small pinhole of 0.2 AU. This enables efficient imaging by making use of all the photons collected by the objective. This gives a resolution of 140 nm laterally and 400 nm axially.

The Olympus FV 3000 is a live cell Laser Scanning Confocal microscope for real-time imaging with solid state lasers and GaAsP detectors. It also has an additional chamber for maintaining samples at temperatures ranging from ambient to 40°C with continuous supply of CO2 for imaging live samples over long time periods.

The facility has recently been equipped with a Leica TCS SP8 X 3D STED super resolution microscope and a Marianas 3i light sheet microscope system.

Leica TCS SP8 X 3D STED Super Resolution Microscope



Marianas 3i Light Sheet Microscope

Leica TCS SP8 X 3D STED Super Resolution Microscope overcomes the diffraction limit of light and allows investigators to study sub-cellular structures in greater detail than achieved with a standard confocal microscope. The Leica STED system uses a picosecond longer wavelength laser to deplete the fluorescence emitted from a shorter wavelength dye creating a doughnut shaped excitation. The emission thus given by the sample is detected using standard detection systems creating a X-Y resolution of 40nm.

Marianas 3i Light Sheet Microscope is a dual inverted selective plane illumination imaging system. It consists of two symmetrical optical paths for light sheet imaging. Two objectives are placed at right angles above a sample mounted horizontally. A light sheet is projected onto the sample from one objective and imaged through the other objective using high speed high resolution sCMOS cameras. This way a stack is collected by moving the light sheet through the sample. The role of the objective is exchanged to collect another stack in the perpendicular direction and the data sets are computationally merged to yield a 3D data set with isotropic resolution. The scanned sheet method reduces phototoxicity, allows 3D imaging and long term time lapse imaging at high spatial and temporal resolution.

Apart from above advanced microscopes, the facility also has the following fluorescence microscopes.

Advanced Fluorescence Zeiss AxioZoom V16 Stereo Microscope with Apotome

This is a high resolution stereo microscope with optical sectioning using the structured illumination principle having a color camera and a monochrome camera for fluorescent samples. The system can be used for fluorescence, bright field and DIC imaging with a zoom ratio of 16. It can be used to scan *Drosophila*, zebrafish, plant samples and 96-well plates. Tile scans can also be done on the system. 3D reconstruction is a part of the Zen analysis software.

Universal Research Microscope Model Axioplan 2 Imaging with Film and Digital Cameras

This is an excellent manual microscope suitable for fluorescence, bright field, phase, DIC, dark field applications. The AxioVision software for capturing images with CCD camera has a number of facilities like capturing images both in black & white and colour, image export or import, enhancement, annotations, archiving and multi-channel acquisitions.

Axioimager Z2 Fluorescence Imaging System with Fully Motorized Microscope

This is an advanced system with fully motorized microscope for imaging both, black and white and color images and also acquire $_2$Z-sections. A color camera for unstained samples and a monochrome digital camera for capturing images of fluorescent samples are the attachments which are also controlled by the inbuilt software.

Apotome Fluorescence Imaging system with Fully Motorized Axioimager. Z1 Microscope and Monochrome Digital Camera

This is a highly sophisticated and motorized fluorescence microscope with DIC attachment. The system is used to observe the biological specimens with fluorescence technique and acquire Z-sections at good resolution. The system works on structured illumination principle to get high quality images and is capable of acquiring images on both DIC and fluorescence. The optical tomography technique uses optical grid for structured illumination. The images are analysed using Zen software.

Animal House

The CCMB Animal House has been registered under CPCSEA [Committee for the purpose of control and supervision of Experimental Animals], Ministry of Animal Husbandry & Dairying, Government of India in the year 1999. The registration number is 20/GO/RBi/S/99/CPCSEA for the purpose of Research and breeding of mice, rats, rabbits, hamsters, and Guinea pigs for in-house purposes and commercial trading purposes.

The main objective of the animal house has to supply genetically defined various strains of mice, rats, and rabbits to CCMB scientific community under strict regulation from CPCSEA, Government of India. All animal house activities are regulated by ONTEX [Online indenting system for experimental animals] software in which PI can raise the online animal request as per IAEC approved project for supply of animals and inventory platform to regulate animal census, mortality, animal production, and supply details and monitoring platform to generate the data of microbial, genetic monitoring with microenvironmental parameters of animal rooms such as temperature and relative humidity. CCMB AH also provides orientation and training programs to authorized animal house users [students & project staff] to maintain high standards of humane, ethical, and responsible use of animals in their research. The animal facility maintains 59 strains of various inbred, outbred mice including different transgenic & knockout mouse models, immuno- compromised (nude & SCID) mice, two strains of rats, one strain of hamster, and one strain of rabbit. All the mice and rat colonies are housed in the individually ventilated caging systems (IVCs) where supply air is filtered through a HEPA filter system and these machines were imported from Techniplast, Italy. All animal rooms are environmentally controlled and monitored for temperature, humidity, and automatic lighting system to control 12 hr light and dark cycle. The Animal House team comprises of one veterinarian and 07 trained staff members who are involved in the breeding, management of various lab animals, and providing technical support to various ongoing research projects. The Total number of projects approved for animal experimentation under the Institutional Animal Ethical Committee this year is 138. Four of our permanent staff Mr.Rajasekar, Principal technical Officer, and Mr.Ravi, Mr.Laliah, and Mr.Ellesh, Lab Assistant retired from their service during this year. During this year, We have purchased a Horiba auto hematology analyzer – veterinary mode to measure the various blood parameters of small and large animals. Also, the Hypoxia work station of mice is installed in our animal facility. The entire animal house has been monitored by CCTV camera systems as per the mandatory requirement of CPCSEA, Ministry of Animal Husbandry & Dairying, New Delhi.

Number of animals supplied during this year are as follows:

Mice: 7689 Rats: 108 Hamsters: 48 Rabbits: 42

Cell Culture Facility

The centralized Cell Culture Facility of CCMB caters to the need of all groups in CCMB using cells for their research. The facility maintains a variety of cells for experimental purpose, and provides cell lines, media, serum, plastic-ware and other specific solutions for more than 100 users in CCMB. Experts help in training CCMB staff, students and researchers in cell culture techniques. The facility also serves as a repository for cells, and provides cell lines to various scientific organizations, educational institutions and industries in the country.

The facility is well-equipped with laminar flow hoods, CO2 incubators, inverted microscopes, freezers, cold storage, liquid nitrogen storage facility, FLoid cell imaging system, electroporator & nucleofector, automated cell counters, photo-dynamic therapy instrument, hypoxia chamber among others. A dedicated BSL2 facility is available that permits use of reagents/viruses/human primary cells requiring biosafety measures. The staff is well-trained in maintenance of cell lines, stem cells, organ explant and primary cultures, cell fusion to produce monoclonal antibodies, DNA transfection to establish stable clones and cryopreservation of cells. More recently, platforms for generation of brain organoids have been established. Staff also provides technical help to facility users from various groups in CCMB, as and when required. Around 150 different cell lines are at present being maintained in the facility and are validated to be free of contamination. A short-term training course on Animal Cell Culture for students/faculty members/researchers from universities/ institutes/ industry interested in learning cell culture techniques has been introduced, this year on.

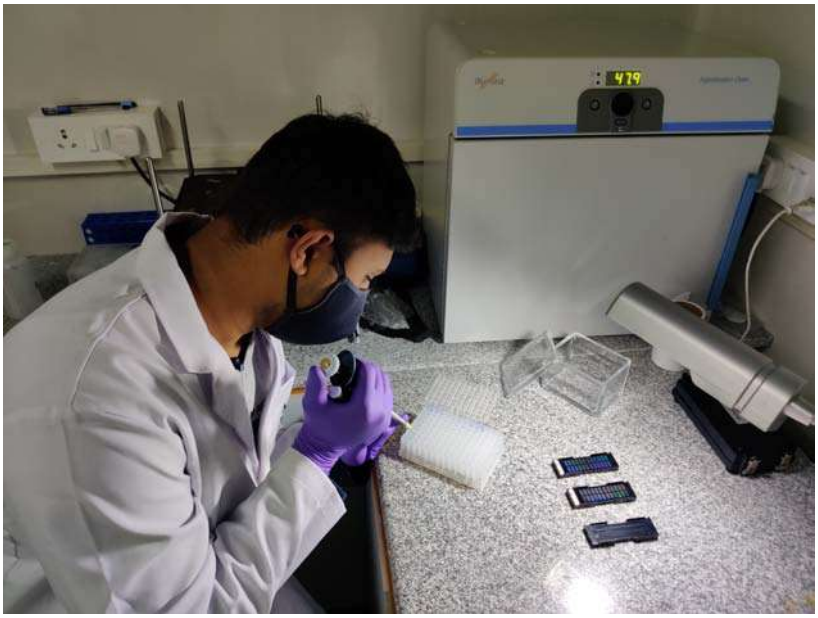
Facility staff:

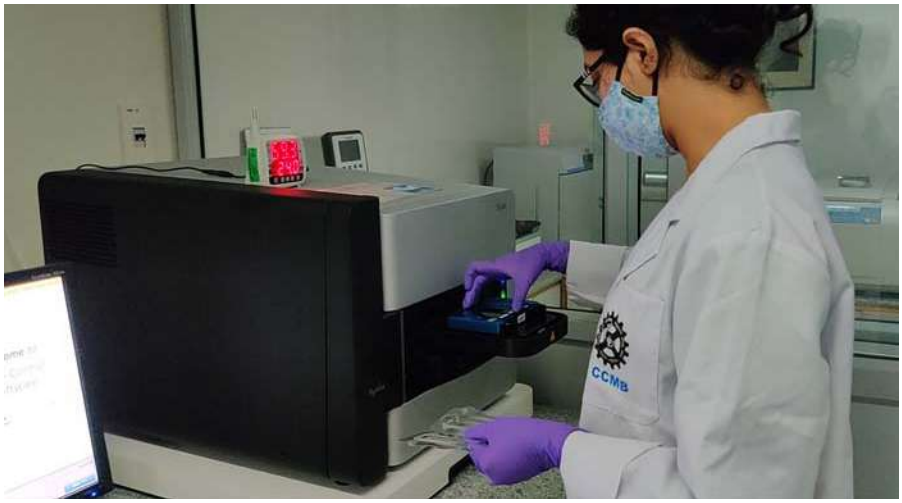
Ch.Varalakshmi, Zareena Begum, BVV Pardhasaradhi, S Easra, T Dayakar, G. Vidyasagar

DNA Microarray Facility

Microarray is a high-throughput technique for analyzing expression levels of thousands of genes or genotyping large numbers of SNPs in a single experiment. The microarray facility is equipped to do genome wide analysis with applications in basic research as well as in biomedicine and agro-biotechnology. Microarrays (also known as DNA/gene chips) are generated by a technology that integrates molecular biology and information technology.

The facility combines dedicated cubicles for wet lab experiments, data generation and data analysis using high-end computing systems. It houses the Illumina HiScan System for sensitive and accurate imaging of Illumina Bead Arrays for Gene Expression, high throughput Genotyping & DNA Methylation and the Affymetrix Gene Chip System for analyzing Affymetrix Chips related to generating similar kind of data. The entire microarray facility is housed in a dust-free room at CCMB main building. The applications that have been used are largely in the areas of gene expression analysis, microRNA profiling, and genotyping. Gene expression studies have been done with mammalian (Mouse, Rat and Human), plants (Rice and *Arabidopsis*), and insects (*Drosophila*) systems. Similarly, the genotyping studies have been carried out in the area of human population genetics and disease association studies.





Fly Lab

Drosophila melanogaster, the fruit fly is one of the most studied and highly tractable genetic model organisms due to its short life-cycle, low maintenance costs, conserved biology, and available powerful genetic toolbox. About 60% of the protein coding genes of *Drosophila* is conserved in human and from these genes about 75% are implicated in various diseases. Therefore, fly is effectively being used for studying basic biology as well as understanding molecular mechanisms underlying human diseases.

In CCMB, we have a well-established fly lab. We maintain about 1500 different fly strains. Among these, we have strains for ongoing research activities that include studies of body patterning, neural development, behavior, stress, longevity, etc. We also have fly stains for *in-vivo* genome editing (CRISPR and MiMIC) and about 100 different tissue specific GAL4 driver lines. In addition, we maintain fly models for various human diseases including cancer, Parkinson's disease, Alzheimer's disease and neurodevelopmental disorders such as microcephaly. These strains can very well be used for drug screening. The main fly lab is equipped with several stereo microscopes for fly pushing, a fluorescent stereo microscope for transgenic larva/fly sorting, and an Axioplan microscope.

In addition, we have a well-established micro-injection facility, which is being used extensively by the research groups from CCMB and CDFD. We also have a fully equipped behavior room with *Drosophila* Activity Monitoring (DAM) system, T-maze, an equipment used to study learning and memory, and set up for tracking larval locomotory behavior.

We have supporting facilities - Nectar and embryo collection lab. Nectar supplies fly food in vials, bottles and embryo collection plates. This facility is equipped with an automatic fly food preparation and dispensing machine, hot plate with magnetic stirrers, cold cabinets, hot air oven and RO water system for fly food preparation. This facility also helps in cleaning and sterilizing the bottles & aluminum trays to prevent contamination. The embryo collection room is a small nonstop fly reproduction center, which is designed for constant supply of fly embryos. This facility is equipped with large fly cages and collection plates to collect embryos for high throughput experiments.

From left to right, starting from top: Rakesh K Mishra, Rashmi Upadhyay Pathak, Bharathi, Ramachandra, Sabitha, Sreekanth

We also provide services to other universities/ institutes. Students and teaching staff from different national and international universities visit fly lab to get a hands on experience of *Drosophila melanogaster* culture and maintenance. Fly lab also provides flies to different colleges in the city for teaching purposes and various strains to other research institutes in India for research purposes.

This year we have procured seven new microscopes with fiber optics lamps attached with high clearance area. Also, fly lab has undergone a major renovation this year to increase the work benches and space to keep more *Drosophila* culture incubators.

Histology Facility

The Histology Facility at CCMB provides the equipment and technical support for producing high quality tissue sections and staining for microscopy. All histological procedures from tissue acquisition, processing, sectioning, and standard histological, and immuno staining is carried out. Our equipment supports both paraffin-embedded and frozen cryo-sectioning. This facility is equipped with the following instruments:

- Cryomicrotome,
- Rotatory Microtome, and
- Wax embedding station

All other small equipments like water bath, centrifuge, and rotatorque are also available in the facility. The facilities cover the preparation and processing of tissues, their cutting/sectioning and staining. The services offered are:

- Tissue processing for paraffin/frozen blocks
- Sectioning of paraffin/frozen blocks
- H and E, Masson trichome, van Gieson, Toluidine blue, oil red and Alcian blue staining of paraffin sections
- Training in general tissue processing and histology study methodologies

This facility supports a wide range of projects of the research groups at CCMB.

Facility staff: T. Avinash Raj

NMR Facility

The 600 MHz narrow bore NMR facility was set up in 2009 to study biomolecular structure and function at the physiological condition in the solution. The facility comprises a 600 MHz narrow bore NMR spectrometer equipped with a cryogenically cooled probe. The enhanced sensitivity of the cryoprobe allows *de novo* 3D structure determination of relatively large proteins (MW > 25 kDa) and nucleic acids and their ligand-bound complexes at the physiological condition. During 2020-21, we have installed the new cryogenically cooled probe in lieu of the existing old cryoprobe. The facility is useful to perform structural studies of dynamic biomolecules that are difficult to crystallize (e.g., multi-domain proteins, majorly disordered proteins). The spectrometer runs 24x7 for 365 days a year and is used to derive biologically relevant conformational flexibility of proteins and nucleic acids *in situ*. Some of the important findings derived from the data generated by the facility are: (1) The solution structure of RDE-4 (*C. elegans*) explained structural modifications in both dsRBDs that selected the trigger dsRNA. (2) Understanding the RNAi initiation in plants through the solution structure complemented with the structure-based activity assays of DRB4 (*A. thaliana*). (3) The solution structure of Crc (~32 kDa and presumably the largest solution structure derived by NMR from India) revealed its non-canonical RNA binding surface responsible for regulating the carbon catabolite repression process. (4) Understanding the process of enantioselection to elucidate the mechanism of chiral proofreading during protein translation. Over the years, the 600 MHz NMR (Structural Biology) has become an integral part of CCMB's research activities and had immensely contributed to numerous projects including studies and design of thermostable Lipases, studies on antimicrobial peptides, to study the interaction of intracellular loops of GPCRs with membranes, structure-function relationship of key proteins in *P. falciparum* etc. The data generated by the 600 MHz NMR facility has been used in research articles published from CCMB in several internationally acclaimed scientific journals such as Proc. Natl. Acad. Sci. USA (2010), J. Mol. Biol. (2011), eLife (2013), Biochem. J. (2014), PLoS Biol. (2016), Nucl. Acids Res. (2017), and BBA-Biomembrane (2019).

Proteomics Facility

Mass spectrometry (MS) based proteomics is fast becoming an essential analytical tool for biological scientists. Modern instrumentation and data analysis software can identify and quantify hundreds or thousands of proteins from complex biological mixtures such as cell lysates or body fluids. At CSIR-CCMB, we are equipped with state-of-the-art chromatography systems and mass spectrometers for LC-MS and LC-MS/MS, with a wide range of bioinformatic tools for data interpretation and evaluation. The facility provides a range of services, including:

- Intact molecular weight measurement of proteins
- Protein identification from gel bands
- Protein identification from complex mixtures
- Identification of post-translational modifications
- SILAC, iTRAQ, and label-free quantification of peptides and proteins

Our instrument platforms include cutting-edge Orbitrap Exploris 240, Q-Exactive-HF, Q-Exactive, and MALDI TOF/TOF mass spectrometers, coupled to ultra-high performance EASY-nLC 1200 Systems.

We also have multiple High Performance Liquid Chromatography (HPLC) instruments. These analytical instruments are routinely used for separation and quantification of mixture of proteins/chemical compounds derived either from natural products or synthetic processes. HPLC-facility offers viable solutions due to vast choice of stationary phases and mobile phase options. The different modes and choice of detectors allows analysis of wide range of samples.

In addition to catering internal users in CSIR-CCMB, We provide mass spectrometry-based proteomics services to external users including many Government-funded or Private research labs as well as to Biotechnology industry.

Facility staff:

Y Kameshwari, Sr. Technical Officer (3)
V Krishna Kumari, Principal Technical Officer
B. Raman, Sr. Technical Officer (3)
K. Ranjith Kumar, Technical Assistant

Q-Exactive HF Mass Spectrometer

From left to right, starting from top: Krishna Kumari, Kameswari, Swasti, Raman, Ranjith

Central Radio Isotope Facility (CRIF)

Radio isotope is one of the imperative tools in biological research. The radio isotopes are used as a tracer in the biological reaction. Researchers can label and trace the biomolecules by using radio labeled precursor molecules of their interested reaction. CCMB is one of the major users of $_{32}$P labeled nucleotides to label DNA and RNA. CCMB also uses other radio isotopes of Hydrogen ($_{3}$H), Carbon ($_{14}$C), Iodine ($_{125}$I), Calcium ($_{45}$Ca), Chromium ($_{51}$Cr), Sulphur ($_{35}$S), and Zinc ($_{65}$Zn) in the form of labeled molecules and biomolecules.

The radio isotope facility works under the guidelines of Atomic Energy Regulatory Board (AERB).The facility ensures and monitors safety of the environment, users and general public. The radio isotope users are quarterly monitored by personal monitoring system (PMS) to ensure that the users are in the safe exposure level. The facility also manages radioactive waste management. The radioactive wastes are collected periodically and disposed as per the guidelines of the AERB.

Facility staff: Kavin Kennedy

X-Ray Crystallography

Structural biology X-ray facility provides state-of-the-art resources to elucidate three dimensional structures of macromolecules and their complexes at atomic level. It is equipped with powerful microfocus rotating anode generators: 1) MicroMax™ 007 HF (Rigaku) Cu anode generator with Mar345-dtb image plate detector and Oxford cryosystem 2) FR-E+ SuperBright (Rigaku) dual wavelength Cu/Cr anode generators with R-axis IV++ image plate detector and X-stream cryosystem. FR-E+ system is the most intense home lab source available today for macromolecular crystallography, with focusing optics that can deliver a flux comparable to second generation synchrotron beamlines. Data collected from single crystal diffraction is processed using crystallographic computational software. Molecular-modeling studies are performed using the open-source crystallographic software on Intel Quad-Core windows and linux-based workstations.

High Throughput (HT) Crystallization

A state-of-the-art HT-Crystallization facility provides automation of the complete crystallization set-up. Three major components operational are: (i) Alchemist for liquid handling, (ii) Crystallization robotic systems: Mosquito and Oryx 4, and (iii) two incubators (4°C and 20°C) for incubation and storage of plates for crystal growth. It is supported by dynamic light scattering (DLS), which is a useful tool to diagnose size distribution, stability and aggregation state of macromolecules in solution prior to crystallization.

Small Angle X-ray Scattering (SAXS)

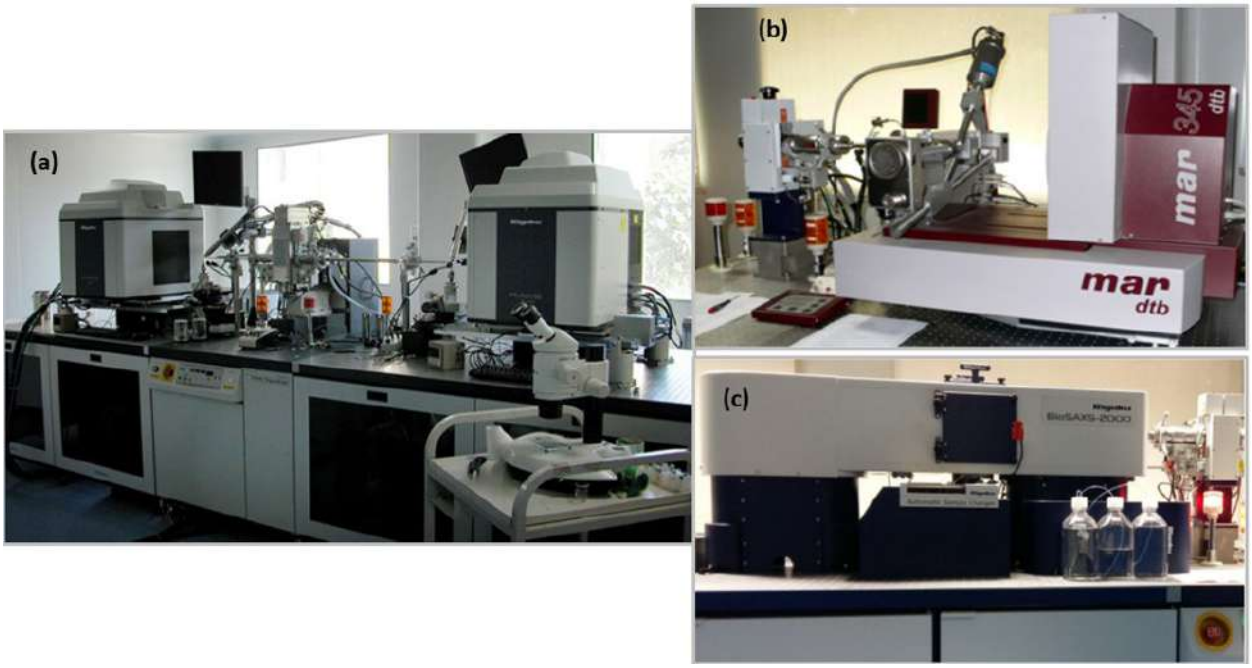
X-ray facility is also equipped with in-house Small Angle X-ray Scattering (SAXS) System for deciphering physical and structural features of macromolecules in solution. SAXS allows to probe size, shape, quarternary structure and complex formation of molecules without crystallization. It helps in understanding (i) structural parameters [radius of gyration (Rg), maximum Dimension (Dmax), partial-specific volume (Vp) etc], (ii) dynamics of molecules and (iii) generation of low-resolution shapes of macromolecules.

SAXS facility houses two systems: 1) S3-MICRO Point-Focus system (Hecus X-ray systems, GmbH) with a 50W X-ray source and a Pilatus-100K detector covering a SAXS range between 2000Å and 10Å. 2) BioSAXS-2000 (Rigaku) with 2-D Kratky collimation, mounted on the existing left port of MicroMax™ 007 HF (Rigaku) Cu anode X-ray generator. It is equipped with OptiSAXS Confocal Max-Flux (CMF) for higher brilliance at the sample position and data collection times in the range of minutes. The configuration incorporates an Automatic Sample Changer for unattended overnight operation and an Automatic Analysis Pipeline based on ATSAS package from EMBL Hamburg.

For details: https://www.ccmb.res.in/Facilities-Services/Research-Facilities/X-ray-Facility#

Several structural biology projects that are carried out at CCMB and other research institutes / universities outside CCMB / pharmaceutical companies / industries are handled at these facilities.

From left to right: Amol, Rukmini, Mallesh, Venkatnarayana



(a) FR-E+ SuperBright (Rigaku) dual wavelength Cu/Cr anode generators with R-axis IV++ image plate detector and X-stream cryosystem
(b) MicroMax™ 007 HF (Rigaku) Cu anode generator with Mar345-dtb mage plate detector
(c) BioSAXS-2000 Small-angle X-ray scattering-2D-Kratky collimation

Zebrafish Facility

Zebrafish facility caters to the needs of different research groups of CCMB and collaborative projects of various institutes (CDFD, LVPEI, IIT-Hyderabad). Apart from providing staged embryos, juveniles and adult fishes for research, we also help users with micromanipulation to generate and maintain desired transgenic fish lines.

The zebrafish Facility provides training and logical support to students from different universities of India and abroad. Facility also offers medium scale testing of various biological potential drug molecules / bioactive agents and developing transgenic fishes. The stock room contains all the stock transgenic lines and wild type strains of the facility. The other rooms are equipped with light dark and temperature controllers to house the ongoing experimental zebrafish for all the users.

Each of these housing rooms are equipped with aeration and pump systems. The zebrafish facility is equipped with

- large scale breeding & embryo collection
- live feed (Artemia) hatching facility
- Advanced automated standalone systems maintain lines for developmental biology, cell biology and behavioural biological studies
- high end microscopy and imaging system (Model M205 FA) that has motorized advanced stereo fluorescence for multichannel fluorescence and bright-field imaging
- micromanipulation systems and trained staff to help researchers generate transgenic fish
- A computer aided tracking system (Danio vision with behavior analysis software) for research on behavioural aspects

From left to right: ML Arvind Swamy, G. Raju

Ground floor - housing systems, microinjection room, behavioral assay set up

BSL2/ BSL3

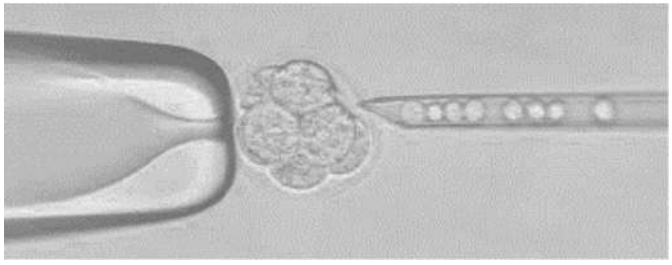
CCMB Biosafety facility has a BSL2 and a BSL3 laboratory. BSL2 laboratory is equipped to handle viral, bacterial, and parasitic organisms. The BSL3 laboratory has the capability to handle both viral and bacterial pathogens.

Biosafety level-2 laboratory

Transgenic and Gene Knock out Facility

The transgenic and gene knock out mice core facility was established to create, procure and maintain, Transgenic and gene knock out mice models. Gene targeting in embryonic stem cells, micromanipulation, survival surgeries are performed to generate Transgenic and gene knock out mice models. The facility generates transgenic animals by pronuclear injections into F1 embryos. The facility generates targeted ES cells lines, which are used in blastocyst injections experiments to generate gene knock mice models. The facility utilizes CRISPR editing to generate genome-edited mice. The facility supports many research groups in CCMB in generating Transgenic and knock-out mice for their research. It also provides technical help for phenotype analysis of transgenic and gene knock-out mice.

The facility provides extensive hands-on training in transgenic and gene knockout technology for users from other institutions. Students/ staff from various institutes like inStem, NCCS, NIAB have been trained.



Injection of genome-edited ES cells being injected to the 8 cell stage morula to generate chimeric mice

Bioinformatics

CCMB was one of the first institutes in the country to have a dedicated Bioinformatics wing, starting in late 1980s. Staying at the forefront, the facility provides support for large scale genomic data analysis, docking, molecular simulations and modelling, and curation of biological databases. As active researchers in the field, we also develop novel tools and algorithms for easier data analysis and visualization.

In particular, the facility supports the analysis of state-of-the-art genomics data such as:

- Whole Genome Sequencing (Human/reference organisms)
- Whole Exome Sequencing (Human/Clinical Panels)
- RNA Sequencing
- Single cell RNA sequencing
- ChIP Sequencing
- Methylome analysis
- de novo Genome Assembly
- Microbial and metagenomics

Data analysis capabilities are well supported by the IT infrastructure at the facility. The heart of the computing infrastructure is a high performance cluster with a performance of >5 TFLOPS, powered by over 280 CPU cores, 4.5TB RAM, and 250TB of SAS storage. Additional servers support the analysis of specific datasets, such as high memory servers (upto 1TB RAM and 80 CPU cores in a single chassis) for genome assembly or other compute-intensive tasks. CCMB also houses a DRAGEN server, a Bio-IT platform that expedites analysis of genomic data using FPGA based hardware acceleration. A 320TB Isilon NAS caters to the storage needs of the institute. In addition, a 5 PB solution is envisaged specifically for genomic data storage.

While it mostly caters to various labs of CCMB, members of the facility also actively collaborate with groups outside the institute, as well as provide analysis support as a service. The most prominent of the data analysis in service mode is our role in CCMB's clinical diagnostics program, where whole exome and/or whole genome data of clinical samples are analyzed to identify causative variants of a phenotype.

Since the COVID-19 pandemic began, the Bioinformatics facility has extended its contributions to the field of SARS-CoV-2 genome analysis. The team constantly scrutinizes in-house as well as publicly deposited viral genomes to track viral evolution and mark any upcoming variants that are of interest or concern. In addition, an active, up-to-date repository of SARS-CoV-2 genomes from India is maintained as a resource called GEAR19 (Genome Evolution Analysis Resource for COVID19), accessible at https://data.ccmb.res.in/gear19.

From left to right, top: Akshay Avvaru, Nitesh Kumar Singh, Abhijeet Karan
Middle: Sai Krishna J, Divya Tej Sowapti, Kiran Thota, Reuben M Jacob, Onkar Kulkarni
Bottom: Sofia Banu, Archana Verma, Payel Mukherjee, Surabhi Srivastava, Priya Singh, Pratheusa Machha, Sreelekshmi MS

1.1C Research Resources

Instrumentation

CCMB has a strong and highly supportive Instrumentation Group which takes care of the Installation maintenance and repairs of Instruments in house, without any maintenance contracts. The group provides technical help to the PI's for the procurement of equipment by way of framing technical specifications and making technical comparisons of bids. Maintenance of UPS and Audio Video projection systems is also taken care by the group. The group conducts training programs, on the usage of Instruments with safety instructions, for the new research students during August every year, for the summer students in May and for the other research staff throughout the year. The state-of-the-art facilities are managed, maintained and run without much down-time due to the support and services provided by the group. Further, the group carries out in-house design, development, modification and fabrication of instruments as and when needed and also provides technical advice to other institutes in the procurement and usage of scientific instruments. The group is also involved in the Young Innovators Program where young school children are taught designing small experiments in Electronic and Physics. The group's contribution to Symposia, Seminars, Workshops and other events are multifarious, particularly for audio-video and exhibition arrangements.

Major equipment procured during the year is as follows:

- Model TCS SP8 STED 3X Stimulated Emission Depletion (STED) based Super Resolution Microscope System with Tunable Pulsed white light Laser -- make M/s Leica
- Model IX73 research grade Inverted Fluorescence Microscope with Phase & fluorescence attachment, high sensitive CCD camera --Make M/s Olympus
- Model King Fisher Flex Purification System with 96 Deep-Well head—make M/s Thermo Scientific
- Model Seahorse XFp Extracellular flux analyzer –make M/s Agilent
- Model MICROCAL PEAQ (ITC) Isothermal Titration calorimeter system –make M/s Malvern Panalytical Limited
- Model Monolith NT.115 Microscale Thermophoresis System - make M/s Nano Temper Technologies GmbH
- Model NGC QUEST 10 Chromatography system –make M/s Biorad --(2 nos)
- Model 800 series Nitrogen gas cryo stream cooler make M/s Oxford Cryo systems
- Model: 4200 Tape Station system -- make M/s Agilent Technologies
- Model: Pyro Mark Q48 Autoprep Automated Pyrosequencing System-- make M/s QIAGEN India Pvt. Ltd
- Model Model Optima XPN-100 Biosafe Ultra Centrifuge with Rotors -- make M/s Beckman Coulter.
- Model Freedom EVO 150 Automated Liquid Handling System - make M/s Tecan


Automated Liquid Handling System
Chromatography system
STED super resolution system
Nitrogen gas cryo stream cooler
Nitrogen gas cryo stream cooler
Microscale Thermophoresis System
King fisher flex purification system
Extracellular flux analyzer
Tape Station system
IX 73 Fluorescence Microscope
Automated Pyrosequencing System
Isothermal Titration calorimeter system
Ultra Centrifuge

Fine Biochemicals

CCMB's Fine Biochemicals facility maintains and stocks large number of biochemicals for the ongoing research activities of the laboratory. The facility has a walk-in freezer (-18°C to -20°C) and a cold room and, two deep freezers (-20°C & -80°C), for storage of chemicals as per the recommended storage conditions. However, the chemicals stable at room temperature are kept in a room (72 sq.mtrs plinth area) where temperature is maintained at 26-28°C. The stocks of fine biochemicals include amino acids, proteins, enzymes, purification kits and buffer reagents. In addition, stocks of restriction enzymes, antibodies, reagents necessary for purification and detection of recombinant proteins, reagents for DNA/protein gel electrophoresis, PCR, RT-PCR, DNA sequencing and synthesis and buffers, and gel electrophoresis. The requirement for these chemicals is monitored such that procurement is carried out on a regular basis, so as to maintain a constant level of supply. Requirement for these chemicals/enzymes is monitored with a help of software developed by CCMB IT Group such that procurement is carried out on regular basis so as to maintain a constant level of supply. Availability of various chemicals can be seen on CCMB intranet.

The fine biochemicals indented by all the scientists is first received by the facility, and issued to the corresponding groups, in addition, to the general chemicals maintained by this facility.

From left to right: M.C. Joseph, Y. Ramadasu, Kishore Joshi

Information Technology Group

The Information Technology group plays a major role in designing, implementing and managing IT infrastructure & services in-house. The group facilitates scientific collaborations by providing secure and faster data transfers, assisting scientists in the creation of computing facilities required for R&D projects, protects the organization's network and research data from cyber-attacks.

IT group creates and manages CCMB website, intranet site, and other websites as and when required for various national and international conferences organized by CCMB. The team also develops many online applications and tools to automate and manage R&D facilities and administrative works.

IT Group also contributed to support COVID 19 related activities of CCMB by developing portal for capturing, record keeping of covid-19 samples-test results and online slot booking system for dry swap test training program being conducted by CCMB.

CSIR-CCMB is connected by a dedicated 1Gigabit leased line connection from NKN and a redundant 100 Mbps leased line connection from BSNL. LAN is built with a high-speed 10 Gbps network backbone and switched 1 Gbps connection to systems. Secured wireless connectivity is implemented in the student's hostel and all the buildings on the campus.

Asi@Connect project has been completed.

IT group manages Cluster that has a compute capacity of 5.525 Tera Flops used for Next-generation sequencing and a centralized Network Access Storage with 400 TB storage capacity mounted to research facilities, servers, and desktops. Other facilities like Surveillance Camera, Biometric system, Fire Alarm system, Telephone, and closed-circuit TV are also managed by the group.

From left to right, starting from top: Geetha Thanu, Sublari Balaraju, Aparna Kumari, Biswajit Roy, P Radhakrishna Murthy, P Nagalinga Chary, N Siva Rama Prasad, K Sambasiva Rao, S Mahalingam, A Padmavathi, K Rama Chary, Sreekanth M, K Gopichand, M Srinivas Rao, K Harinath, Shiva Kumar M, B Shiva Kumar, G Sai Krishna

Rajbhasha Unit

This unit helps the institute mainly in complying with various provisions of Official Language envisage by the GoI. It provides training to the officials in Hindi, Hindi typing & stenography and also conducts Hindi workshops for its employees at regular intervals. This unit helps scientists in preparing papers, articles, reports in Hindi. This unit also ensures issue of official documents in Hindi as per the OL Act Provisions. This unit also facilitates issuing of press releases in Hindi.

For the past 21 years, Rajbhasha unit has been bringing out a popular science magazine in Hindi viz., Jigyasa dedicating every issue to a special topic of Life Sciences. English is being used internationally, for the spread of science extensively for a long time. But in India, use of regional language is must to reach out to the common public to make them aware of scientific developments taking place around them. The main aim of publishing Jigyasa is to popularize and disseminate science among the common public and students in their own language. The latest issue comprised of recent articles in the field of Environmental Sciences. The latest edition will be on Climatic Changes and the Living Planet.

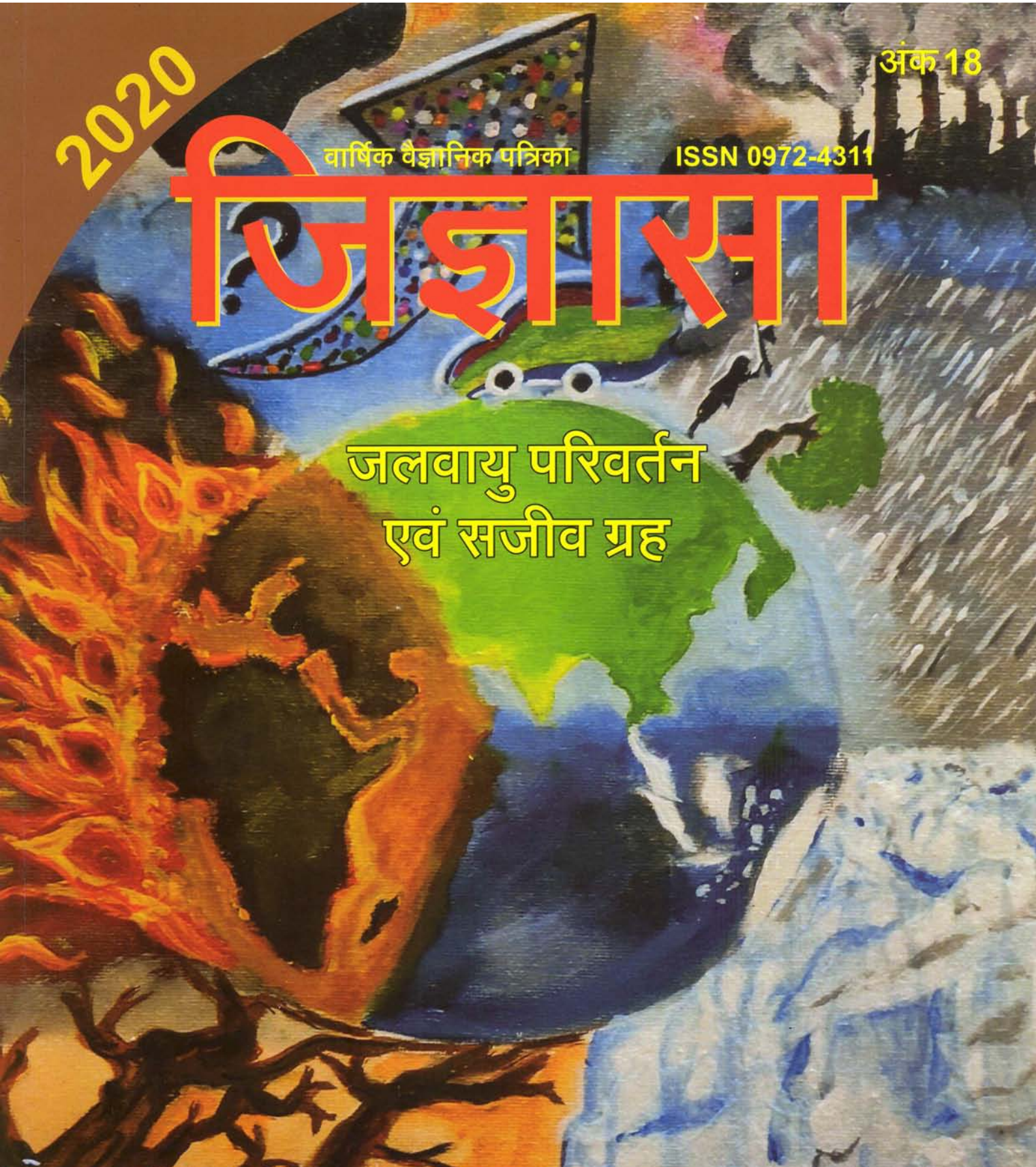
We have a reason to be proud that the articles published in these issues are written in Hindi by the scientists and students of CCMB. This act of contributing articles to Jigyasa helped in inculcating a habit of writing regularly in Hindi among our scientists, thus, enabling them to fulfill their responsibility towards the society.

This Rajbhasha Unit conducts 'Hindi Day' on 14th September every year. Various Hindi competitions and programmes are organized on the occasion. This year Hindi Fortnight was conducted on 14th September, 2020. The winners of the competitions and the officials who do their official work in Hindi were awarded. Every year, we invite some eminent writer, poet or expert of a subject of general interest to deliver a popular lecture in Hindi. This helps our staff and students to interact with such personalities and get benefited by listening to their valuable views.

The unit provides opportunity to students and staff to showcase their cultural and literary talents by organising a programme named 'Pratibha'. The main aim of the programme is to provide a platform to the inherent talents of research students and staff of CCMB. The programme is held annually, usually in the month of June. The programme mainly includes literary and cultural activities.

The Unit also conducts other activities, viz., inviting eminent speakers of various fields to deliver popular talks in Hindi for the benefit of staff and research students. The spectrum of topics includes personality development, space technology, geology, management skills, classical music, etc., and they have proved very useful for the staff to gain some basic knowledge in these areas.

The Rajbhasha unit has a very good library consisting 2879 Hindi books on various subjects viz., classic works of Hindi literature, science, translations and books of general interest, personality development, etc. Thus, the Rajbhasha unit takes care of CCMB in respect of implementation of Official Language as prescribed by GoI from time to time.



2020

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वार्षिक वैज्ञानिक पत्रिका

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जिज्ञासा

जलवायु परिवर्तन एवं सजीव ग्रह

सीसीएमबी

सीएसआईआर - कोशिकीय एवं आणविक जीवविज्ञान केन्द्र

उप्पल रोड, हैदराबाद - 500 007

Laboratory Technical Services

The Lab Technical Services (LTS) in CCMB, CRF (CCMB Annexe 2), Uppal, and LaCONES, Attapur (CCMB Annexe 1), acts as a bridge beetween the scientific staff and the engineering services. Thus it is the single contact point for scientific staff for all their needs that require involvement of engineers.

This section is headed by an engineer, and some of the major services for which LTS is responsible are: (i) Housekeeping, (ii) Manpower supply, (iii) general maintenance like civil, electrical, etc., of laboratory buildings, (iv) maintenance of lifts, (v) Pest control services, (vi) Horticulture, (vii) maintenance of fire extinguishers, (viii) arrangements for scientific and other conventions.

1.2 Academics

1.2 A Academic Cell & PhD Program

CCMB imparts training to doctoral students in an academic program linked either to Jawaharlal Nehru University (JNU), New Delhi or Academy of Scientific and Innovative Research (AcSIR). The PhD program is run by an Academic Cell, which consists of two academic co-ordinators and an assistant. This cell handles almost all the academic activities related to PhD students, including selection and recruitment of students, course work, lab allotment, Doctoral Advisory Committee (DAC) meetings, Comprehensive Exam, and PhD thesis submission. The Academic Cell keeps records of the performance in course work, progress reports of the PhD work, and all AcSIR related documents. All administrative matters of the JNU-CCMB PhD program are dealt by a separate JNU-CCMB committee.

CCMB's PhD program targets students who intend to pursue research-oriented careers in interdisciplinary areas within or outside academic. Our main goal is to provide students a strong technical background, enhance their capacity for analytical thinking, and address new kinds of problems for the advancement of science and society.

CCMB selects candidates for the PhD program in August and January. Eligible candidates are invited to apply and selected based on performance in a written test, followed by two rounds of interviews at CCMB. The students can apply through CCMB-JNU, CCMB-AcSIR and CCMB-JGEEBILS streams. ___ students joined for August 2020 and ___ students joined for January 2021 PhD programs. ___ students gave their PhD colloquia and ____ students submitted PhD thesis during April 2020 to March 2021. ____ students have been awarded PhD degree from JNU/AcSIR during this academic year.

1.2 B PhDs Awarded

List of students awarded with PhD degrees during April 2020 to March 2021

Parijat Sarkar

Interplay between Membrane Lipids, Actin Cytoskeleton and GPCRs: Organization, Dynamics and Function (30.03.2021)

Guide: ***Prof. Amitabha Chattopadhyay***

Md. Jafurulla

Membrane Lipids in GPCR Function and Pathogen Entry (24.03.2021)

Guide: ***Prof. Amitabha Chattopadhyay***

Zuberwasim Sayyad

Understanding the role of OPTN in autophagy and neurodegeneration using disease associated mutant M98K (09.03.2021)

Guide: ***Dr. Ghanshyam Swarup***

Kranthi Kiran Akula

Cellular functions of alpha B crystallin: Role of phosphorylation (12.02.2021)

Guide: ***Dr. Ch. Mohan Rao***

Sunil Kumar Tripathi

Exploring additional Genetic factors associated with susceptibility/resistance to malaria among Indian populations (02.02.2021)

Guide: ***Dr. K. Thangaraj***

Pankaj Kumar

Role of heat shock protein 90 (Hsp90) in drug resistant cancer cells (28.01.2021)

Guide: ***Dr. A.S. Sreedhar***

Renu Sudhakar

Investigation of autophagy in malaria parasites (12.01.2021)

Guide: ***Dr. Puran S. Sijwali***

Ashish Jha

Conservation of Endangered Species - Phylogeny and Population genetics of Yellow-throated Bulbul (*Pycnonotusxantholaemus*) (28.12.2020)

Guide: ***Dr. Karthikeyan Vasudevan***

Umesh Kumar

Functional characterization of a novel male fertility gene TEX13B (18.12.2020)

Guide: ***Dr. K. Thangaraj***

Hanuman T Kale

Regulation of pluripotency factor-Nanog in pluripotency state (10.12.2020)
Guide: ***Dr. P. Chandra Shekar***

P. Anuradha Reddy

Elucidating population dynamics of Tiger (*Pantheratigristigris*) using DNA-based genetic analysis (03.06.2020)
Guide: ***Dr. Karthikeyan Vasudevan***

Radhika Khandelwal

Structural and Functional Determinants of a Calcium Sensor Protein-Secretagogin (16.07.2020)
Guide: ***Dr Yogendra Sharma***

Shivranjani Moharir

Molecular mechanisms of neurodegeneration caused by deficiency of optineurin (18.08.2020)
Guide: ***Dr Ghanshyam Swarup***

Sana Parveen

Investigation of the role of Eukaryotic translation initiation factor 4E-binding proteins (4E-BPs) in cap-dependent and independent translations (01.09.2020)
Guide: ***Dr. H.H. Krishnan***

Sohini Deb

Suppression of innate immune responses in Oryza sativa by the type III effectors of Xanthomonasoryzaepv. oryzae, the bacterial blight pathogen of rice (11.09.2020)
Guide: ***Dr. Ramesh V Sonti***

Neha Kachewar

Characterizing rice functions potentially involved in damage associated Molecular Pattern (DAMP) induced innate immune responses: Studies on an E3 ubiquitin ligase (15.09.2020)
Guide: ***Dr. Ramesh V. Sonti***

Deepika

Proteomic approach to functions of Exoribonuclease R in the cold adaptation of Antarctic bacterium Pseudomonas syringae Lz4W (05.10.2020)
Guide: ***Dr. Malay K. Ray &***
Dr. M.V. Jagannadham

Santosh Kumar Kuncha

Mechanism and Physiological Role of Chiral Proofreading Modules Involved in Translation of Genetic Code (21.10.2020)
Guide: ***Dr R Sankaranarayanan***

Budnar Prashanth

αB Crystallin in Stress and Neurodegeneration (27.10.2020)
Guide: ***Dr. Ch. Mohan Rao***

1.2 C Training Programs

Dissertation Research Training Program

The dissertation research training program (DRTP) is an interdisciplinary research training program for students from M.Sc. /M.Pharm./M.Tech./M.D./B.Pharm./B.D.S./B.Tech. to do six months to a one-year research project on payment basis at CSIR-CCMB under the supervision of a scientist towards their partial fulfillment of the degree. In this program, in addition to routine laboratory training, candidates are exposed to recent research developments, scientific ethics, good laboratory practices, and career opportunities in life sciences. At the end of the training, candidates present their work through posters to the scientific community at CCMB. On successful completion of their research work and submitting the dissertation report, students will receive a certificate. The program was formalized under the skill development program in June 2017. In 2020-2021, there have been 65 students who enrolled and carried out their dissertation research training for either six months or one-year duration.

Project-based Research Training

Project-based training programme, initiated in October 2017 caters to students (rather interested individuals), who wish to carry out research-based training in specific areas, based on research expertise of the various PIs at CCMB. In 2020-21, 18 students enrolled for either a 6-month or 1-year duration. Presently, there are 26 project-based trainees associated with various PI labs at CCMB

Skill/Training Development Program

Under the CSIR-Integrated Skill Initiative CCMB has been conducting its Skilling/Training Programs, from 2017 onwards. This year as well, various Skilling Programs were conducted with a view to cater to both academia and industry needs.

As a part of the essential step taken by the Telangana State government /Hospitals towards capacity building for corona virus screening, /testing preparedness, several onsite/ virtual Virology training programmes on RT-PCR based diagnostics for SARS-COV-2, were held for students, doctors, and medical lab technicians both from government and Private institutes. Around 230 personnel were trained in this process.

A total of 30 Lab Technicians, and Clinicians in need of Skilling/Upskilling on qPCR were Trained, on RT-PCR based diagnostics for SARS-COV-2 in collaboration with Foundation for innovative New Diagnostics (FIND).

On-line and on-site Training Programmes for scientists/Lab technicians/doctors/paramedical staff/students/diagnostic labs were conducted on "The Dry Swab based direct method of COVID testing' a rapid, cost-effective and safer method for testing SARS-CoV-2 which was developed by CSIR-Centre for Cellular and Molecular Biology (CCMB). During this process we have successfully trained around 26 personnel from various private and government institutes.

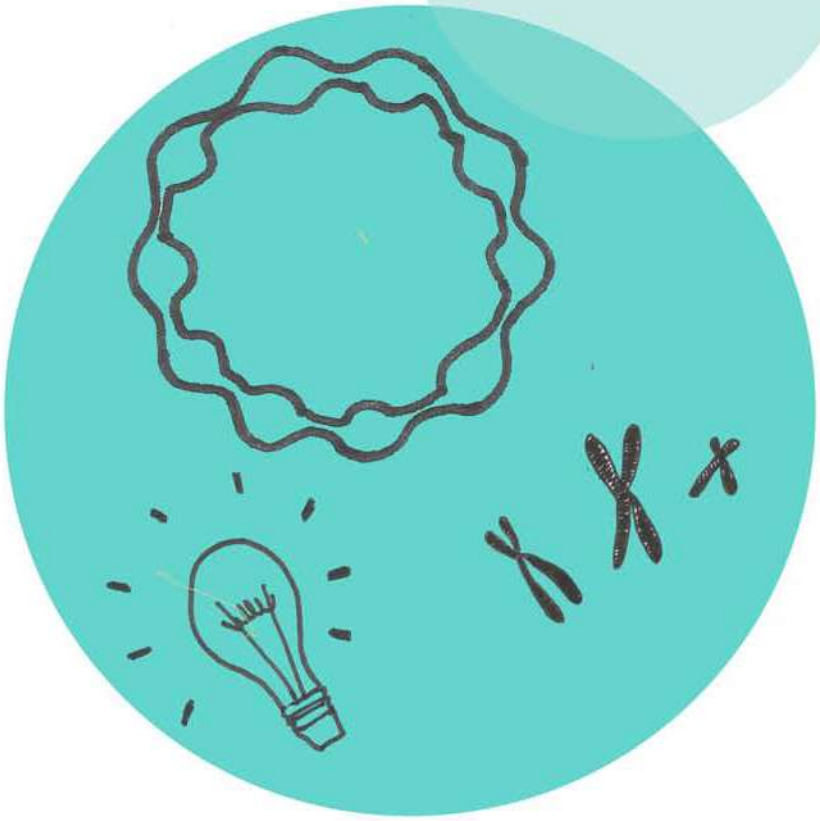
An application training workshop on FACS- Mo Flow XDP was conducted for 3 company personnel from Beckman coulter.

To address the constant need of faculty to upgrade their knowledge in the cutting-edge areas of Life Science research a one week Webinar series on ''Advanced Topics in Life Sciences'' targeted to faculty teaching Undergraduate and Postgraduate courses in Life Sciences & Allied areas was conducted benefitting 60 candidates.

In a view to successful partnership with the line agencies involved in controlling and preventing wildlife crimes, a 2-day workshop was conducted at Amrabad Tiger Reserve, Mannanur for the Telangana Forests field staff. Around 86 Forest Range Officers, Dy. Forest Range Officers and Forest Section Officers from various circles of Telangana namely Amrabad, Mahabubnagar, Adilabad, Warangal, Kothagudem, Nizamabad, Medak, Rangareddy, Hyderabad, Karimnagar, Khammam and Kawal Tiger reserve participated in the workshop.

Glimpses of the training programs at CCMB

1.3
Innovation Hub (iHUB)



1.3 A Services

Centralized Diagnostics Facility at iHUB

The molecular and chromosomal diagnostic activities are now running in a centralized facility at the CSIR-CCMB, Annexe-II. Last year witnessed addition of several new diagnostic tests in to our armamentarium. NGS services are now being offered to various hospitals across the country. Utility of diagnostic exome sequencing has been expanded by the addition of CNV detection pipelines in analysis of raw data. Whole genome analysis is now being offered for diagnostic purposes as well. Genetic counseling services are being provided to more than 50 patients and families every month. New technical staff, Manjeet, Elizabeth, Deepthi and Ramya have been recruited. 1760 patients have been tested in spite of the restrictions imposed by the Pandemic. The staff also contributed significantly to the COVID-19 testing activity.

Molecular Diagnostics

Advances in molecular and cell biology have provided an understanding of the mechanisms of disease at molecular and genetic levels, which can now be translated into diagnostic, prognostic, and therapeutic applications in modern medicine. A number of genetic disorders are known to result from the defects in a single gene. Although rare in comparison to the infectious diseases, genetic disorders cause enormous misery since they are largely incurable and result in many cases, severe morbidity and mortality. In the absence of specific treatments, molecular diagnosis, genetic screening for carrier detection, genetic counseling, pre-pregnancy testing, pre-implantation genetic diagnosis and prenatal diagnosis for these disorders becomes the best approach to prevent their transmission to next generation. The Molecular Diagnostics Facility, CSIR-CCMB, Hyderabad provides diagnostic services for about 30 such monogenic disorders. The facility provides DNA-based testing for a number of inherited and acquired genetic diseases including hemoglobinopathies, musculopathies, bleeding and clotting disorders and neurodegenerative diseases. The strategy is to identify the causal genetic defect in an individual, screen at risk members for carrier status, tracking inheritance of the genetic defect in the fetus by performing prenatal diagnosis on fetal samples (procured at appropriate stage of pregnancy through hospitals) and providing appropriate and timely genetic counseling. The major thrust of these diagnostic services is to provide reliable genetic testing services to the common man within a rapid turnaround time and at affordable rates.

The advent of Next Generation Sequencing in to clinical practice has tremendously increased out potential to identify the molecular defect in a wide spectrum of genetic diseases. Exome sequencing enables us to screen ~20,000 genes at a go for pathogenic variants. The initiation of NGS diagnostic services is in line with our moto to provide quality, low cost genetic diagnostics to the people of our country and at the same time aid in generation of data important for research and public health care.

Chromosomal Diagnostics

Chromosomal abnormalities are a group of genetic disorders due to microscopically detectable defects at the level of chromosomes. They are commonly implicated in mental retardation, congenital malformations, dysmorphic features, primary and secondary amenorrhea, bad obstetric history, infertility and neoplastic diseases. Cytogenetic evaluation of patients is helpful in the counseling and management affected individuals and families. Prenatal diagnosis of chromosomal abnormalities in high-risk pregnancies helps in detecting chromosomal abnormalities in fetuses and aids in their genetic counseling and reproductive decision making. The state-of-the-art facility offers cytogenetic tests such as karyotyping (

conventional-G banding techniques) and FISH (fluorescence in situ hybridization which includes probes using WCP and LSI, mFISH, mBAND, SKY), which involves investigation of genetic defects at the chromosome level.

Wildlife Diagnostics

Wildlife forensics has developed as a major tool in keeping a check over wildlife crimes. Wildlife forensics bring awareness and speeds up reporting of crime involving poaching, illegal hunting and trade, thereby, speeding up justice process directly contributing to conservation of the endangered Indian species. Today, wildlife forensics employs modern molecular genetic techniques to resolve wildlife crimes based on the fact that DNA is present in all life-forms from viruses to the biggest of the mammals.

Further, DNA is species-specific, unique to an individual of the species, identical in all the cells of the individual and related to its parents and siblings. Thus, DNA is the basis of modern wildlife forensics and has the power not only to establish the identity of a species but also to establish genetic relationships between individuals.

We are providing DNA-based species, individual identification, sexing and rehabilitation services to the nation for the purpose of wildlife crime investigation. Biological specimens confiscated in wildlife related crime cases are forwarded by state forest, judiciary, police and custom departments. During last year (April 2020-March 2021) a total of 267 wildlife crime cases were received for different analyses. The forwarded biological samples comprised of 421 types such as cooked/raw meat, skin, venom, tusks, bones, claws, hair, feces, blood stains, saliva swabs and Hatha Jodi samples. During this period, a revenue of more than Rs. 16 lakhs was generated towards the DNA analysis fee charges.

Forensic samples received at CCMB

1.3 B Atal Incubation Centre-CCMB

Incubation at CCMB

The pandemic threw us a curveball, but the human ingenuity once again prevailed and is emerging triumphant. The year 2020 will go down in the history not only for the pandemic, but also for the pioneering science in mitigating the Covid-19 disease. The 2020's will be known as the decade of science and technology.

In time when everything was locked down, the Atal Incubation Centre-CCMB (AIC-CCMB), backed by CSIR-CCMB said Yes, We Can. We supported our incubating startups, first by waiving our service charges, then by ensuring they had access to the facility even during the lockdown. Once CCMB was made a validating centre for ICMR, we facilitated validations of number of Covid-19 kits from Indian companies and also the startups incubated at the incubation centre. We were able to ensure they got resource materials required for the research activities, and their staff was able to commute to the centre. We made relevant R&D as well as industrial connections for them, helped them traverse the regulatory jungle, opened up pathways for funding, sales, and more. All in all, the pandemic has been a very busy time for AIC-CCMB to be on the mission of supporting healthcare innovations.

Some highlights of the year:

- Our community grew by more than 20 new startups joining us in the pandemic times.
- Ten startups successfully graduated, with three taking larger manufacturing spaces right next to our campus.
- Incubated over 75 startups and innovators till date through a diverse Mentoring Pool
- Ranked #5 Top Biotech Incubators in India by BioSpectrum Magazine – 2019 & 2020
- Successfully fulfilled translational innovation projects and programs from CSIR, Industries &Humane Society International – India (HSI-I)
- Successfully launched 2 fellowship programs with other government agencies – Social Innovation programme for Products: Affordable & Relevant to Societal Health (SPARSH) program by Biotechnology Industry Research Assistance Council (BIRAC) & TIDE 2.0 program by MeitY Startup Hub, Ministry of Electronics and Information Technology (MeitY), Govt. of India
- Indigenization of Diagnostic Kits by Foundation for Innovative New Diagnostics (FIND), Research and Innovation Circle of Hyderabad (RICH), supported by Bill & Melinda Gates Foundation (BMGF) & Centre of COE by The Rockfeller Foundation
- Now ready to financially aid technology-based startups, specially in Genomics & Precision Medicine
- Formed strategic partnerships with industries, international agencies, public agencies and academia to promote social innovation and technology entrepreneurship
- Startups got recognition and awards
- Raised over Rs. 3 crores through grants and other strategic investments based on the work by them
- Successfully completed the first cohort of the TIDE 2.0 program supported by MeitY Startup Hub (MSH). Eight companies have successfully graduated and a few of them have received further funding to continue their projects. We also have begun the application process for the Second cohort under this program.
- Successfully completed the FIND project, an initiative by BMGF to assess the capability of the diagnostic machines and its components which are produced locally in India
- Validated over 30 indigenous diagnostic kits of various startups and MSMEs to fight against the COVID-19 pandemic
- Successfully carried out testing of samples forsero-surveillance study of Hyderabad city in collaboration with CSIR-CCMB, ICMR-NIN and Bharat Biotech

- Under the aegis of Dr. Madhusudhana Rao, Centre for Predictive Human Model Systems (CPHMS) has become one of the most relevant scientific and policy think tank for enabling and promoting human relevant, non-animal technologies in biomedical and clinical research in India. The centre will be organising prestigious EMBO lecture series on 'Microphysiological Systems: Advances and Applications in Human-Relevant Research'.

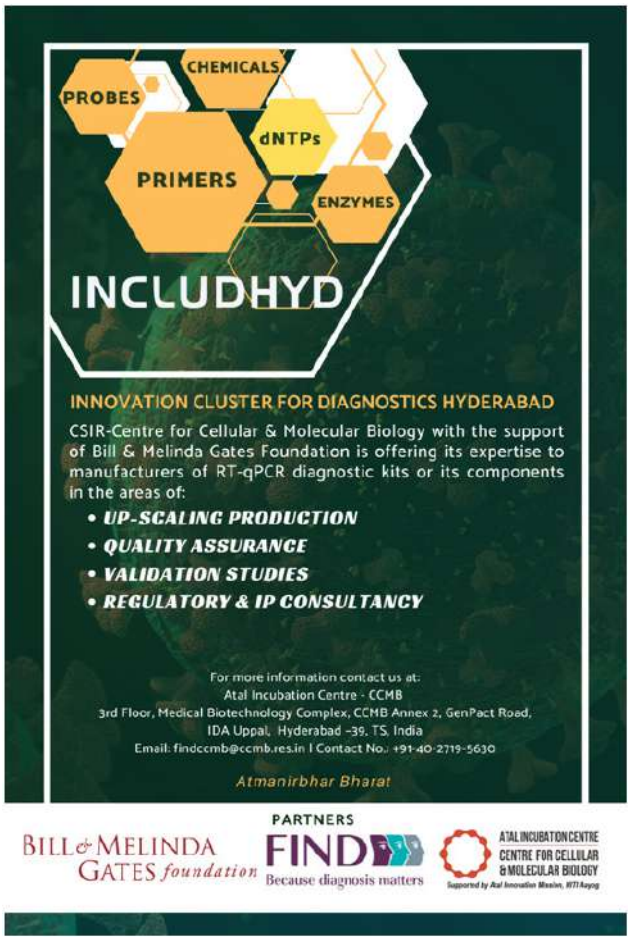
COVID-19 Mitigation

Leveraging on CCMB's leadership role in COVID-19 mitigation, AIC-CCMB has been working closely with startups and MSMEs to validate their diagnostic kits. This was critical as only AIC - CCMB was allowed to collect clinical samples for validation purposes. AIC-CCMB has validated 30 such kits and continues to consult these along with other companies in the domain. Out of the 30 kits which were received for validation, 4 of them were given approval based on the criteria set by ICMR.

Indigenous COVID-19 Test Reagents-Project with FIND

CCMB is a part of the Hyderabad Consortium for Diagnostics Components and COVID-19 RT-PCR Kit Development, working in making India self-reliant (Atmanirbhar Bharat) in COVID-19 diagnostic kits. In India most of the components of the testing kits are imported. Given the present demand of the components globally there has been inconsistency with the supply. The critical components of the RT-PCR kit are enzymes, NTPs, primers and probes. Enzymes are perishable as they are sensitive to many factors. Another critical component for primer/probe synthesis such as amidites, CpG, fluorescent dyes are also dependent on imports from other continents for large scale manufacture.

When the pandemic had only just begun, India did not have adequate infrastructure to develop COVID-19 testing solutions and was heavily dependent on imports. Ever since, the country has demonstrated its resolve in attaining self-reliance in the critical *in vitro* diagnostics (IVD) manufacturing landscape in face of COVID-19 pandemic. Indian IVD manufacturers relentlessly worked to address the crisis with rapid ramp-up of testing solutions for COVID-19, as testing was considered most critical to containing the health crisis.



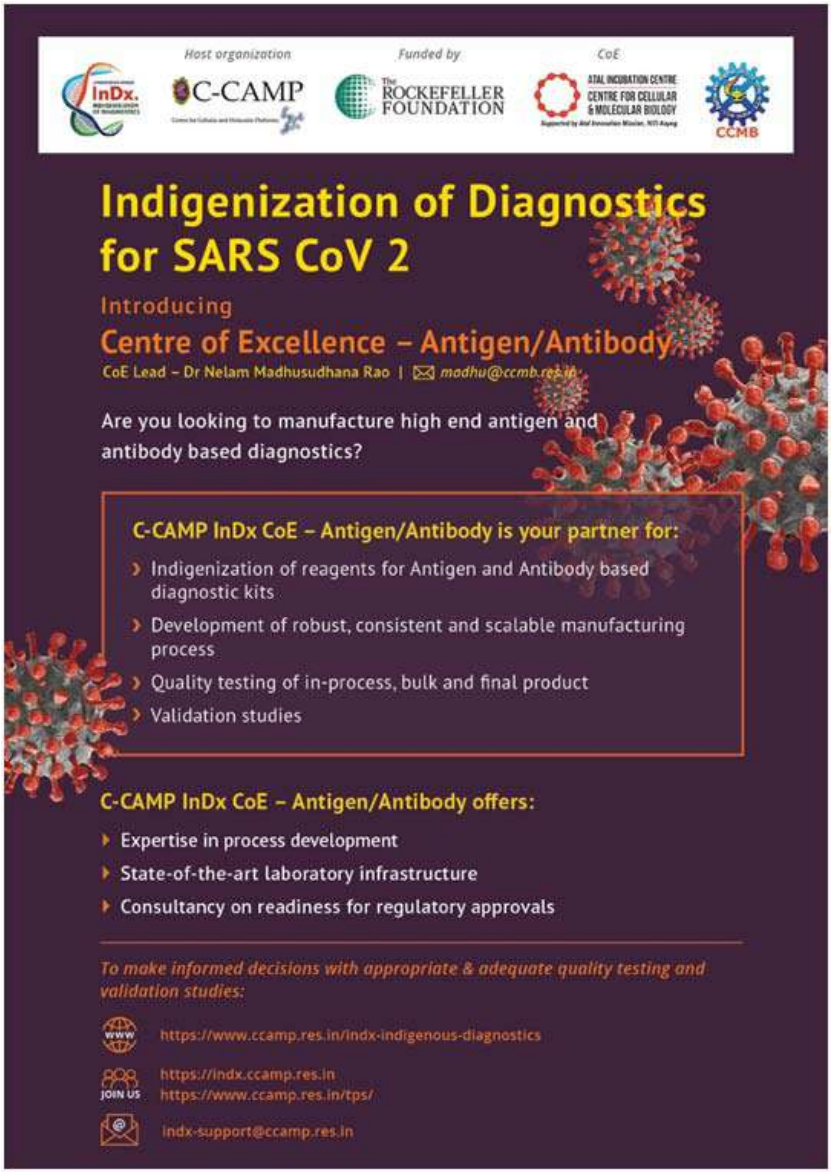
AIC-CCMB collaborated with FIND (Foundation for Innovative New Diagnostics), an initiative by the Bill & Melinda Gates Foundation to assess the capability of the diagnostic machines and its components which are produced locally in India. The aim of the project is to conduct tests on various components of diagnostic kits and evaluate them against proven established industry standards. This is done to provide feedback to companies and suppliers of diagnostics kits to improve their standards and provide reliable testing kits. So far diagnostic kit components of over 10 companies have been tested and the required inputs to improve their products have been communicated to them.

Centre of Excellence: Antigen/ Antibody

The Principal Scientific Advisor, Government of India, under the Atmanirbhar Bharat initiative, launched the Indigenization of Diagnostics (InDx) program. This program was anchored from Centre for Cellular and Molecular Platforms (C-CAMP), Bangalore and was supported by organizations specializing in various domains along with The Rockefeller Foundation. CSIR-CCMB was conferred with the Centre for Excellence for Antigen/Antibody based validation of diagnostics devices and kits. The CoEs are key drivers to:

- Enhance quality for indigenously manufactured reagents, components, critical raw materials and diagnostic kits for SARS-CoV-2
- Offer scale-up for technologies
- Evaluate interchangeability of reagents, components and critical raw materials from indigenous sources
- Adopt best practices in quality and manufacturing to meet global standards

As a part of this initiative, AIC-CCMB was involved in activities ranging from indigenization of antigen/antibody based diagnostic kits, development of robust, consistent and scalable manufacturing processes, quality testing of products and validation studies.



Sero-Surveillance

In January 2021, Hyderabad's leading life science organizations CCMB, AIC-CCMB, ICMR-National Institute of Nutrition (ICMR-NIN) and Bharat Biotech decided to conduct a mass sero-surveillance study to initiate interventional programs to mitigate the pandemic. As the pandemic was raging, apart from the routine lab studies on the virus, it was the need of the hour to have a concrete understanding of the virus spread in the community, for which collecting on field data from individuals was key. Nearly 10,000 blood samples from over 50 wards of the Greater Hyderabad Municipal Corporation (GHMC) were collected within a record time of 2 weeks. These samples were analyzed for the presence of antibodies against SARS-CoV-2, using state of the art equipment. After a thorough analysis of the samples, and having comprehensive data covering almost every corner of Hyderabad, a preliminary report of the sero-surveillance study indicated that almost 54% of the population had antibodies against coronavirus. The numbers point to the fact that, apart from the active recorded infections, there was also a wide community spread of the virus. A press conference was organized on March 4th, 2021 to announce the outcome of the sero-surveillance study to the larger public.

Building Immunity

As the pandemic began to spread, there was a surge in demand for proven immune-boosters to equip the body to fight against the virus. AIC-CCMB collaborated with Clone Deals Private Limited, a Hyderabad based start-up for validating their product 'CoronAid', a novel nutraceutical to boost immunity against COVID-19.

Cordyceps militaris that grows in the Himalayan region and is known for its immune boosting and anti-oxidant properties along with circumin, present in turmeric are used in the formulation to make CoronAid Anti-Viral Immunity Booster Oral Suspension. This product was launched in October 2020 at AIC-CCMB in the presence of Dr. Rakesh Mishra, then Director, CCMB, Dr. Madhusudhana Rao, CEO, AIC-CCMB along with representatives from Clone Deals.

Incubation Programs

Over the last year, AIC-CCMB has proved to be a go-to place for researchers and innovators to take their early-stage ideas and leads to Proof-of-Concept stage (TRL 3 or 4). For us, enabling the translation by encouraging and supporting researchers develop their technologies to market as an enterprise is not just a job, but a passion. AIC-CCMB wants to create a new wave of industrialization in lifesciences through robust facilities, network and access to funding.

At AIC-CCMB, we urge our startups to create a goal-oriented roadmap for themselves. It is necessary to have a focused time-based schedule as most of the startups are either bootstrapped or operate through limited grants for developing the Proof of Concept (PoC). Only when a founder can develop a scalable and replicable PoC, can then they can move forward to validation, prototyping and bringing a product or service into the market. Our core thrust is to ensure that startups achieve this at the earliest by providing them with equipment, scientific and technical support as well as mentoring. Additionally, the startups get exposed to monthly workshops/trainings, gatherings through effective networking and handholding mechanisms.

National Initiative for Developing and Harnessing Innovations -Seed Support System (NIDHI-SSS)

AIC-CCMB has been sanctioned withRs 5.25 crore grant by National Science & Technology entrepreneurship Development Board (NSTEDB) to invest in promising startups in the healthcare space. Under this scheme, startups will get early-stage investment for:

- Product development
- Testing and Trials
- Test Marketing
- Mentoring
- Professional Consultancy (To attract professors/experts from institutions to work with start ups.)
- IPR issues
- Manpower for day-to-day operations
- Any other area as deemed necessary and recommended by the Seed Support Management Committee of STEP/TBIS.

Technology Incubation and Development of Entrepreneurship (TIDE 2.0)

Technology Incubation and Development of Entrepreneurship (TIDE 2.0) is a program supported under MeitY Statup Hub (MSH) by Ministry of Electronics and Information Technology (Meity), GoI. AIC-CCMB was granted TIDE centre in October 2019. Through TIDE 2.0, the centre aim to support innovations that are addressing healthcare challenges using Information and Communications Technology (ICT). AIC-CCMB is focused on fostering innovations in genomics and other health-tech using emerging technological interventions such as IoT, Robotics, Rapid prototyping, Data analytics, AI & ML.

- Financial support is offered in ways
- Grant-in –aid – INR 7 lakhs each to 4 companies per cohort
- EIR – INR 4 lakhs each to 4 innovators per cohort
- Each cohort is supported for 1 year for a total period of 5 Years
- First cohort commenced from- August 2020

8 startups were selected under this program under two categories, Grant-in-Aid and Entrepreneur-in-Residence.

Social Innovation for Products – Affordable and Relevant to Societal Health (SPARSH)

AIC-CCMB proposed to BIRAC to act as a SPARSH Centre for the implementation of BIRAC's SPARSH Fellowship Program aimed at promoting the development of innovative solutions to society's most pressing social problems through biotechnological interventions. The SPARSH Fellowship Program is an 18-month program to create a pool of biotech Social Innovators who could identify the needs and gaps within their communities and then bridge the gap through innovative products and services.

- Supported by BIRAC (Department of Biotechnology).
- SPARSH is the social innovation program of BIRAC aimed towards finding innovation solutions to society's most pressing social problems through Biotechnology interventions.
- Each fellow will get INR 50k as a fellowship for 18 months and INR 5L as kick start grant.
- Fellows will get access to mentoring, prototyping lab and bio incubator network.

Program Structure

- Pre-Immersion Orientation & Induction at the Immersion Centres
- Immersion with Immersion Partners.
- Product Design, Prototyping and Delivery Mechanisms

COHORT 1 (2020-22) Fellows - Ageing and Health

All fellows are identified their innovations and are developing their proof-of-concept or a minimum viable product to demonstrate the solution on which they have worked on.

Nimat - Entrepreneurship Training Program (Online)

Batch 1 – completed March 2021

AIC-CCMB is selected to host DST training workshops to supports enthusiasts interested in entrepreneurship. We conducted three workshops in Jan- Feb 2021 with special focus of different demographics.

- Women Entrepreneurship Development Program – Focused on Women.
- Technology Entrepreneurship Development Program – Aimed at Technology Enthusiasts.
- Faculty Development Program – Aimed at equipping faculty at schools & colleges with skills to support innovations.

Centre for Predictive Human Model Systems (CPHMS)

CPHMS @ AIC-CCMB was established as India's first scientific and policy think tank to enable and promote human relevant, non-animal technologies in clinical and biomedical research in India. Since its inception, the centre has carried out various activities listed below.

- **White papers** - To understand the status quo of research and funding in these areas in India, the centre has come up with three white papers each on Microphysiological systems, Computational and Systems Biology and Adverse outcome pathways. These white papers document the research in various research institutes, colleges, and private companies across the country. Personal communication with several scientists were used to analyse the challenges in this area and, recommendations were provided to overcome the challenges currently being faced in the field.

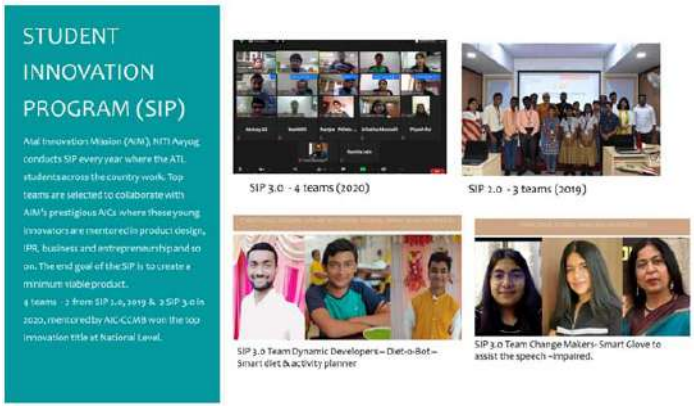
- **Webinar series on 'Developing Human relevant research in India'** – The centre organises a monthly webinar series to inform and create awareness on various technologies being developed in India under the umbrella of Microphysiological systems i.e., Organoids, Organ-on-chip etc and its applications in toxicology, pharmacology, Drug discovery and biomedical research. Until now the centre has conducted 13 such webinars where eminent scientists, researchers, startup founders and company representatives have shared their work. More than 1000+ people have been reached via these webinars which indicates that there is a growing interest among students and young researchers to know and understand more about this field.

- **Publications** – The centre is actively involved in publishing research review articles in journals in order to inform the scientific community regarding the applications, challenges faced and to provide recommendations to promote human relevant technologies in India.

- EMBO Lecture course – Recently the centre has been awarded with funding from the European Molecular Biology Organisation (EMBO) to conduct a lecture course on 'Microphysiological systems: Advances andapplications in human-relevant research'. This lecture course is one of a kind where researchers globally as well as from India from the field of Microphysiological systems are to gather and share their research. We plan to have a 5 -day hands on lecture course in the coming year.

Student Innovation Program – AIM

All fellows are identified their innovations and are developing their proof-of-concept or a minimum viable product to demonstrate the solution on which they have worked on.



CRTDH – Supporting MSMEs

CCMB activities are aligned with the Govt. of India's mission of Startup India & Make-in-India. We are contributing to the vision of "Atmanirbhar Bharat" by supporting inventions from scientists within the host organization and CRTDH MSEs, but also from the wider ecosystem of Telangana. CCMB is in a position to fill the validation and scale-up gaps in the lifesciences & healthcare cluster in South India as an Institute of National importance. We have the resources to develop all of these indigenously – by enabling and empowering our Micro and Small sectors to pursue technological excellence through research and translation. This is the objective of CRTDH, and we are one of the first centres to demonstrate how such a program can have a tremendous impact on industries. With AIC-CCMB, CRTDH will continue to

- Provide an ecosystem to promote technologies in Healthcare and Biopharma
- Facilitate MSEs to undertake new/improved product/process development
- Extend research and technology development infrastructure
- Supporting potential in-house leads towards translation

CRTDH –CCMB has successfully demonstrated that research facilities for MSMEs can propel them to a higher growth, and create value for the economy on the whole. Our incubatees have filed almost 16 patents till date and raised over Rs 700 lakhs based on the work done here.

Our Strengths:

- Affiliated labs, research institutes and industries.
- Mentoring from dedicated pool of mentors from industry, academia, business, finance, regulatory agencies and finance.
- Standard cell line library, Zebrafish facility and transgenic animal models for various diseases
- Large pool of scientists with excellent experience can be advisors/mentors
- Sophisticated facilities at CCMB on service basis.
- Regular workshops and events aimed at developing entrepreneurs
- Fundraising through grants, venture capitalists, banks and other sources.
- Network and fund-raising opportunities

The Covid-19 crisis has squarely put the focus of the nation on becoming self-reliant in every field, especially healthcare. With a growing realisation that science and technology are critical drivers not just the well-being of a people, but world economies as well. We need to be prepared for whatever next is thrown at us, and how quickly we can work to mitigate it. AIC-CCMB has demonstrated that by helping industry pivot through access to research labs, scientific intelligence, mentoring and funding, we can build best-in-class products in healthcare products and solutions for the future.

2.1 Administration & Management

Research Council

Research Council of a laboratory under CSIR provides direction and vision and helps it to formulate R&D programmes keeping in view the national priorities and opportunity niches and facilitates to design a road map to achieve it. The following are the constituent members of the Research Council of CCMB:

Prof P. Balaram **Chairman**
Molecular Biophysics Unit
Indian Institute of Science
Bengaluru – 560012

Dr Roop Mallik **Member**
Professor
Department of Biosciences &
Bioengineering, IIT Bombay
Powai, Mumbai – 400076

Dr Rajesh S. Gokhale **Member**
Head, Department of Plant
Molecular Biology
Delhi University, South Campus
New Delhi

Dr Anand Kumar Bachhawat **Member**
Professor (Biology)
Indian Institute of Science Education
and Research (IISER)
Mohali, Knowledge City, SAS Nagar
P.O. Manauli – 140 306

Prof Sandhya Visweswaraiah **Member**
Professor
Department of Molecular Reproduction,
Indian Institute of Science
Bangalore 560012

Dr Deepanwita Chattopadhyay **Member**
Chairman and CEO
IKP Knowledge Park
Genome Valley,
Hyderabad-500101

Dr Subeer S. Majumdar **Member**
National Institute of Animal Biotechnology
Gachibowli, Hyderabad – 500032

Dr Arvind Sahu **Member**
National Centre for Cell Science (NCCS)
NCCS Complex,
S.P. Pune University Campus
Ganeshkhind, Pune – 411 007

Dr Sanjeev Khosla **Member**
Director
CSIR-Institute of Microbial Technology
Sector 39-A, Chandigarh – 160014

Dr Lalita Goyal **Member**
Senior Principal Scientist
Technology Management Directorate
Council of Scientific & Industrial Research
Rafi Marg, New Delhi - 110001

Dr Vinay K. Nandicoori **Member**
Director
CSIR-Centre for Cellular and Molecular Biology
Hyderabad

Dr Anant B. Patel **Secretary**
Senior Principal Scientist
CSIR-Centre for Cellular and Molecular Biology
Hyderabad

Management Council

Following is the composition of the Management Council of CCMB for the period 01.01.2019 to 31.12.2021 as approved under Rule-65 of the CSIR Rules 7 Regulations:

Dr Vinay K. Nandicoori **Chairman**
Director
CSIR-Centre for Cellular and Molecular Biology
Hyderabad

Dr N. Nagesh **Member**
Chief Scientist
CSIR-Centre for Cellular and Molecular Biology
Hyderabad

Dr A. Vijaya Lakshmi **Member**
Senior Principal Scientist
CSIR-Centre for Cellular and Molecular Biology
Hyderabad

Dr B. Kiran Kumar **Member**
Senior Scientist
CSIR-Centre for Cellular and Molecular Biology
Hyderabad

Dr C.B. Tripura Sundari **Member**
Senior Scientist
CSIR-Centre for Cellular and Molecular Biology
Hyderabad

Ms Seema Bhaskar **Member**
Principal Technical Officer
CSIR-Centre for Cellular and Molecular Biology
Hyderabad

Dr V.M. Tiwari **Member**
Director
CSIR-National Geophysical Research Institute
Hyderabad

Dr Archana B. Siva **Member**
Senior Principal Scientist & Head-BDG
CSIR-Centre for Cellular and Molecular Biology
Hyderabad

Finance & Accounts Officer **Member**
CSIR-Centre for Cellular and Molecular Biology
Hyderabad

Controller of Administration **Member-Secretary**
CSIR-Centre for Cellular and Molecular Biology
Hyderabad

Director's Office

The Director's office is responsible for central planning, co-ordination and execution of all activities at the Centre. This includes maintaining relationships with stakeholders interested in the Centre's development and collaborating with them.

Finance & Accounts

All financial matters pertaining to CSIR-CCMB, including budget planning, allocation and expenditure are taken care of by the Finance and Accounts section.

Planning Monitoring and Evaluation Group

The primary responsibility is to assist the Director, CCMB in project management activities and act as a liaison between the Director and other research groups, CSIR-HQ and other organizations. The PME takes care of various in-house, sponsor, collaborative, grant-in-aid and NMITLI projects and provides inputs related to projects. In addition, PME provides information to project audit agencies and RTI queries.

PME assists the Director in preparation and collating institutional data for onward transmission to CSIR head quarters, survey agencies. PME also conducts various institutional programs as advised by the Director from time to time.

Administration

The overall administration of the Centre and the supervision of ancillary services such as transport and telecommunications are under the purview of the administration. In addition, secretarial assistance is provided to the staff for the preparation of the reports, manuscripts and correspondence.

Stores & Purchase

CCMB has a modern stores building with a cold storage facility and separate rooms for the storage of solvents and acids. The Stores and Purchase section maintains an exhaustive inventory of inorganic chemicals, stationery, glassware, plastic ware and other items. The staff of this section carries out the processing of orders and the procurement of materials for the Centre.

Business Development Group

Business Development Group of CCMB carries out various activities related to technical services, IPs and technology transfers. Technical services include diagnostics services (Molecular Diagnostics, Wildlife Forensics & Chromosomal Diagnostics) and various analytical services. BDG coordinates with CSIR HQ for facilitating the research leads from CCMB for patenting. The group also facilitates CCMBs connect with industry for contract & collaborative research projects, technical services, tech transfers, trainings, etc.

Security

Main Activities:

- Checking of material coming in & going out
- Contract staff attendance maintenance
- Issue of visitors passes
- Issue of identity-card to all students / guest workers
- Issue of entry passes to the Contractors .
- Providing security coverage during VVIP visits.
- Checking of vehicles
- Liaison and co-ordination civil authority such as local police
- Security arrangement for workshop/seminar/training programme /exhibition etc.
- Emergency evacuation drills
- Fire fighting & maintenance of fire extinguishers
- Investigation on the issues such as missing material, theft of material etc.
- Patrolling and carrying out surprise checks
- Any other responsibility given by the authorities from time to time

Canteen Services

The CCMB Canteen provides food for CCMB staff, students, contract staff and visitors. We serve breakfast, lunch, dinner and high tea. We have Canteens at three different campuses- CCMB, LaCONES, CCMB Annexe-I and iHUB, CCMB Annexe-II. All canteens are operated with Canteen Smart Card System making it the first canteen in CSIR labs to operate in cashless mode. Canteen has also Online Advance Booking application for Breakfast, Lunch and Dinner. From this application Canteen users can see the menu and they can book their meals up to 7 days in advance. Canteen users can also do online recharge of their cards from this application.

There are four food outlets in CCMB Canteen, these are Baithak, Ahlaad, Samvaad and Kiosk. We serve North Indian, South Indian, Continental and Chinese food. We serve 1000 people during the day and through various meals. We have also in-house bakery and all bakery products are made here like Bread, Cookies, Veg. Puffs, Cakes, Pastries, Pizza, etc. We also serve hot beverages 24/7 which is touchless, cashless and unmanned. Apart from regular dinner, we also cater to conferences, seminars, and symposia conducted by CCMB.

We serve breakfast, lunch, dinner and high tea everyday for around fifty people in LaCONES Canteen, CCMB Annexe -I.

We serve lunch and high tea for 100 people in iHUB Canteen, CCMB Annexe-II daily.

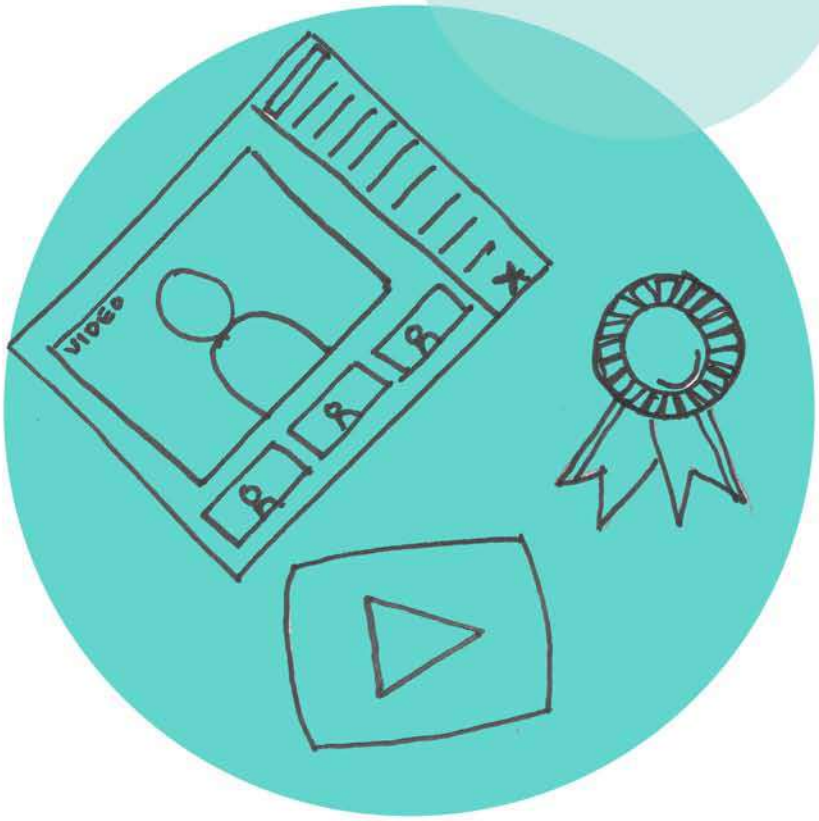
Medical Services

CCMB Health center is catering the medical needs of employees, pensioners, and their dependants, students. Also visiting faculty/guest house inmates. Available facilities are: Consultation, diagnostic services, Pharmacy and Physiotherapy. Earlier (till Jan 2021), there is combined medical facilities for IICT and CCMB. At present Dispensary is temporarily accommodated in CRF. Pressently only consultation services are availble. At present CCMB Health center ismanned by 3 doctors, 2 lab technitians, 1 Physiotherapist, 1 female nurse and 1 receptionist. Dispensary Soft ware developed by It Department CCMB and ready for use.

Guest House

CCMB is maintaining an ultra modern Guest House, having 28 Rooms and 2- Suits.The Guest House is well equipped for the comfort of the guests. GH staffs are well trained,GH also serves Breakfast, Lunch, Dinner and also well equipped for special services during seminars and symposium and VIP visits.

2.2 General Information



2.2 A List of Publications

- Sharma A, Shukla A, Attri K, Kumar Megha, Kumar Puneet, Suttee A, Singh Gurpal, Barnwal RP, Singla Neha (2020). Global trends in pesticides: A looming threat and viable alternatives. ***Ecotoxicology and Environmental Safety*** 201: 110812.
- Kalra RS, Tomar D, Meena AS, Kandimalla Ramesh (2020). SARS-CoV-2, ACE2, and Hydroxychloroquine: Cardiovascular Complications, Therapeutics, and Clinical Readouts in the Current Settings. ***Pathogens*** 9(7): 546.
- Banu S, Jolly B, Mukherjee P, Singh P, Khan S, Zaveri L, Shambhavi S, Gaur N, Reddy S, Kaveri K, Srinivasan, Sivasubramanian G, Dhinakar R, Siva AB, Thangaraj K, Tallapaka KB, Mishra RK, Scaria V, Sowpati DT (2020). A Distinct Phylogenetic Cluster of Indian Severe Acute Respiratory Syndrome Coronavirus 2 Isolates. ***Open Forum Infectious Diseases*** 7(11): ofaa434.
- Sarkar P, Chattopadhyay A (2020). Cholesterol interaction motifs in G protein-coupled receptors: Slippery hot spots? ***Wiley Interdisciplinary Reviews-Systems Biology and Medicine*** 12(4): e1481.
- Singh A, Gupta S, Badarukhiya JA, Sachan M (2020). Detection of aberrant methylation of HOXA9 and HIC1 through multiplex MethyLight assay in serum DNA for the early detection of epithelial ovarian cancer. ***International Journal of Cancer*** 147(6): 1740-1752.
- Sinha P, Singh VK, Saxena RK, Kale SM, Li Y, Garg V, Tang M, Khan AW, Kim K Do, Chitikineni A, Saxena KB, Kumar CVS, Xin Liu, Xun Xu, Jackson S, Powell W, Nevo E, Searle IR, Lodha M, Varshney RK (2020). Genome-wide analysis of epigenetic and transcriptional changes associated with heterosis in pigeonpea. ***Plant Biotechnology*** Journal 18(8):1697-1710.
- Johri MK, Lashkari HV, Gupta D, Vedagiri D, Krishnan HH (2020). mTORC1 restricts hepatitis C virus RNA replication through ULK1-mediated suppression of miR-122 and facilitates post-replication events. ***Journal of General Virology*** 101(1): 86-95.
- Alavala S, Nalban N, Sangaraju R, Kuncha M, Jerald MK, Kilari EK, Sistla R (2020). Anti-inflammatory effect of stevioside abates Freund's complete adjuvant (FCA)-induced adjuvant arthritis in rats. ***Inflammopharmacology*** 28(6): 1579-1597.
- Prashanth B, Singh NP, Rao Mohan Ch (2021). HSPB5 (alpha B-crystallin) confers protection against paraquat-induced oxidative stress at the organismal level in a tissue-dependent manner. ***Cell Stress & Chaperones*** 26(1): 229-239.
- Lakshmi MK, Sowjanya T, Kumar DS, Arpita S, Kiranmai G, Arunasree MK, Mallika A, Chandraiah G, Nagesh N, Babu BN (2020). Design and synthesis of beta-carboline linked aryl sulfonyl piperazine derivatives: DNA topoisomerase II inhibition with DNA binding and apoptosis inducing ability. ***Bioorganic Chemistry*** 101: 103983.
- Kamal Kumar M, Ranjan A, Shiva Jyothi H, Patel HK, Sonti RV (2020). Dual Activities of Receptor-Like Kinase OsWAKL21.2 Induce Immune Responses. ***Plant Physiology*** 183(3):1345-1363.
- Paramasivam A, Meena AK, Venkatapathi Ch, Pitceathly Robert DS, Thangaraj K (2020). Novel Biallelic NSUN3 Variants Cause Early-Onset Mitochondrial Encephalomyopathy and Seizures. ***Journal of Molecular Neuroscience*** 70(12):1962-1965.
- Sadasivam M, Sakthivel A, Nagesh N, Hansda S, Veerapandian M, Alwarappan S, Manickam P (2020). Magnetic bead-amplified voltammetric detection for carbohydrate antigen 125 with enzyme labels using aptamer-antigen-antibody sandwiched assay. ***Sensors And Actuators B-Chemical*** 312: 127985.
- Venugopal N, Ghosh A, Gala H, Aloysius A, Vyas N, Dhawan J (2020). The primary cilium dampens proliferative signaling and represses a G2/M transcriptional network in quiescent myoblasts. ***BMC Molecular and Cell Biology*** 21(1): 25.
- Mishra PK, Madhavi A, Pallavi D, Graeme FM, Kumar A, Patel AB (2020). Impaired neuronal and astroglial metabolic activity in chronic unpredictable mild stress model of depression: Reversal of behavioral and metabolic deficit with lanicemine. ***Neurochemistry International*** 137: 104750.

- Nalban N, Sangaraju R, Alavala S, Mir SM, Jerald MK, Sistla R (2020). Arbutin Attenuates Isoproterenol-Induced Cardiac Hypertrophy by Inhibiting TLR-4/NF-kappa B Pathway in Mice. ***Cardiovascular Toxicology*** 20(3):235-248.
- Gowthami VN, Sourabh S, Satish S, Samu J, Pankaj K; Khanderao P, Sreedhar AS (2020). Altered molecular pathways decides the treatment outcome of Hsp90 inhibitors against breast cancer cells. ***Toxicology In vitro*** 65: 104828.
- Karthikeyan R, Gayathri P, Gunasekaran P, Jagannadham MV, Rajendhran J (2020). Functional analysis of membrane vesicles of Listeria monocytogenes suggests a possible role in virulence and physiological stress response. ***Microbial Pathogenesis*** 142: 104076.
- Sriram D, Chintala R, Parthasaradhi BVV, Nayak SC, Mariappan I, Radha V (2020). Expression of a novel brain specific isoform of C3G is regulated during development. ***Scientific Reports*** 10(1): 18838.
- Chatterjee B, Suman ST (2020). ACE2 as a potential therapeutic target for pandemic COVID-19. ***RSC Advances*** 10: 39808-39813.
- Gluck-Thaler E, Cerutti A, Perez-Quintero AL, Butchacas Jule, Roman-Reyna V, Madhavan VN, Shantharaj D, Merfa MV, Pesce C, Jauneau A, Vancheva T, Lang JM, Allen C, Verdier V, Gagnevin L, Szurek B, Beckham GT, De La Fuente L, Patel HK, Sonti RV, Bragard C, Leach JE, Noel LD, Slot JC, Koebnik R, Jacobs JM (2020). Repeated gain and loss of a single gene modulates the evolution of vascular plant pathogen lifestyles. ***Science Advances*** 6(46): eabc4516.
- Uday CK, Tripathi R, Kameshwari Y, Rangaraj N, Jerald MK, Singh Shashi (2021). Refunctionalization of Decellularized Organ Scaffold of Pancreas by Recellularization: Whole Organ Regeneration into Functional Pancreas. ***Tissue Engineering and Regenerative Medicine*** 18(1): 99-112
- Salunkhe S, Vaidya T (2020). CD40-miRNA axis controls prospective cell fate determinants during B cell differentiation. ***Molecular Immunology*** 126: 46-55.
- Dutta P, Talenti A, Young R, Jayaraman S, Callaby R, Jadhav SK, Dhanikachalam V, Manikandan M, Biswa BB, Low Wai Y, Williams JL, Cook E, Toye P, Wall E, Djikeng A, Marshall K, Archibald AL, Gokhale S, Kumar S, Hume DA, Prendergast James GD (2020). Whole genome analysis of water buffalo and global cattle breeds highlights convergent signatures of domestication. ***Nature Communications*** 11(1): 4739.
- Deb S, Ghosh P, Patel HK, Sonti RV (2020). Interaction of the Xanthomonas effectors XopQ and XopX results in induction of rice immune responses. ***Plant Journal*** 104(2): 332-350.
- Reddy GR, Bhat UA, Chakravarty S, Kumar A (2020). Advances in histone deacetylase inhibitors in targeting glioblastoma stem cells. ***Cancer Chemotherapy and Pharmacology*** 86(2): 165-179.
- Joshi J, Karanth PK, Edgecombe GD (2020). The out-of-India hypothesis: evidence from an ancient centipede genus, Rhysida (Chilopoda: Scolopendromorpha) from the Oriental Region, and systematics of Indian species. ***Zoological Journal of the Linnean Society*** 189: 828-861.
- Rajan Roopa, Divya KP, Kandadai RM, Yadav R, Satagopam VP, Madhusoodanan UK, Agarwal P, Kumar N, Wadia P, Ramalingam S, Wali GM, Pandey Sanjay, Sturm M, Roeper J, Busskamp V, Chandak GR, Schwamborn J, Seth P, Gasser T, Riess O, Goyal V, Pal PK, Borgohain R, Krueger R, Kishore A, Sharma M (2020). Genetic Architecture of Parkinson's Disease in the Indian Population: Harnessing Genetic Diversity to Address Critical Gaps in Parkinson's Disease Research. ***Frontiers in Neurology*** 11: 524.
- Mamidala S, Mudigunda VS, Peddi SR, Kiran Kumar B, Manga V, Rajeswar Rao V (2020). Design and synthesis of new thiazoles by microwave-assisted method: Evaluation as an anti-breast cancer agents and molecular docking studies. ***Synthetic Communications*** 50: 2488-2501.
- Shivaji S, Reddy GSN (2020). Mitsuaria chitinivorans sp. nov. a potential candidate for bioremediation: emended description of the genera Mitsuaria, Roseateles and Pelomonas. ***Archives of Microbiology*** 202: 1839-1848.

- Gaikwad VR, Karale UB, Govindarajalu G, Adhikari N, Krishna EV, Krishna VS, Misra S, Sriram D, Sijwali PS, Rode HB (2020). Synthesis and efficacy of pyrvinium-inspired analogs against tuberculosis and malaria pathogens. ***Bioorganic & Medicinal Chemistry Letters*** 30(8): 127037.
- Moharana TR, Rao NM (2020). Substrate structure and computation guided engineering of a lipase for omega-3 fatty acid selectivity. ***Plos One*** 15(4): e0231177.
- Tanwar VS, Ghosh S, Sati S, Ghose S, Kaur L, Kumar KA, Shamsudheen KV, Patowary A, Singh M, Jyothi V, Kommineni P, Sivasubbu S, Scaria Vinod, Raghunath M, Mishra RK, Chandak GR, Sengupta S (2020). Maternal vitamin B-12 deficiency in rats alters DNA methylation in metabolically important genes in their offspring. ***Molecular and Cellular Biochemistry*** 468(1-2): 83-96.
- Bisht S, Banu S, Srivastava S, Pathak RU, Kumar R, Dada R, Mishra RK (2020). Sperm methylome alterations following yoga-based lifestyle intervention in patients of primary male infertility: A pilot study. ***Andrologia*** 52(4): e13551.
- Rao BR, Kumar R, Haque S, Jerald MK, Rao TN, Kothapalli Raju VSN, Patra CR (2021). Ag-2[Fe(CN)(5)NO]-Fabricated Hydrophobic Cotton as a Potential Wound Healing Dressing: An In Vivo Approach. ***ACS Applied Materials & Interfaces*** 13(9): 10689-10704.
- Ramya T, Mahajan S, Kiranmai G, Dilep Kumar S, Sravani S, John Stephy E, Nagesh N, Shankaraiah N (2021). Development of beta-carboline-benzothiazole hybrids via carboxamide formation as cytotoxic agents: DNA intercalative topoisomerase II alpha inhibition and apoptosis induction. ***Bioorganic Chemistry*** 106: 104481.
- Majumdar P, Karidas P, Siddiqi I, Nath U (2020). The Ubiquitin-Specific Protease TNI/UBP14 Functions in Ubiquitin Recycling and Affects Auxin Response. ***Plant Physiology*** 184(3): 1499-1513.
- Pati S, Saba K, Salvi SS, Tiwari P, Chaudhari PR, Verma V, Mukhopadhyay S, Kapri D, Suryavanshi S, Clement JP, Patel AB, Vaidya VA (2020). Chronic postnatal chemogenetic activation of forebrain excitatory neurons evokes persistent changes in mood behavior. ***E life*** 9: e56171.
- Ghosh S, Sinha JK, Khandelwal N, Chakravarty S, Kumar A, Raghunath M (2020). Increased stress and altered expression of histone modifying enzymes in brain are associated with aberrant behaviour in vitamin B12 deficient female mice. ***Nutritional Neuroscience*** 23(9): 714-723.
- Quoseena M, Sowmya V, Hussain S, Banu S, Bharathi S, Idris MM (2020). Functional role of annexins in zebrafish caudal fin regeneration - A gene knockdown approach in regenerating tissue. ***Biochimie*** 175: 125-131.
- Shrivastava S, Yamuna Devi P, Mamata K, Krishnamoorthy G, Chattopadhyay A (2020). Role of Cholesterol and Its Immediate Biosynthetic Precursors in Membrane Dynamics and Heterogeneity: Implications for Health and Disease. ***Journal of Physical Chemistry B*** 124(29): 6312-6320.
- Purohit D, Ram MS, Pandey VK, Pravalika S, Deka PJ, Narayan G, Umapathy G (2020). Cross-specific markers reveal retention of genetic diversity in captive-bred pygmy hog, a critically endangered suid. ***Conservation Genetics Resources*** 12: 269–273.
- Srivastava R (2021). Chemical reactivity theory (CRT) study of small drug-like biologically active molecules. ***Journal of Biomolecular Structure & Dynamics*** 39(3): 943-952.
- Banu S, Srivastava S, Mohammed A, Kushawah G, Sowpati DT, Mishra RK (2021). Tissue-specific transcriptome recovery on withdrawal from chronic alcohol exposure in zebrafish. ***Alcohol*** 91: 29-38.
- Baron Nofar, Tupperwar N, Dahan I, Hadad U, Davidov G, Zarivach R, Shapira M (2021). Distinct features of the Leishmania cap-binding protein LeishIF4E2 revealed by CRISPR-Cas9 mediated hemizygous deletion. ***PLoS Neglected Tropical Diseases*** 15(3): e0008352.
- Bharti DK, Shanker K (2021). Environmental correlates of distribution across spatial scales in the intertidal gastropods Littoraria and Echinolittorina of the Indian coastline. ***Journal of Molluscan Studies*** 87(1): eyaa029.
- Shukla A, Bhalla P, Potdar PK, Jampala P, Bhargava P (2021). Transcription-dependent enrichment of the yeast FACT complex influences nucleosome dynamics on the RNA polymerase III-transcribed genes. ***RNA*** 27(3): 273-290.

- Athira KV, Abhipradnya BW, Kalyani S, Tapatee D, Sandeep D, Pavan Kumar S, Kumar A, Mangala L, Chakravarty S (2021). Differential modulation of GR signaling and HDACs in the development of resilient/vulnerable phenotype and antidepressant-like response of vorinostat. ***Psychoneuroendocrinology*** 124: 105083.
- Srivastava S, Banu S, Singh P, Sowpati DT, Mishra RK (2021). SARS-CoV-2 genomics: An Indian perspective on sequencing viral variants. ***Journal of Biosciences*** 46(1): 22.
- Katoch A, Nayak D, Faheem MM, Kumar A, Sahu PK, Gupta AP, Kumar LD, Goswami A (2021). Natural podophyllotoxin analog 4DPG attenuates EMT and colorectal cancer progression via activation of checkpoint kinase 2. ***Cell Death Discovery*** 7(1): 25.
- Mamta V, Mohd Imran KK, Rajashekar VK, Baskar C, Sharad A, Arun M, Gayathri G, Chavali PL, Rajavelu A, Chavali S, Dhayalan A (2021). PRMT3 interacts with ALDH1A1 and regulates gene-expression by inhibiting retinoic acid signaling. ***Communications Biology*** 4(1): 109.
- Dave KM, Kaur L, Randhir KN, Mehendale SS, Sundrani DP, Chandak GR, Joshi SR (2021). Placental growth factor and Fms related tyrosine kinase-1 are hypomethylated in preeclampsia placentae. ***Epigenomics*** 13(4): 257-269.
- Ponrathnam T, Saini R, Banu S, Mishra RK (2021). Drosophila Hox genes induce melanized pseudo-tumors when misexpressed in hemocytes. ***Scientific Reports*** 11(1): 1838.
- Mutnale MC, Reddy GSN, Vasudevan K (2021). Bacterial Community in the Skin Microbiome of Frogs in a Coldspot of Chytridiomycosis Infection. ***Microbial Ecology*** 82(2): 554-558.
- Kotwal A, Suran S, Sreedhar AS (2021). Hsp90 chaperone facilitates E2F1/2-dependent gene transcription in human breast cancer cells. ***European Journal of Cell Biology*** 100(1): 151148.
- Shahabuddin G, Goswami R, Krishnadas M, Menon T (2021). Decline in forest bird species and guilds due to land use change in the Western Himalaya. ***Global Ecology and Conservation*** 25: e01447.
- Reetika MY, Maya G, Aparna D, Umair AB, Gouri H, Snehal S, Jahnavi A, Manasi K, Priyanka K, Ramya U, Suresh S, Sujatha J, Beena S, Jayarekha R, Prasad T, Sivasankar M, Priyanka G, Shweta M, Priya K, Harsha P, Parag T, Vasundhara T, Shilpa M, Sagar B, Prerna J, Adinarayan M, Vandana B, Malathi P, Geeta G, Beena G, Karthik Bharadwaj T, Mukesh D, Revathi R, Manisha R. Prenatal Diagnosis for Primary Immunodeficiency Disorders-An Overview of the Indian Scenario. ***Frontiers in Immunology*** 11: 612316.
- Kotwal A, Sreedhar AS (2020). Hsp90 regulates HDAC3-dependent gene transcription while HDAC3 regulates the functions of Hsp90. ***Cellular Signalling*** 76: 109801.
- Parvatam S, Bharadwaj S, Radha V, Rao NM (2020). The need to develop a framework for human-relevant research in India: Towards better disease models and drug discovery. ***Journal of Biosciences*** 45: 144.
- Parween S, Bhatnagar I, Bhosale S, Paradkar S, Michael IJ, Rao Mohan Ch; Asthana A (2020). Cross-linked chitosan biofunctionalized paper-based microfluidic device towards long term stabilization of blood typing antibodies. ***International Journal of Biological Macromolecules*** 163: 1233-1239.
- Srivastava R (2020). Interactions, electronic and optical properties of nanographene-peptide complexes: a theoretical study. ***RSC Advances*** 10: 38654-38662.
- Jamwal VS, Vishnu Vijay V, Anusha D, Yash P, Kiran Kumar B, Chandra Shekar P, Singh S (2020). Generation of iPSC from fetal fibroblast cells obtained from an abortus with type-I tri-allelic variants. ***Stem Cell Research*** 48: 101963.
- Sarkar P, Jafurulla Md, Bhowmick S, Chattopadhyay A (2020). Structural Stringency and Optimal Nature of Cholesterol Requirement in the Function of the Serotonin(1A) Receptor. ***Journal of Membrane Biology*** 253(5): 445-457.
- Dharaskar SP, Paithankar K, Vijayavittal AK, Kara HS, Sreedhar AS (2020). Mitochondrial chaperone, TRAP1 modulates mitochondrial dynamics and promotes tumor metastasis. ***Mitochondrion*** 54: 92-101.

- Nair RA, Verma VK, Beevi SS, Rawoof A, Alexander LE, Prasad ER, Kumari PK, Kumar P, Kumar LD (2020). MicroRNA Signatures in Blood or Bone Marrow Distinguish Subtypes of Pediatric Acute Lymphoblastic Leukemia. ***Translational Oncology*** 13(9): 100800.
- Rawat S, Ghosh S, Mondal D, Anusha V, Raychaudhuri S (2020). Increased supraorganization of respiratory complexes is a dynamic multistep remodelling in response to proteostasis stress. ***Journal of Cell Science*** 133(18): jcs248492.
- Das T, Soren K, Yerasi M, Kamle A, Kumar A, Chakravarty S (2020). Molecular Basis of Sex Difference in Neuroprotection induced by Hypoxia Preconditioning in Zebrafish. ***Molecular Neurobiology*** 57(12): 5177-5192.
- Meena S, Deb S, Samtani H, Khurana P (2020). Dissecting the Molecular Function ofTriticum aestivum STIFamily Members Under Heat Stress. ***Frontiers in Genetics*** 11: 873.
- Gopinathan A, Moidu M, Mukundan M, Narayanan SE, Narayanan H, Adhikari N (2020). Design, synthesis and biological evaluation of several aromatic substituted chalcones as antimalarial agents. ***Drug Development Research*** 81: 1048-1056.
- Kumar P, Devaki B, Ujwal Kumar J, Sreedhar AS (2020). Hsp90 facilitates acquired drug resistance of tumor cells through cholesterol modulation however independent of tumor progression. ***Biochimica Et Biophysica Acta-Molecular Cell Research*** 1867(8): 118728.
- Harrison JW, Divya Sri Priyanka T, Baptist Alma, Sharp SA, Seema B, Jog Kalpana S, Patel KA, Weedon MN, Chandak GR, Yajnik CS, Oram RA (2020). Type 1 diabetes genetic risk score is discriminative of diabetes in non-Europeans: evidence from a study in India. ***Scientific Reports*** 10(1): 9450.
- Lasagna E, Ceccobelli S, Cardinali I, Perini F, Bhadra U, Thangaraj K, Dababani RC, Rai N, Sarti FM, Lancioni H, Ige AO (2020). Mitochondrial diversity of Yoruba and Fulani chickens: A biodiversity reservoir in Nigeria. ***Poultry Science*** 99(6): 2852-2860.
- Nayak SC, Radha V (2020). C3G localizes to the mother centriole in a cenexin-dependent manner and regulates centrosome duplication and primary cilium length. ***Journal of Cell Science*** 133(11): jcs243113.
- Sudhakar DVS, Jaishankar S, Phanindranath R, Kumar U, Singh R, Kabilan U, Namduri S, Dhyani J, Gupta NJ, Chakravarthy B, Vaman K, Shabir I, Khadgawat R, Deenadayal M, Chaitanya DA, Dada R, Sharma Y, Anand A, Thangaraj K (2020). Novel NR5A1 Pathogenic Variants Cause Phenotypic Heterogeneity in 46,XY Disorders of Sex Development. ***Sexual Development*** 13(4): 178-186.
- Pillai SE, Kumar C, Dasgupta M, Kumar BK, Sridivya V, Patel HK, Sonti RV (2020). Ectopic Expression of a Cell-Wall-Degrading Enzyme-Induced OsAP2/ERF152 Leads to Resistance against Bacterial and Fungal Infection in Arabidopsis. ***Phytopathology*** 110(4): 726-733.
- Danda S, Mohan S, Devaraj P, Dutta AK, Nampoothiri S, Yesodharan D, Phadke SR, Jalan AB, Thangaraj K, Verma IC, Danda D, Jebaraj I (2020). Founder effects of the homogentisate 1,2-dioxygenase (HGD) gene in a gypsy population and mutation spectrum in the gene among alkaptonuria patients from India. ***Clinical Rheumatology*** 39(9): 2743-2749.
- Sharma D, Rao NMN, Arasaretnam S, Sainath AVS, Dhayal M (2020). Functionalization of structurally diverse glycopolymers on graphene oxide surfaces and their quantification through fluorescence resonance energy transfer with fluorescein isothiocyanate. ***Colloid and Polymer Science*** 298: 365–375.
- Jha A, Vasudevan K (2020). Demographic history of the fragmented yellow-throated bulbul (Pycnonotus xantholaemus) population in the Deccan Peninsula, India. ***Endangered Species Research*** 43: 199.
- Srinivasan A, Mishra RK (2020). Lessons on gene regulation learnt from the Drosophila melanogaster bithorax complex. ***International Journal of Developmental Biology*** 64: 161-168.
- Srivastava R (2021). Application of Optimization Algorithms in Clusters. ***Frontiers in Chemistry*** 9.

- Soni ND, Ramesh A, Roy D, Patel AB (2021). Brain energy metabolism in intracerebroventricularly administered streptozotocin mouse model of Alzheimer's disease: A H-1-[C-13]-NMR study. ***Journal of Cerebral Blood Flow And Metabolism*** 41(9): 2344-2355.
- Singu PS, Chitakamarthi U, Mahadik NS, Keerti B, Narasimhulu V, Santosh MN, Nagesh N, Kumbhare RM (2021). Benzimidazole-1,2,3-triazole hybrid molecules: synthesis and study of their interaction with G-quadruplex DNA. ***RSC Medicinal Chemistry*** 12(3): 416-429.
- Srivastava R (2021). Theoretical studies on the electronic and optoelectronic properties of DNA/RNA hybrid-metal complexes. ***Polyhedron*** 196: 115015.
- Vijayavittal AK, Sreedhar AS (2021). The conformation-specific Hsp90 inhibition interferes with the oncogenic RAF kinase adaptation and triggers premature cellular senescence, hence, acts as a tumor suppressor mechanism. ***Biochimica Et Biophysica Acta-Molecular Cell Research*** 1868(3): 118943.
- Amalakanti S, Bhat UA, Madhavi MB, Khandelwal N, Sundarachary NV, Chakravarty S, Kumar A (2021). Gene Expression Analysis Identifies Cholesterol Metabolism Dysregulation in Hippocampus of Phenytoin-Resistant Pentylenetetrazol-Kindled Epileptic Mice. ***Neuromolecular Medicine*** doi: 10.1007/s12017-021-08648-0
- Agarwal PB, Thakur NK, Sharma R, Singh P, Joseph J, Tripura C (2021). Chemical-free and scalable process for the fabrication of a uniform array of liquid-gated CNTFET, evaluated by KCl electrolyte. ***Scientific Reports*** 11(1): 3979.
- Sai Pawan N, Banu S, Idris MM (2021). Transcriptomic and proteomic analysis of Hemidactylus frenatus during initial stages of tail regeneration. ***Scientific Reports*** 11(1): 3675.
- Chilukoti N, Sil TB, Sahoo B, Deepa S, Cherakara S, Maddheshiya M, Garai K (2021). Hsp70 Inhibits Aggregation of IAPP by Binding to the Heterogeneous Prenucleation Oligomers. ***Biophysical Journal*** 120(3): 476-488.
- Kowtharapu BS, Damaraju JS, Nitesh K, Ziebart J, Bader R, Koczan D, Stachs O (2021). Analysis of the Differential Gene and Protein Expression Profiles of Corneal Epithelial Cells Stimulated with Alternating Current Electric Fields. ***Genes*** 12(2): 299.
- Mazeed M, Singh R, Kumar P, Roy A, Raman B, Kruparani SP, Sankaranarayanan R (2021). Recruitment of archaeal DTD is a key event toward the emergence of land plants. ***Science Advances*** 7(6): eabe8890.
- Patel AB, Veeraiah P, Shameem M, Jerald MK; Saba K (2021). Impaired GABAergic and glutamatergic neurometabolic activity in aged mice brain as measured by H-1-[C-13]-NMR spectroscopy. ***FASEB Journal*** 35(2):e21321.
- Deepha S, Govindaraj P, Sankaran BP, Chiplunkar S, Kashinkunti C, Nunia V, Nagappa M, Sinha S, Khanna T, Thangaraj K, Taly AB, Gayathri N (2021). Clinico-pathological and Molecular Spectrum of Mitochondrial Polymerase gamma Mutations in a Cohort from India. ***Journal of Molecular Neuroscience*** doi: 10.1007/s12031-020-01765-8.
- Rohit N, Gopal, A, Page N, Ghuman S, Ramachandran V, Joshi J (2021). Large frugivores matter more on an island: Insights from island-mainland comparison of plant-frugivore communities. ***Ecology and Evolution*** 11: 1399-1412.
- Puri D, Swamy ChVB, Dhawan J, Mishra RK (2021). Comparative nuclear matrix proteome analysis of skeletal muscle cells in different cellular states. ***Cell Biology International*** 45: 580-598.
- Dhandapany PS, Kang S, Kashyap DK, Rajagopal R, Sundaresan NR, Singh R, Thangaraj K, Jayaprakash S, Manjunath CN, Shenthar J, Lebeche D (2021). Adiponectin receptor 1 variants contribute to hypertrophic cardiomyopathy that can be reversed by rapamycin. ***Science Advances*** 7(2): eabb3991.
- Komakula SB, Tiwari AK, Singh S (2021). A novel quantitative assay for analysis of GLUT4 translocation using high content screening. ***Biomedicine & Pharmacotherapy*** doi: 10.1016/j.biopha.2020.111032.

- Kumaran K, Krishnaveni GV, Suryanarayana GK, Prabhu MP, Belavendra A, Atkinson S, Balasubramaniam R, Robert Bandsma H J, Bhutta ZA, Chandak GR, Comelli EM, Davidge ST, Cindy-Lee D, Geoffrey LH, Jha P, Joseph KS, Joshi SR, Krishna M, Lee K, Lye S, McGowan P, Nepomnaschy P, Padvetnaya V, Pyne S, Sachdev HS, Sahariah SA, Singhal N, Trasler J, Yajnik CS, Baird J, Barker M, Marie-Claude M, Husain N, Sellen D, HD Fall C, Shah PS, Matthews SG (2021). Protocol for a cluster randomised trial evaluating a multifaceted intervention starting preconceptionally-Early Interventions to Support Trajectories for Healthy Life in India (EINSTEIN): a Healthy Life Trajectories Initiative (HeLTI) Study. ***BMJ Open*** 11(2): e045862.
- Ramachandran G, Moharir SC, Raghunand RT, Swarup G (2021). Optineurin modulates ER stress-induced signaling pathways and cell death. ***Biochemical and Biophysical Research Communications*** 534: 297-302.
- Sureka R, Mishra RK (2021). Identification of Evolutionarily Conserved Nuclear Matrix Proteins and Their Prokaryotic Origins. ***Journal of Proteome Research*** 20: 518-530.
- Krishnadas M, Osuri AM (2021). Environment shapes the spatial organization of tree diversity in fragmented forests across a human-modified landscape. ***Ecological Applications*** 31(2): e02244.
- Jha A, Vasudevan K (2020). Environmental niche modelling of globally threatened yellow-throated bulbul, Pycnonotus xantholaemus for conservation prospects in the Deccan Peninsula, India. ***Current Science*** 119(11): 1815-1823.
- Krishnadas M, Agarwal K, Comita LS (2020). Edge effects alter the role of fungi and insects in mediating functional composition and diversity of seedling recruits in a fragmented tropical forest. ***Annals of Botany*** 126(7): 1181-1191.
- Bhattacharjee M, Adhikari N, Sudhakar R, Rizvi Z, Das D, Palanimurugan R, Sijwali PS (2020). Characterization of Plasmodium falciparum NEDD8 and identification of cullins as its substrates. ***Scientific Reports*** 10(1): 20220.
- Dhawan J (2020). Devidayal's sons: Satish and Ranjit Dhawan and the fellowship of flight. ***Current Science*** 119(9): 1479-1488.
- Kinatukara P, Subramaniyan PS, Patil GS, Shambhavi S, Singh S, Mhetre Amol, Madduri MK, Soundararajan A, Patel KD, Chandra Shekar P, Kamat SS, Kumar S, Sankaranarayanan R (2020). Peri-natal growth retardation rate and fat mass accumulation in mice lacking Dip2A is dependent on the dietary composition. ***Transgenic Research*** 29(5-6): 553-562.
- Maitra S, Khandelwal N, Kootar S, Sant P, Pathak SS, Reddy S, Annapoorna PK, Murty US, Chakravarty S, Kumar A (2020). Histone Lysine Demethylase JMJD2D/KDM4D and Family Members Mediate Effects of Chronic Social Defeat Stress on Mouse Hippocampal Neurogenesis and Mood Disorders. ***Brain Sciences*** 10(11): 833.
- Manasa KL, Thatikonda S, Sigalapalli DK, Vuppaladadium S, Devi GP, Godugu C, Alvala M, Nagesh N, Babu BN (2020). Design and synthesis of substituted (1-(benzyl)-1H-1,2,3-triazol-4-yl) (piperazin-1-yl) methanone conjugates: study on their apoptosis inducing ability and tubulin polymerization inhibition. ***RSC Medicinal Chemistry*** 11(11): 1295-1302.
- Saha P, Sowpati DT, Soujanya M, Srivastava I, Mishra RK (2020). Interplay of pericentromeric genome organization and chromatin landscape regulates the expression of Drosophila melanogaster heterochromatic genes. ***Epigenetics & Chromatin*** 13(1): 41.
- Fatakia SN, Sarkar P, Chattopadhyay A (2020). Molecular evolution of a collage of cholesterol interaction motifs in transmembrane helix V of the serotonin(1A) receptor. ***Chemistry and Physics of Lipids*** 232: 104955.
- Saffari A, Shrestha S, Issarapu P, Sajjadi S, Betts M, Sahariah SA, Tomar AS, James P, Dedaniya A, Yadav DK, Kumaran K, Prentice AM, Lillycrop KA, Fall Caroline HD, Chandak GR, Silver MJ (2020). Effect of maternal preconceptional and pregnancy micronutrient interventions on children's DNA methylation: Findings from the EMPHASIS study. ***American Journal of Clinical Nutrition*** 112(4): 1099-1113.
- Sarkar P, Rao BD, Chattopadhyay A (2020). Cell Cycle Dependent Modulation of Membrane Dipole Potential and Neurotransmitter Receptor Activity: Role of Membrane Cholesterol. ***ACS Chemical Neuroscience*** 11(18): 2890-2899.

- Singh S, Pavuluri S, Lakshmi BJ, Biswa BB, Venkatachalam B, Tripura C, Kumar S (2020). Molecular characterization of Wdr13 knockout female mice uteri: a model for human endometrial hyperplasia. ***Scientific Reports*** 10(1): 14621.
- Viswanathan G, Chung LY, Srinivas UK (2021). Heterogeneous Differentiation of Highly Proliferative Embryonal Carcinoma PCC4 Cells Induced by Curcumin: An In Vitro Study. ***Nutrition and Cancer*** 73(9): 1780-1791.
- Mani S, Rao SN, Kumar MVK (2020). G6036A substitution in mitochondrial COX I gene compromises cytochrome c oxidase activity in thiamine responsive Leigh syndrome patients. ***Journal of the Neurological Sciences*** 415: 116870.
- Sahu P, Mohan KV, Aggarwal S, Arindkar S, Jerald MK, Kumar Pramod U, Ramakrishna G, Nagarajan P (2021). Apoptosis-inducingfactor deficient mice fail to develop hepatic steatosis under high fat high fructose diet or bile duct ligation. ***Cell Biochemistry and Function*** 39(2): 296-307.
- Srivastava R (2020). Nucleobase Pair-Metal Dimer/Dinuclear Metal Cation Interaction: A Theoretical Study. ***ACS Omega*** 5(30): 18808-18817.
- Verma SK, Biswas N (2020). A novel nucleic acid extraction method from aromatic herbs and dried herbal powders using cow skim milk. ***Scientific Reports*** 10(1): 11513.
- Mani S, Chandak GR, Singh KK, Singh R, Rao SN (2020). Novel p.P298L SURF1 mutation in thiamine deficient Leigh syndrome patients compromises cytochrome c oxidase activity. ***Mitochondrion*** 53: 91-98.
- Transcriptomic dataset of zebrafish tissues following chronic alcohol exposure and withdrawal. Banu S, Srivastava S, Mohammed A, Kushawah G, Sowpati DT, Mishra RK (2020) ***Data in Brief*** 33: 106442
- Siddamalla S, Govatati S, Venu VK, Erram N, Deenadayal M, Shivaji S, Bhanoori M (2020). Association of genetic variations in phosphatase and tensin homolog (PTEN) gene with polycystic ovary syndrome in South Indian women: a case control study. ***Archives of Gynecology and Obstetrics*** 302(4): 1033-1040.
- Maasen K, James PT, Prentice AM, Moore SE, Fall CH, Chandak GR, Betts M, Silver MJ, Buxton JL (2020). Periconceptional environment predicts leukocyte telomere length in a cross-sectional study of 7-9 year old rural Gambian children. ***Scientific Reports*** 10(1): 9675.
- Rao BD, Sarkar P, Chattopadhyay A (2020). Selectivity in agonist and antagonist binding to Serotonin(1A) receptors via G-protein coupling. ***Biochimica Et Biophysica Acta-Biomembranes*** 1862(6): 183265.
- Kuncha SK, Venkadasamy VL, Amudhan G, Dahate P, Kola SR, Pottabathini S, Kruparani SP, Chandra Shekar P, Sankaranarayanan R (2020). Genomic innovation of ATD alleviates mistranslation associated with multicellularity in Animalia. ***E life*** 9: e58118.
- Khan S, Sowpati DT, Srinivasan A, Soujanya M, Mishra RK (2020). Long-Read Genome Sequencing and Assembly of Leptopilina boulardi: A Specialist Drosophila Parasitoid. ***G3-Genes Genomes Genetics*** 10(5): 1485-1494.
- Miki Y, Devi L, Imai Y, Minami N, Koide T, Goel S (2020). Deletion of the PDZ-binding kinase (Pbk) gene does not affect male fertility in mice. ***Reproduction Fertility and Development*** 32(10): 893-902.
- Testing and surveillance strategies in the context of COVID-19 in India. Karak S⁎, Srivastava S⁎, Mishra RK (2020) ***Indian Chemical Engineer*** 62:4, 343-350

2.2 B List of Patents

- A novel process and kit for detection of novel Coronavirus and other viruses. Peddapuvala Sai Uday Kiran, Coimbatore Gurumoorthy Gokulan, Kuncha Santosh Kumar, Tallapaka Karthik Bharadwaj, Mishra Rakesh Kumar. NFNO: 0202NF2020/IN, Country: IN, Lab: CCMB, India. Filing Date: 04.12.2020; Application No. 202011053106

- Rapid, low cost process for the preparation of SERS substrate and SERS substrate prepared thereby. Amit Asthana, Mohan Rao Chintalagiri, Saurabh Kumar Srivastava, Gopi Suresh Oggu. NFNO: 0071NF2018/EP, Country: EP, Lab: CCMB, India. Filing Date: 21.12.2020; Application No. 19707889.2

- Rapid, low cost process for the preparation of SERS substrate and SERS substrate prepared thereby. Amit Asthana, Mohan Rao Chintalagiri, Saurabh Kumar Srivastava, Gopi Suresh Oggu. NFNO: 0071NF2018/AU, Country: AU, Lab: CCMB, India. Filing Date: 22.12.2020; Application No. 2019292332

- Rapid, low cost process for the preparation of SERS substrate and SERS substrate prepared thereby. Amit Asthana, Mohan Rao Chintalagiri, Saurabh Kumar Srivastava, Gopi Suresh Oggu. NFNO: 0071NF2018/CA, Country: CA, Lab: CCMB, India. Filing Date: 22.12.2020; Application No. 3104782

- Rapid, low cost process for the preparation of SERS substrate and SERS substrate prepared thereby. Amit Asthana, Mohan Rao Chintalagiri, Saurabh Kumar Srivastava, Gopi Suresh Oggu. NFNO: 0071NF2018/US, Country: US, Lab: CCMB, India. Filing Date: 28.12.2020; Application No. 17/256555

- Rapid, low cost process for the preparation of SERS substrate and SERS substrate prepared thereby. Amit Asthana, Mohan Rao Chintalagiri, Saurabh Kumar Srivastava, Gopi Suresh Oggu. NFNO: 0202NF2020/WO, Country: WO, Lab: CCMB, India. Filing Date: 03.03.2021; Application No. PCT/IN2021/050198

2.2 C Awards & Honors

Research Staff

G R Chandak

- Elected Fellow, Indian National Science Academy, New Delhi, India
- Invited to be Adjunct Faculty, JSS Medical College, Hospital and Research Centre, Mysuru, India
- Member of National Institute of Biomedical Genomics (NIBMG) Governing Board
- Technical Advisory Committee of the Biological Sciences Division, Indian Statistical Institute for the term of 2020-2022
- Member of Selection Committee to select Biotechnology Research Innovation and Technology Excellence (BRITE) Awardees
- TAC Member of the Biological Sciences Division ISI
- DBT Nominee' for the Institutional Biosafety Committee (IBSC) constituted at Aurobindo Pharma Limited

Manjula Reddy

- Elected Fellow, Indian National Science Academy, New Delhi, India

Ramesh V. Sonti

- Prof. N. Appaji Rao Best Mentor Award 2020
- K. K. Nanda Memorial Lecture Award 2019 of the Indian Society of Plant Physiology

K. Thangaraj

- Awarded J C Bose Fellowship

Pavithra L. Chavali

- SERB-Women Excellence Award, 2020-2022

Mandar Deshmukh

- 2020 NMRS Subramanian Award of National Magnetic Resonance Society, India

R. Sankaranarayanan

- Infosys Award in Life Sciences 2020
- Board of Reviewing Editor at eLife

Rakesh K. Mishra

- Prof. Har Swarup Memorial Lecture (2020), Indian National Science Academy (INSA)
- Prof. N.R. Dhar Memorial Lecture (2020), National Academy of Sciences, India (NASI)

Students

Santosh Kumar Kuncha

- KV Rao Scientific Society Research Award

Pavan Kumar Chodisetty

- KV Rao Scientific Society Research Award (Runner up)

2.2 D Conferences & Symposia

Hy-Sci - 2021

HySci 2021 is a CCMB students' driven conference providing an excellent opportunity for PhD students and post-docs to showcase their research and also engage in discussions on troubleshooting and collaborating with peers in Hyderabad. The second edition of HySci, held online due to pandemic, from December 17 to 18, 2020, comprised of oral talks, posters, flash talks, panel discussions, plenary talk and expert interactions.

International e-conference on Recent Advances and Status of Wildlife Forensics

LaCONES-CCMB Organised 3-day International e-conference from 3rd to 5th November, 2020 on "Recent Advances and Status of Wildlife Forensics", which brought together nearly 700 wildlife biologists, veterinarians, scientists, students and conservationists from across the world. The conference was inaugurated by Director-General, CSIR, Dr. Shekhar Mande and Director, CCMB, Dr. Rakesh Mishra, and was also addressed by Shri Prakash Javadekar, Union Minister, Ministry of Environment, Forest & Climate Change. The objectives of the conference were to discuss global status of wildlife crime, molecular technologies available to tackle the same, and their applications for law enforcement

Workshop on Wildlife DNA Forensics

LaCONES-CCMB conducted Two-day workshop on "Workshop on Wildlife DNA Forensics and proper collection, storage, sealing, forwarding of different types of biological samples to the lab for DNA analysis for species identification, individual identification, sexing, relatedness etc." for 86 ACFs, RFOs, Veterinarians, Biologists, Education Officers and other field staff of Telangana Forest Department at Amrabad Tiger Reserve, Mannanur on 18-19 March 2021 mainly to enlighten them about the sample collection and preservation methods, DNA techniques and protocols developed by CCMB and their use in wildlife forensics and conservation breeding programs.

2.2 E MoUs & Agreements

- Towards Microbiome sequencing of throat swab samples from 500 suspected COVID-19 patients (Understanding the role of respiratory microbiome in Covid-19 disease susceptibility & progression and translational
  MoU with Tata Consultancy Services Limited (TCS)

- Collaborating for undertaking the research project on SARS-CoV2 "Covid19-Research Project"
  MoU with AIIMS-Bhubaneswar.

- Development of inactivated Covid-19 virus as antigen for the production of therapeutic immunoglobulin fragment for treatment of Covid-19 infection
  MoU with VINS Bioproducts Limited (Along with University of Hyderabad)

- Establishment of Proof-of-concept : NGS based diagnostics for COVID-19 (Proof-of-concept using 500 samples)
  MoU with Syngene International Limited

- Non binding mutual understanding between both for developing a covid 19 vaccine agaisnt SARS COV 2 VIRUS The GMP Compliant development and scale up of the vaccine developed for potential clinical trials & commercialisation of the vaccine
  MoU with Aurobindo Pharma Limited

- INCUBATEE UNDER AIC-Evaluation and Purification of Cordycepin as an anti-Viral agent against SARS.
  Clone Deals Private Limited-Tripartite

- INCUBATEE UNDER AIC-Collaboration on "Identification and Evaluation of repurposed Drugs for SARS-COV2
  QSTATIX Private Limited-Tripartite

- INCUBATEE UNDER AIC-Collaboration on "Development of LAMP based SARS-COV2 DIAGNOSTICS KITS
  Acrannolife Genomics Private Limited-Tripartite

- INCUBATEE UNDER CRTDH-Incubatee is engaged in Research & Development on oral insulin delivery
  Neelagil Technologies Private Limited-Licence Agreement

- INCUBATEE UNDER CRTDH-Incubatee is engaged in Evaluation of anti oxidant,Anti -Inflammatory, Immunomodulatory activities of selected medicinal /Herbal extracts using in vitro and ex/in-vivo systems"
  Sarvotham Care Limited - Licence Agreement

- INCUBATEE UNDER CRTDH-Incubatee is engaged in ïdentification of Neo-Antigens in various cancer models from Indian Patients
  PULSE PHARMACEUTICAL PRIVATE LIMITED-LICENCE AGREEMENT

- To formalize a framework of co- operation and to facilitate the collaboration between the parties to promote programmes and /or joint activities aimed at promoting a human-focused health research and ultimately full replacement for animal use through the "centre for Predictive Human Model Systems
  Humane Society International India

- Towards Microbiome sequencing of throat swab samples from 500 suspected COVID-19 patients (Understanding the role of respiratory microbiome in Covid-19 disease susceptibility & progression and translational
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  Pulse Pharmaceutical Private Limited-Licence Agreement

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  MoU with Humane Society International India

- Exploring the efficacy of U-VC BOX against SARS-COV2
  JCS Innovation India Pvt limited

- Hyderabad Reagent Consortium--An initiative to aggregate the capacities of delivering quality Covid-19 diagnostic kits for the nation. The Program aims to build a supply chain consortium of suppliers of reagents,components & KITS of COVID-19 testing.
  MoU with FIND (Foundation of Innovative New Diagnostics in India)

- ARCI will provide the UV-C box designsed by them for testing the Anti-viral efficacy. CCMB will obtain the necessary ethical and biosaftery approvals for conducting the project at CSIR-CCMB premises
  MoU with ARCI-Intenational Advanced Research center

- Improved Samba Mahsuri-Benefit sharing 40:40:20
  MoU with IIRR-ANGRAU

- Contractual services for the testing ,characterisation,method development and related activities
  Service Agreement-SANOFI

- CCMB and Kamineni Hospitals are desirous of collaborating for undertaking the research project on SARS-CoV2 "Covid19 –Research and Diagnostics"
  MoU with Kamineni Hospitals

- Indigenisation of DIAGNSOTICS (INDX)" with C-CAMP & Rockefeller Foundation. The Project Involves identifying bottlenecks in the supply chain network, Short falls in quality levels and gaps in the ability of these MSMEs to scale up diagnostics kits for Covid -19 virus.
  MoU with C-CAMP (Centre for Cellular & Molecular Platforms)

- CCMB is willing, on non-exclusive basis, to provide necessary technical help to Spice Healthcare for the "Implementation of the dry-swab protocol in the COVID diagnostics work being conducted by S-H"
  MoU with Spice Healthcare Private Limited

- Collaborating to develop and commercialize Covid test Kits based on DArRT-PCR Technology, developed and owned by CSIR-CCMB
  MoU with Apollo Hospitals

- CCMB & AHERF are desirous for undertaking the research project on SARS-COV2 covid19-Research & Diagnostics
  MoU with Apollo Hospitals Educational and Research Foundation

- CCMB & MERIL are joining hands for technology /know-how transfer of the "Dry swab Technology "from CCMB to MERIL for commercialization of COVID RT PCR-based test kits based on Dry-swab Technology, developed and owned by CCMB
  MoU with Meril Diagnostics

- Exploring the SARS-CoV-19 inhibitory, and/ or anti-Covid19 efficacy activities of selected Ayurvedic products/ formulations prepared by Arya Vaidya Sala
  MoU with Arya Vaidya Sala

- Community screening sero surveillance of COVID-19
  MoU with Bharat Biotech International Ltd.

- For wider outreach and utilization of CCMB facilities by C-CAMP.
  MoU with C-CAMP (Centre for Cellular & Molecular Platforms)

- Developing a software platform- SANDHI GENE VARIANT ANALYSIS
  MoU with Semantic Web India Private Limited-AIC-CCMB----------Tripartite

- FOSS & CCMB are collaborating for undertaking joint projects of common interests including material transfer, utilizing the facilities , expertise of both parties specific to the collaborative work proposed
  MoU with Friends Snake Society

- IIIT & APBL & CCMB collaborating for running the campus screening at IIIT for Covid 19 with ABPL Labs , a Startup out of IIT Bombay, providing pooling guidance software and CSIR-CCMB supporting the collaborative research project with their diagnostic expertise
  MoU with IIIT-Hyderabad & Algorithmic Biologicals Private Limited

- LifeCell has approached CCMB for utilizing its Novaseq 6000, NGS equipment and conducting SP flow cell runs for diagnostic purposes
  MoU with Lifecell International Private Limited

- Collaboration project on In vitro validations of whole crude and fractional extracts from punica granatum against different pathogenic viral strains of commercial importance
  MoU with Consytel Life Sciences

- Chattisgharh forest department with the help of CCMB, aims to take forward the critical need of conservation of Wildlife through use of modern scientific Technologies inputs and fact based management intervention
  MoU with Principal Chief Conservator of forest cum chief wildlife warden, Chattisgarh

- CCMB and TIFRH outlines the purpose and mode of execution for establishing and maintaining a TIFRH-CCMB Animal Unit, within the existing CCMB Animal Facility, at the site/ address of CCMB At the request of TIFRH
  Agreement with Tata Institute of Fundamental Research (TIFR)

2.2 F Invited Talks

Dr. Dhananjay Chaturvedi
National Center For Biological Sciences, Bangalore
"Muscle Repair and Maintenance in vivo"
March 31, 2021

Prof. Gagandeep Kang
Christian Medical College (CMC), Vellore
"Nevertheless we persist - A career in 10 chapters"
December 30, 2020

Prof. Raghavendra Gadagkar
Centre for Ecological Sciences, IISc, Bangalore
"Can We Understand an Insect Society, and Why Should We Care?"
November 26, 2020

CCMB Biologue

CCMB Biologue is a student-led initiative that invites varied experts in life sciences for online talks. These talks are open for all to attend.

Dr. Vishwesha Guttal
Centre for Ecological Sciences, IISc, Bangalore
"The Physics of Ecology: Fundamental Parallels Between Statistical Physics and Ecology"
March 11, 2021

Dr. **Sam Illingworth**
Edinburgh Napier University, Scotland
"Poetry of Science: Using poetry and games to develop dialogue between scientists and non-scientists"
February 12, 2021

Dr. Dasaradhi Palakodeti
InStem, Bangalore
"tRNA derived small RNA fragments: their biogenesis and function in stem cells"
January 28, 2021

Dr. Siddhesh Kamat
Indian Institute of Science Education and Research, Pune
"Chemicals Lens on Biology: A chemical biology approach towards understanding a human neurological disorder"
October 16, 2020

Dr. Madeline Lancaster
MRC Laboratory of Molecular Biology, Cambridge, UK
"Sneak peek into Mini-Brains: Examining Human Brain Structure and Function with Cerebral Organoids"
September 18, 2020

Dr. Steven Henikoff
Fred Hutchinson Cancer Research Center, HHMI Investigator
"Genome-wide mapping of protein-DNA interaction dynamics"
August 10, 2020

Prof. Grant Jensen
Caltech, HHMI Invetigator
"Potentials of Electron Cryo-tomography in unravelling the fundamentals of the cell"
July 9, 2020

2.2 G Events & Popular Talks

Independence Day (August 2020)

On the 74th Independence Day, on August 15, 2020, the Director, CCMB, hoisted the national flag on CCMB campus and addressed staff and students in a virtual session. In his address, he briefed the significant role that CCMB fraternity was playing in COVID activities including testing and training.

Hindi Day (September 2020)

September 14th, Hindi Day was celebrated in a virtual mode. Various competitions were held during the week and winners were awarded with prizes. Director, CCMB, addressed the staff and students.

CCMB Foundation Day (November 2020)

CCMB celebrates November 26th every year as its Foundation Day. This year, the foundation day lecture was delivered by Prof. Raghavendra Gadagkar, Centre for Ecological Sciences, IISc Bangalore on "Can We Understand an Insect Society, and Why Should We Care?"

Defence management officers from neighbouring countries visit (January 2021)

CCMB organized a special visit for 12 foreign delegates who hold higher defence management positions in their respective countries. This visit was requested by the College of Defence Management for the participants of their Discover India Program. As a part of this program, their participants closely interacted with organizations of national importance in India. The delegates belonged to the foreign countries with friendly relations with India. These included Bangladesh, Sri Lanka, Saudi Arabia, Turkey, Maldives and Myanmar. They visited CCMB premises on 21st Jan, 2021.

Republic Day (January 2021)

On the occasion of 72nd Republic Day, CCMB invited Shri Mahesh MuralidharBhagwat, IPS, Commissioner of Police, Rachakonda, as its Chief Guest.

Founder's Day (February 2021)

February 22nd is the birth date of CCMB Founder, Dr P M Bhargava. CCMB celebrates this day as its Founder's Day. In the year 2021, Dr Ashish Kothari (Founder, Kalpavriksh) was the Chief Guest and he delivered Founder's Day lecture on "Eco-swaraj: Towards a Rainbow New Deal". As part of Sci-setu, CCMB Alumni talks were delivered by Dr. Siyaram Pandey (University of Windsor, Canada) on "Role of mitochondrial dysfunction and oxidative stress in cell death; translational research for neurodegenerative diseases & cancer" and Dr.Shradha Goenka (Founder & Managing Director, Biotech Desk Pvt. Ltd.) on "Journey from Academia to Industry".

Visiting delegates with CCMB Director, Dr Rakesh Mishra

2.2 H Science Outreach & Popularization Programs

COVID-19 Communications

CCMB developed multiple posters to explain COVID-19 appropriate behaviour during the COVID-19 pandemic. It worked with CSIR HQs to reach a wide audience.

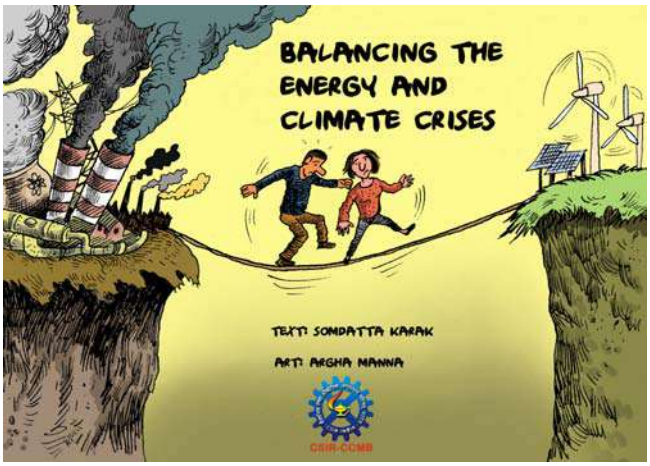
Open Week

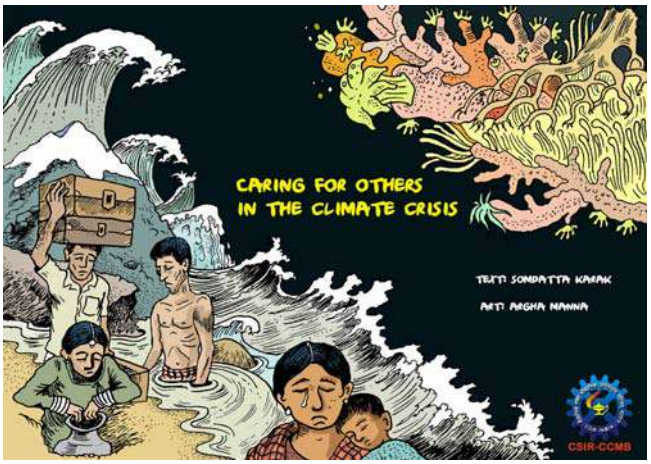
CCMB celebrated an online Open Week from 21-26 Sept, 2020. It conducted 20 sessions across the week focusing on the research areas in the institute. It also conducted 4 discussions on various aspects of pursuing life sciences as a career to inform and inspire the young attendees into science. In addition, there were many competitions and quiz to engage the attendees. More than 2000 people registered for the event across the country.

Climate Change Challenge

From Aug 2020 to Jan 2021, CCMB organized the Climate Change Challenge 2020 for high school students. The challenge aimed at equipping young students to think of climate change from a local perspective. This included lecture series by scientists working of different aspects on climate science and technological developments to fight climate change. The speakers also included entrepreneurs, social activists and citizen science organizers who are working towards the cause. Inspired by these talks, we developed comics that explain climate change from an Indian perspective, and are available here: https://www.ccmb.res.in/ClimateChangeChallenge/ Comix

Following the lecture series, the school students were encouraged to participate in a challenge to develop games and art to spread awareness on the issue, technological solutions to make their communities more resilient to climate change and research ideas to study climate change in their local communities. We reached out to Kendriya Vidyalayas and Jawahar Navodaya Vidyalayas across India through CSIR and NITI Aayog. 380 students participated in the challenge.





Wildlife Week Celebrations

LaCONES-CCMB conducted online art, poetry and quiz competitions for middle and high school students for Wildlife Week Celebrations in Oct 2020.

Vigyan Yatra by IISF 2020

CCMB participated in Vigyan Yatra conducted by India International Science Festival and conducted a day long session with its scientists for high school and college students. Scientists working in different areas of life sciences at CCMB spoke about their work to the audience in an online setting.

Young Innovators Program

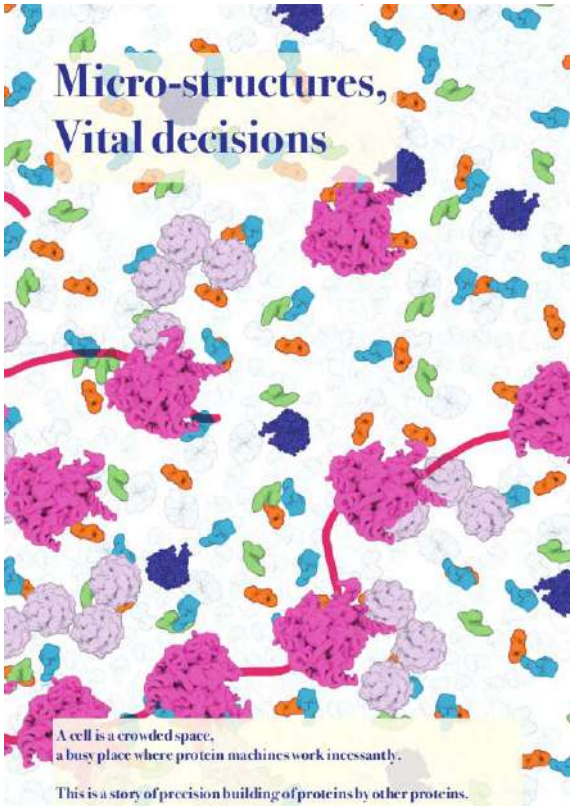
CCMB celebrated its 8th Young Innovators Program. The program started with a talk by Prof Gagandeep Kang, CMC Vellore on her career in infectious biology. This program provided a platform for high school students to spend a week in CCMB, perform hands-on experiments and discuss with scientists on their research questions.

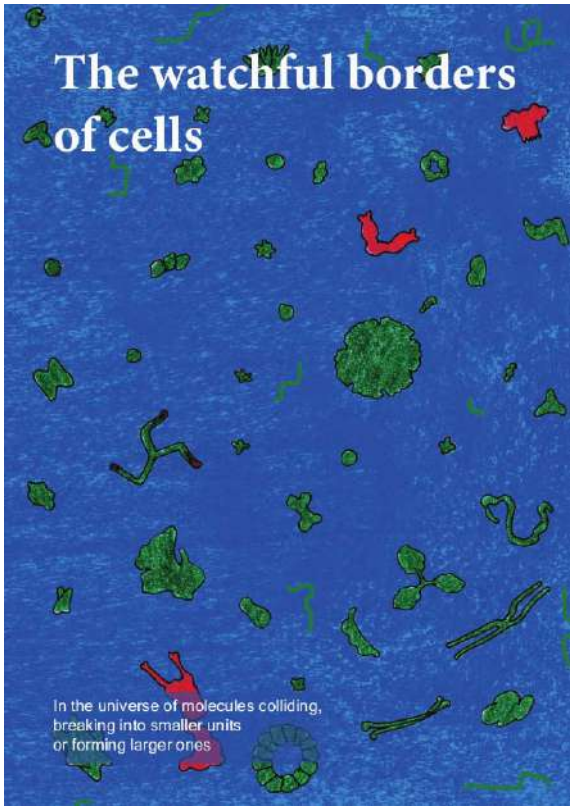
Ten students were selected from around 120 applicants across schools of Hyderabad on the basis of an online test. The number of students and the duration of the program was reduced to half due to the COVID-19 pandemic.

Zines on research at CCMB

CCMB developed a set of zines on structural biology, called Life, in short. This includes zines understanding physical basis of life, correlation between structure and function of proteins, and its importance in working of cells.

The zines are available here: https://www.ccmb.res.in/Zines





Milo CCMB

CCMB, in collaboration with Telangana Social Welfare Residential Educational Institutions Society (TSWREIS), is doing a series of animation videos and scientist-interaction series for high school and undergraduate students. These videos and follow-up discussions aim at exploring the role science plays in addressing social challenges. This includes questions of ancestry of Indians, disease prevalence and prevention, crop improvement.

Through this series, CCMB reaches out to thousands of women students, mostly from SC and ST communities at TSWREIS.

Antibiotic usage awareness

CCMB, as a scientific partner of Superheroes against Superbugs initiative, has released an animated video on correct usage of antibiotics in an Indian household. The video is available here: https://www.youtube.com/watch?v=K0ure8ZUS6U&list=PL6FAIj7XldHspWMPeFVwtTjflMiN4xhy8

2.2 I Media coverage


THE TIMES OF INDIA
WEDNESDAY, JANUARY 6, 2021
No Virus In Non-Covid Wards ■ Positivity Rate On Tue Less Than 1%
Coronavirus lingers in air of Covid-19 wards, finds study
CAUTION THE BEST WAY FORWARD
6,370
5,879
రండి.. పరీక్ష చేస్తాం
ప్రయోగాత్మకంగా కమ్యూనిటీ పరీక్షలు నిర్వహిస్తాం
GREAT
ఆన్‌లైన్‌లో సీసీఎంబీ ఓపెన్ డే
THE HINDU
FRIDAY, DECEMBER 11, 2020
dry swab tests
INDIAN EXPRESS
22.09.2020
BOVINE BOOST
Gene editing can help raise better cattle breeds: CCMB study
EXPRESS NEWS SERVICE
CSIR-CCMB, Apollo to scale up
Direct Amplification rapid RT-PCR test reduces time and human effort by 40-50%
HYDERABAD
ANDHRAJYO
MONDAY, 21 SEPTE
JANUARY 21, 2021
CCMB's Atal Incubation Centre gets ₹5.25 cr. seed support grant
ఒకే వ్యాక్సిన్.. అందరికీ!
హైదరాబాద్‌లో 6.6 లక్షల మందికి కరోనా.. పట్టించింది.. పోయింది!
THE TIMES OF INDIA
TUESDAY, DECEMBER 15, 2020
CCMB MoU with SpiceHealth for dry swab tests
Deccan Chronicle
Friday 5, March 2021
Study: Over half of city residents are asymptomatic
KANIZA GARARI | DC
HYDERABAD, MARCH 4
NEARLY 9,000 samples were collected in the first two weeks of January in 30 wards of the GHMC before the launch of the vaccine
LIGHT AT THE END
Killing SARS-CoV2 with
Tech made by a rural innovator who alre
Telangana Today
Covid: CCMB ties up with Bengaluru firm
calls for enhanced genome sequencing
397 COVID cases on Monday
Two samples with new virus variant genome-sequenced
ADVETCON 2020 Day 2: Scientific Session II on Molecular Technologies to f

2.2 J Staff, Research Students, Project Staff

SCIENTIFIC RESEARCH GROUPS

A S Sreedhar Group

A S Sreedhar	Senior Principal Scientist
A Vijaya Lakshmi	Senior Principal Scientist
K R Paithankar	Principal Technical Officer
Akhil Kotwal	Ph.D. student
Shrikant Dharaskar	Ph.D. student

Karthik Bharadwaj Group

Karthik Bharadwaj	Scientist
Anuj Dwivedi	Project Scientist-II
Lamuk Zaveri	Project Scientist
Chandreswara Raju K	Senior Project Associate
Vidhyadhari Methuku	Senior Project Associate
Ashutosh Aasdev	Project Associate-I
Aman Kumar Suryan	Project Associate-I
Devavrat Santosh Desai	Project Associate-I
Sai Priya Nurkurthy	Project Associate-I
Sumedha Avadhanula	Project Associate-I
Nemalikanti Uma Malini	Project Associate-I
Kottapalli Srividya	Project Associate-I
Himasri B	Project Associate-I
Navleen Kour Anand	Project Associate-I
Vodapalli Amareshwar	Project Associate-I
R. Hema Sindhuja	Project Associate-I

Purnima Bhargava Group

Purnima Bhargava	Emeritus Scientist

Venkata R Aditya Chalamcharla Group

Venkata R Aditya Ch	Senior Scientist
Anubhav Bhardwaj	Sr. Technical Officer (1)
Harsh Kapoor	Ph.D. student
Annapoorna K P	Ph.D. student
Sauvik Dasnaskar	Ph.D. student
Mamta Barku Nirmal	Project Associate-I

G R Chandak Group

G R Chandak	Chief Scientist
Seema Bhaskar	Principal Tech. Officer
Inder Deo Mali	Lab Assistant
P Ashok	Lab Assistant
Ashutosh Singh Tomar	Ph.D. student
Prachand Issarapu	Ph.D. student
Sara Sajjadi	Ph.D. student
Swati Bayyana	Ph.D. student
Sohail Rafik Mansuri	Ph.D. student
Alagu Sankareswaran	Ph.D. student
Suraj Singh Nongmaithem	Project Scientist-I
Rajnish Kumar Singh	Project Scientist-I
Harsha Lad	Project Scientist-I
Ajay Deepak Verma	Sr. Project Associate
Arumalla Manisha	Project Associate-I
Shoma Kumaresh Naskar	Project Associate-I
Bernadette Mathew	Project Associate-I
Punya Sri PSKDB	Project Assistant
ShaguftaTasneem	Project Assistant
Varsha Kolaria	Project Assistant

Amitabha Chattopadhyay Group

Amitabha Chattopadhyay	CSIR Bhatnagar Fellow
Ashwani Sharma	Ph.D. student
Subhashree S. Sahu	Ph.D. student
Parijat Sarkar	Sr. Project Associate
Sreetama Pal	Sr. Project Associate
Abhishek Kumar	Project Associate-I

Ch Mohan Rao Group

Ch Mohan Rao	CSIR-Distinguished Scientist
Kamakshi Dandu	Ph.D. student

Saikat Chowdhury Group

Saikat Chowdhury	Senior Scientist
Justus Francis	Ph.D. student

Mandar V Deshmukh Group

Mandar V Deshmukh	Principal Scientist
Sneha Paturi	Ph.D. student
Jaydeep Paul	Ph.D. student
Aute Ramdas Annasaheb	Ph.D. student
Debadutta Patra	Ph.D. student
Priti Chanda Behera	Ph.D. student

Jyotsna Dhawan Group

Jyotsna Dhawan	Emeritus Scientist
Sujoy Deb	Ph.D. student
Debarya Saha	Ph.D. student
Swetha S	Ph.D. student
Priti A S	Ph.D. student
Ananga Ghosh	Ph.D. student

G Umapathy Group

G Umapathy	Senior Principal Scientist
Vinod Kumar	Technical Officer
V Purushottam	Technical Officer
Mihir Trivedi	Ph.D. student
Manu S	Ph.D. student
Krupa Vinay Teja P	Ph.D. student
G Anusha	Ph.D. student
Gopikrishnan P	Ph.D. student
Manisha Ray	Ph.D. student
Khan Aamer S Zafarullah	Project Associate-I
Karne Divya Sree	Project Field Assistant

Ajay Gaur Group

Ajay Gaur	Senior Principal Scientist

H H Krishnan Group

H H Krishnan	Principal Scientist
M Mohan Singh	Technical Officer
Haripriya Parthasarathy	Ph.D. student
Divya Gupta	Ph.D. student
Vishal Sah	Ph.D. student
Dixitkumar Nanubhai T.	Ph.D. student
P. Sai Poojitha	Ph.D. student
Prangya Paramita Sahoo	Ph.D. student
Anoop B S	Sr. Project Associate

K Thangaraj Group

K Thangaraj	Chief Scientist (on lien)
Nitin C Tupperwar	Principal Scientist
G Mala	Principal Tech. Officer
S Deepa Selvi Rani	Sr. Technical Officer (3)
Jagamohan Chhatai	Technical Officer
Nipa Basak	Ph.D. student
Jaydeep A Badarukhiya	Ph.D. student
Lomous Kumar	Ph.D. student
Deepak Kumar Kashyap	Ph.D. student
Partheusa Machha	Ph.D. student
Rajesh V Iyer	Ph.D. student
Sunitha Reddy Kundur	Project Investigator
Narmadha Ganapathy	SERB National PDF

Arvind Kumar Group

Arvind Kumar	Senior Principal Scientist
Sachin Singh	Senior Scientist
Annapoorna P Karthyayani	Ph.D. student
Aditya Undru	Ph.D. student
Bhanu Pranav N S	Ph.D. student
Arpan Mukhoti	Ph.D. student
Devika Dnyanraj Mahimkar	Ph.D. student
Unis Ahmad Bhatt	Project Associate-II
Harish Anantha K. Iyer	Project Associate-I

Lekha Dinesh Kumar Group

Lekha Dinesh Kumar	Senior Principal Scientist
Rohitesh Gupta	Senior Research Associate

Megha Kumar Group

Megha Kumar	DST-INSPIRE Faculty
Sharda Ravi Iyer	Ph.D. student
Tuhina Prasad	Ph.D. student

Santosh Kumar Group

Santosh Kumar	Senior Scientist
Sitanshu Kumar Sarangi	Ph.D. student
Ketaki Bhagwat	Ph.D. student
Etikala Apoorva	Ph.D. student

Mukesh Lodha Group

Mukesh Lodha	Principal Scientist
Akanksha Garhewal	Ph.D. student

M Mohammed Idris Group

M Mohammed Idris	Senior Principal Scientist

Rakesh Kumar Mishra Group

Rakesh Kumar Mishra	AcSIR Disting. Emer. Professor
Rashmi Upadhyay Pathak	Senior Principal Scientist
Phanindhar K	Ph.D. student
Nikhil Hajirnis	Ph.D. student
Ashish Bihani	Ph.D. student
Ravina Saini	Ph.D. student
Avvaru Akshay Kumar	Ph.D. student
Soujanya M S	Ph.D. student
Sonu Yadav	Ph.D. student
Saketh Murthy	Ph.D. student
Puja Singh	DST-INSPIRE Faculty
Shreekant Verma	Project Scientist
Sankara Rao Kola	Senior Project Associate
Ashmala Naz	Senior Project Associate
Saher Chawla	Project Associate-I

N Nagesh Group

N Nagesh	Chief Scientist
Ira Bhatnagar	Principal Scientist
C B Tripura Sundari	Senior Scientist
Joel Kiran George	Project Associate-I
Nahid Anjum	Project Associate-I
Vimal Raj	Project Associate-I
Ekta Dagar	Project Associate-I
Renuga Devi M	Project Associate-I

Vinay K Nandicoori Group

Vinay K Nandicoori	Director
Yogita Kapoor	Ph.D. student
Priyadarshini Sanyal	Ph.D. student
Abhishek Saha	Ph.D. student
Saba Naz	Sr. Project Associate

P Chandra Shekar Group

P Chandra Shekar	Principal Scientist
Debabrata Jana	Ph.D. student
Vishnu Vijay	Ph.D. student
Mansi Srivastava	Ph.D. student
NiharikaTiwary	Ph.D. student
Hiral Shailesh Shah	Project Associate-I

Anant B Patel Group

Anant B Patel	Senior Principal Scientist
K S Vardarajan	Sr. Technical Officer (1)
Narayan Datt Soni	Ph.D. student
Dipak Roy	Ph.D. student
Bedaballi Dey	Ph.D. student
Kamal Saba	Ph.D. student
Ajay Sarawagi	Ph.D. student
Prajakta Pramod Biyani	Ph.D. student
Chaynita Dashora	Ph.D. student
Akila Ramesh	Ph.D. student
Sanjana Sinha	Project Associate-I

Hitendra Kumar Patel Group

Hitendra Kumar Patel	Principal Scientist
Raju Madanala	Sr. Technical Officer (2)
B Kranthi	Technical Officer
Vinoth Kumar	Technician
Vishnu Narayanan M	Ph.D. student
Komal Ashok Awalellu	Ph.D. student
Gokulan C G	Ph.D. student
Donald James	SERB National PDF
Rajkanwar Nathawat	Sr. Project Associate
Kamal Kumar Malukani	Sr. Project Associate
Jamaloddin	Sr. Project Associate
Palash Ghosh	Project Associate-I
Bipin Kumar K	Project Associate-I
Rennya P R	Project Associate-I
Namami Gaur	Project Associate-I
Deepak Niranjan	Project Associate-I
Vutukuri Rani	Project Field Worker

R Nagaraj Group

R Nagaraj	INSA Senior Scientist

Swasti Raychaudhuri Group

Swasti Raychaudhuri	Principal Scientist
Shemin Mansuri	Ph.D. student
Harshit Vaish	Ph.D. student
Pooja Ramesh Gupta	Ph.D. student
Aanchal	Ph.D. student
Suparna Ghosh	Ph.D. student
Pallavi Rao T	Ph.D. student
Richa Singh	Project Associate-I

Manjula Reddy Group

Manjula Reddy	Chief Scientist
G S N Reddy	Principal Tech. Officer
M B Madhavi	Sr. Technical Officer (2)
S Venugopal	Senior Technician (2)
Nilanjan Som	Ph.D. student
Raj Bahadur	Ph.D. student
Shambhavi Garde	Ph.D. student
Ashis Kumar Pradhan	Ph.D. student
Moneca Kaul	Ph.D. student
G Bhargavi Krishnasree	Ph.D. student
Suraj Kumar Meher	Ph.D. student
Vaidehi Mihir Rajguru	Ph.D. student
Nallamotu Krishna Chaitanya	Ph.D. student
Mangayarkarasi Nivaskumar	Project Scientist-II
Balaji V	Prl. Project Associate
Pavan Kumar Ch	Sr. Project Associate
Naga Sowmya V.	Project Associate-I

Kumaraswamy Regalla Group

Kumaraswamy Regalla	Senior Scientist
Abishek Bharadwaj	Ph.D. student
Priyanka Pant	Ph.D. student
Disha Nanda	Ph.D. student
Garima Slathia	Project Associate-I

Rajan Sankaranarayanan Group

Rajan Sankaranarayanan	Outstanding Scientist
P Shobha Krupa Rani	Senior Principal Scientist
Biswajit Pal	Principal Scientist
P Sambhavi	Sr. Technical Officer(1)
Jotin Gogoi	Ph.D. student
Sudipta Mondal	Ph.D. student
Pradeep Kumar	Ph.D. student
Sakshi Shambhavi	Ph.D. student
Koushick S	Ph.D. student
Mukul J S	Ph.D. student
Santhosh K	Ph.D. student
K Priyadarshan	Sr. Project Associate

Dinesh Babu K S	Senior Project Associate
Raghvendra Singh	Prl. Project Associate
Akshay Bhatnagar	Sr. Project Associate
Vinitha Lakshmi V	Project Associate-I
Ankit Roy	Project Associate-I
Bapin Kumar Panda	Project Associate-I

Yogendra Sharma Group

Yogendra Sharma	J C Bose Fellow
Syed Sayeed Abdul	Lab Attendant (2)
R Phanindranath	Sr. Technical Officer(1)
Amrutha H C	Ph.D. student
SaiUday Kiran P	Ph.D. student
Venu Sankeshi	Post-Doctoral Fellow

Imran Siddiqi Group

Imran Siddiqi	CCMB Emeritus Scientist
A Venkata Pardha Sardhi	Ph.D. student
Frank Keith Max	Ph.D. student
Sivakumar P	Ph.D. student
Aswan Nalli	Project RA-I
Jayesh Kumar Davda	Project RA-I
Arkasarathi Gope	Project Associate-I
Vishakha Bhardwaj	Project Assistant-II
Avinash Kumar Singh	Project Assistant-II
Chandan Kumar	Project JRF
Kaladhar Bethoju	Job Contract

Puran Singh Sijwali Group

Puran Singh Sijwali	Sr. Principal Scientist
Manish Bhattacharjee	Ph.D. student
Deepak Kumar	Ph.D. student
Zeba Rizvi	Ph.D. student
Srinivas Reddy G	Ph.D. student
Chhavi Dhawar	Ph.D. student
Somesh Machhindra Gorde	Ph.D. student
Kanika Saxena	Ph.D. student
Gayatri Pratyusha M	Ph.D. student
Renu Sudhakar	Sr. Project Associate
Angel Nivya M	Project RA-I
Priyanka Pundir	Project Associate-I

Divya Tej Sowpati Group

Divya Tej Sowpati	Scientist
Nitesh Kumar Singh	Sr. Technical Officer (1)
Sofia Banu	Ph.D. student
Sangepu Jyothi	Scientific Admin. Asst.

Ghanshyam Swarup Group

Ghanshyam Swarup	INSA Senior Scientist
A. Kishore Raghawan	Sr. Project Associate

Raghunand R Tirumalai Group

Raghunand R Tirumalai	Principal Scientist
Ravi Prasad Mukku	Ph.D. student
Korak Chakraborty	Ph.D. student
Shiela Chetri	Research Associate-I
Kokavalla Poornima	Project Associate-I
Muskan Gupta	Project Associate-I

Shrish Tiwari Group

Shrish Tiwari	Principal Scientist
Prachi Singh	Senior Scientist
P Ramesh	Prl. Technical Officer
Deepti Rao	Ph.D. student
Ruby Srivastava	Project Investigator
Tummala Nikhila Sai	Project Associate-I

Tushar Vaidya Group

Tushar Vaidya	Chief Scientist
Sanjay Kumar Suman	Technical Officer
Loka Ram Prasad	Ph.D. student
Pradyumna Swanand P.	Ph.D. student
Devi Prasad V	Ph.D. student
Salunkhe Satyajeet Sunil	Ph.D. student
Aayushi Arora	Project Associate-I

Karthikeyan Vasudevan Group

Karthikeyan Vasudevan	Senior Principal Scientist
B Sambasiva Rao	Principal Scientist
S Harika	Technical Officer
K Rajya Lakshmi	Technical Officer
Afsar Sogra	Lab Assistant
Siddharth Bhatia	Ph.D. student
Gayathri Sreedharan	Ph.D. student
Ravi Kumar Singh	Ph.D. student
Avni Blotra	Ph.D. student
Alka Sahu	Ph.D. student
Yashwant Singh Panwar	Ph.D. student
Snehalatha Vadigi	DST Inspire Faculty
Ranjit Kumar Sahoo	DST Inspire Faculty
Tanushree Srivastava	Sr. Project Associate
Javaid Hameed	Project Associate-I
Moomin John	Project Associate-I
Sneha N	Project Associate-I
Sripuram Srinivas	Project Field Assistant
Anand Meharwade	Project Field Assistant
Dheeravath Sarika	Project Field Assistant

P Anuradha Reddy Group

P Anuradha Reddy	Principal Scientist

V Radha Group

V Radha	Emeritus Scientist
Aswathy G Krishnan	Project Assistant-I

Sonal N Jaiswal Group

Sonal N Jaiswal	Senior Scientist
J Nandan	Ph.D. student
K Aishwarya Arun	Ph.D. student
Priyanka Pandey	Ph.D. student
Brinda Palliyana	Project Associate-I
Reshmi Varghese	Project Associate-I

Pavithra Chavali Group

Pavithra Chavali	Senior Scientist
Sourav Ganguli	Ph.D. student
Dhruv Kumar Shakyawar	Project RA-I
Rajashree Ramaswamy	Project Associate-I

B Kiran Kumar Group

B Kiran Kumar	Senior Scientist
Mohammed Ghalib	Project Associate-I
Parekh Yash Rajendra	Project Associate-I
Jessie Thomas	Project Associate-I

Meghna Krishna Das Group

Meghna Krishna Das	Senior Scientist
Vinayak Prakash Saini	Ph.D. student
Rishiddh Jhaveri	Ph.D. student

Jahnavi Joshi Group

Jahnavi Joshi	Senior Scientist
Aditi	Ph.D. student
Abhishek Gopal	Ph.D. student
Mihir R Kulkarni	SERB National PDF
Bharti K Dharapuram	Sr. Project Associate
Pooja Pawar	Project Associate-I
Pragyadeep Roy	Project Associate-I
Nehal Gurung	Project Associate-I

PhD Students on Lab Rotation

Pathri Achyutha Krishna
Deena T David
Suhail Madhar Hanif S
Amit Chakraborty
Manash Kumar Behera
Elarani Majhee

S&T Resource Group

K Lakshmi Rao	Sr. Principal Scientist
P Kavin Kennedy	Sr. Principal Scientist
V Vijaya Bhaskar	Principal Scientist
Suman Siddharth Thakur	Principal Scientist
Manoj Balyan	Senior Scientist
S Thanumalayan	Sr. Technical Officer (3)
Sandeep Shrivastava	Sr. Technical Officer (1)
M Sanjeev Chavan Nayak	Technical Officer
G Vidyasagar	Lab Attendant (2)

Innovation Cell

V Srinivas	Prl. Technical Officer
Y V Subba Lakshmi	Sr. Technical Officer (3)
Hemalatha	Senior Steno
K Srinath	Lab Attendant (2)
Afna Safia	Project Associate-II
Asmita Abuwani	Project Associate-I
Varnali Acharya	Project Associate-I
Sharath Chandra T	Project Associate-I

Diagnostics Facility

M K Kanakavalli	Sr. Technical Officer (1)
V Jyothi	Project Assistant
M Pallavi	Project Assistant

Wildlife Forensics Facility

O V Padmalatha	Sr. Technical Officer (2)
Raghavendra Babu	Technician (1)

SAXS Facility

R Rukmini	Prl. Technical Officer
K Mallesham	Technical Officer

Research Grants Office

Sravanti Vaidya	Project Scientist-III
Shailaja Kanumuri	Lab Technician

Academic Cell

Anitha V	Office Assistant

CCMB-Atal Incubation Centre

N MadhusudhanaRao	Chief Executive Officer
Ramjee Pallela	Chief Operating Officer
Ritika Marrampalli	Commun. Manager
Ashish Kumar Perukari	Manager – Technology & Innovations

TECHNICAL GROUPS

RESEARCH FACILITIES

Animal House

M Jerald Mahesh Kumar	Sr. Principal Scientist
Jedy Jose	Sr. Technical Officer (2)
N Sairam	Technical Officer
S Prashanth	Technician (1)
M Nageswara Rao	Lab Assistant
K Raju	Lab Assistant
M Rajeshwari	Multitask Staff

Bioinformatics

Surabhi Srivastava	Sr. Technical Officer (2)
Archana Verma	Project Associate-I
Deepak Sharma	Project Associate-I
Priya Singh	Project Assistant-II
Onkar Vasanthrao Kulkarni	Project Associate-I
Abhijeet Karan	Project Associate-I
Tummala Nikhila Sai	Project Associate-I
Priya Singh	Project Associate-I

BSL 2/3 facility

Amit Kumar	Technical Assistant

Cryo EM facility

Harikrishna Adicherla	Sr. Technical Officer (2)

Drosophila Facility

V Bharathi	Sr. Technical Officer (2)
K Ramachandra Rao	Technical Officer

Imaging Facility

Nandini Rangaraj	Chief Scientist
C Subbalakshmi	Prl. Technical Officer
G Srinivas	Sr. Technical Officer (2)
T Avinash Raj	Sr. Technical Officer (1)
Suman Bhandari	Technical Officer

Next Generation Sequencing Facility

Mohammad Jafurulla	Sr. Technical Officer (2)
A Sreenivas	Sr. Technical Officer (1)

Proteomics Facility

V Krishna Kumari	Prl. Technical Officer
B Raman	Prl. Technical Officer
Y Kameshwari	Prl. Technical Officer
K Ranjith Kumar	Technical Assistant

Tissue Culture Facility

Avtar Singh Meena	Scientist
Ch Varalakshmi	Prl. Technical Officer
V R Sundereswaran	Prl. Technical Officer
Zareena Begum	Prl. Technical Officer
B V V Pardhasaradhi	Prl. Technical Officer
D Partha Sarathi	Sr. Technical Officer (2)
S Easra	Senior Technician (2)
T Dayakar	Lab Attendant (2)

Transgenic Knockout Facility

B Jyothi Lakshmi	Sr. Technical Officer (2)
S Purnima Sailasree	Sr. Technical Officer (1)
Asha Kumari	Technical Officer

Zebrafish Facility

M L Arvinda Swamy	Sr. Technical Officer (1)

SUPPORT FACILITIES

Planning, Monitoring and Evaluation (PME)

M R Vishnu Priya	Chief Scientist
B V Ramakrishna	Public Relations Officer & Central Public Information Officer
Gulzar Khan	Lab Attendant (2)

Business Development, Human Resources & Documentation Group

Archana B Siva	Sr. Principal Scientist
R Leela Kumari	Prl. Technical Officer
Divya Singh	Sr. Technical Officer (2)
K Anitha	Technician (1)

Fine Biochemicals

Y Rama Dasu	Prl. Technical Officer
Kishore Joshi	Prl. Technical Officer

Instrumentation Group

I Asha Ramesh	Prl. Technical Officer
Mahesh Prasad	Prl. Technical Officer
U S T R B Bapi Raju	Prl. Technical Officer
B Venkata Narayana	Prl. Technical Officer
N Ravindra Chakravarthi	Sr. Technical Officer (3)
Dattatrya N Gurkhel	Sr. Technical Officer (2)
K Sanjeev Kumar	Sr. Technical Officer (2)
A Syam Kumar	Sr. Technical Officer (2)
A Bala Murugan	Sr. Technical Officer (1)

Sudatt T Tambe	Sr. Technical Officer (1)
Devender Sundi	Sr. Technical Officer (1)
Chetan R Khapekar	Technical Officer
Amol Mandlik	Technical Assistant
Angothu Ramesh	Technical Assistant

Information Technology (IT) Group

GeethaThanu	Principal Scientist
Sublari Balaraju	Principal Scientist
Aparna Kumari	Senior Scientist
Biswajit Roy	Scientist
P Nagalinga Chary	Prl. Technical Officer
P Radhakrishna Murthy	Prl. Technical Officer
K Sambasiva Rao	Sr. Technical Officer (3)
N Siva Rama Prasad	Sr. Technical Officer (3)
A Padmavathi Devi	Sr. Technical Officer (3)
S Mahalingam	Sr. Technical Officer (2)
K Rama Chary	Sr. Technical Officer (2)
Sreekanth Mamidala	Sr. Technical Officer (1)
K Gopichand	Sr. Technician (2)
M Srinivasa Rao	Lab Assistant

Laboratory Technical Services & Horticulture

Mani Ramana Rao	Senior Steno
P Gyaneshwar	Lab Assistant
L Laxman Dora	Lab Assistant
M A Jaleel	Lab Assistant
B Sanjeeva Rao	Lab Assistant

Engineering Services

G C Thanu	Senior Suptd Engineer
Ch Bikshamaiah	Senior Suptd Engineer
Ashok Baswa	Senior Suptd Engineer
G Rajendra Prasad	Senior Suptd Engineer
Devidas M Nikhar	Suptd Engineer
B Vijaya Kumar	Executive Engineer
K Nagendrababu	Executive Engineer
A Varaprasada Rao	Executive Engineer
V Prabhakar	Senior Technician (2)
Ch Ravindra Babu	Senior Technician (2)
K Mohan	Senior Technician (2)
M Tirumala Rao	Senior Technician (2)
Ananda S Pahurkar	Senior Technician (2)
A J Narsing Rao	Senior Technician (2)
K Shankar	Senior Technician (1)
D Vinod Kumar	Technician (1)
L Kumar	Technician (1)
Anirban Adhikari	Technician (1)
Mallikanti Srinu	Technician (1)
Suresh Babu Mareedu	Technician (1)
S Venkata Sastry	Lab Assistant
P Venkatarama Rao	Lab Assistant
T Venkateswar Rao	Lab Assistant
M Mazhar Ali	Lab Assistant
K Sreeram	Lab Assistant
K Nagabhushanam	Lab Assistant
Syed Khundmier	Lab Assistant
C Rosaiah	Lab Assistant
V Shankar Rao	Lab Assistant
B Satyanarayana	Lab Assistant
T SambasivaRao	Lab Attendant (2)
P Srinivas	Lab Attendant (2)

ADMINISTRATION & MANAGEMENT

Director's Office

D Lavanya	Sr. Technical Officer (3)
B V N Naveen Kumar	Technical Officer
S Madhuri	Staff Officer & I/c Academic Cell
Somdatta Karak	Communications Officer

Administration

Pooja P. Kulkarni	Controller of Administration
Amarjeet	Administrative Officer
Ram Kumar Singh	Administrative Officer
Anirudh Manwal	Section Officer (G)
Noopur Rani Prasad	Hindi Officer
Naveen Kumar	Private Secretary
J Venu	I/c Transport
S Kanchanamala	Asst Section Officer (G)
R Gopal	Asst Section Officer (G)
Manju Singh	Asst Section Officer (G)
T Rajani	Sr. Secretariat Assistant (G)
ChSridevi	Sr. Secretariat Assistant (G)
Ashok Kumar Swasani	Sr. Secretariat Assistant (G)
Abdul Raheem Qureshi	Jr. Secretariat Assistant (G)
Savita Kumari	Junior Hindi Translator
K Madhavi	Receptionist
Mohd Pasha	Senior Technician (2)
M Devendra Nath	Senior Technician (2)
D Ramesh	Senior Technician (2)
B Sadanandam	Senior Technician (2)

Mahender Vynala	Technician (1)
Mohd Gazanfar Ali	Lab Assistant
K Krishnamacharyulu	Lab Assistant
Ch Chandrashekar	Lab Assistant
S Yadaiah	Lab Assistant
Savitri Luhura	Lab Attendant (2)
M Sharadha	Bearer
Ambe Naveen Kumar	Multitask Staff

Finance & Accounts

Kolla Ramesh	Controller of Finance & Accounts
K Mahalakshmi	Section Officer (F&A)
K Rama Krishna	Asst Section Officer (F&A)
Vimala Prakash	Asst Section Officer (F&A)
V V L Prasanna	Sr. Secretariat Assistant (G)
K Sujatha	Sr. Secretariat Assistant (F&A)
M V Subba Rao	Senior Steno
G Anuradha	Junior Secretarial Assistant
W Sudhakar	Senior Technician (2)
M Vishnu Yadav	Technician (1)
K Venkateswarulu	Lab Assistant

Stores & Purchase

S Gnanaprakasam	Senior Controller of Stores & Purchase
Jai Singh	Stores & Purchase Officer
Govind Kumar Jha	Asst. Section Officer (S&P)
S Aruna	Asst. Section Officer (S&P)
S S Lakshmi	Sr. Secretariat Assistant (S&P)
N S Sandeep Kumar	Sr. Secretariat Assistant (S&P)
D Balaji Prasad	Senior Technician (2)
S Riyasat Ali	Senior Technician (1)
Maqsood Ali	Junior Steno
Preethi Arjunan	Jr. Secretariat Assistant (S&P)
Mohd Yakub Akheel	Lab Attendant (1)

Medical Services

V Venugopal Rao	Medical Officer
T Nagalakshmi	Sr. Technical Officer (1)
A Mahesh	Technical Officer
U V Sitaramamma	Senior Technician (2)
R Palnitkar	Consultant
G Sujatha	Consultant
Ravinder Reddy D	Project Fellow

Security

C V Tirumala Rao	Senior Security Officer
Raveendra Kumar KVVS	Senior Security Officer*

* On deputation

Guest House

Anil Kumar Sahu	Principal Tech Officer
G Christy Wilson	Senior Technician (2)
Benedict	Senior Technician (2)
K Ramesh Babu	Senior Technician (2)
Mohd Jaffer	Lab Assistant

Canteen Group

Vikram Kumar	Sr. Technical Officer (1)
M Venkatesan	Senior Technician (2)
P M Mani Maran	Senior Technician (2)
Mohd Athar Ali	Lab Assistant
N Aruna	Lab Assistant
R Suresh Kumar	Lab Assistant

2.3 JONAKI-BRIT/DAE ^{32}P Labelled Biomolecules Laboratory

The Labelled Biomolecules Laboratory, Regional Centre (RC), Jonaki, Board of Radiation & Isotope Technology (BRIT), Department of Atomic Energy, situated in the Centre for Cellular & Molecular Biology (CCMB) campus is serving the various national laboratories, universities, industrial research centres, and hospitals involved in biotechnology, agriculture, life sciences & medical research by providing ^{32}P labelled nucleotides since 1988.

We supply ^{35}S labelled amino acids and a range of 99m Tc-radiopharmaceutical cold kits produced at Radiopharmaceutical laboratory of BRIT in Mumbai. Cold kits are for use in conjunction with 99m Tc-Pertechnatate, in imaging of human organs for diagnosis and treatment, to the nuclear medicine centres of the hospitals and diagnostic centres in and around Andhra Pradesh. In order to expand the service we will soon begin supply of 99m Tc sodium pertechnetate from radio-pharmacy laboratory at RC, JONAKI.

JONAKI, BRIT has a patented FRET based qPCR chemistry which has been validated. Real time M.tb detection kit based on the above FRET technology have been developed and clinically evaluated in collaboration with Nizam's Institute of Medical Sciences (NIMS), Hyderabad. Proto type kits are under evaluation before they are introduced as regular products. We supply Taq DNA polymerase, PCR master mix, and DNA Isolation kits across the country on a regular basis.

LIST OF PRODUCTS

RADIOACTIVE BIOCHEMICALS

1. ^{32}P Nucleotides:

CODE	PRODUCT
101	[γ ^{32}P] ATP
102	[α ^{32}P] dCTP
103	[α ^{32}P] dATP
104	[α ^{32}P] dGTP
106	[α ^{32}P] ATP
107	[α ^{32}P] GTP
108	[α ^{32}P] UTP
109	[α ^{32}P] CTP
1010	[3'5'- α ^{32}P] pCP
1011	[γ ^{32}P] GTP
LCP 32	[32P]-Orthophosphoric acid

The above products are available in two formulations (dry ice and ambient temperature shipments) fortnightly.

2. ^{35}S Amino acids:

CODE	PRODUCT
LCS 1/LCS 2	^{35}S Methionine
LCS 3	^{35}S Cysteine
LCS 7	^{35}S Methionine-Cysteine mix Eleg mix
LCS 6	^{35}S Glutathione
LCS 8	Protein *in vivo* twin label mix

NON-RADIOACTIVE BIOCHEMICALS

CODE	PRODUCT
LCK-1	Nick Translation Kit
LCK-2	Random Primer Kit
LCK-1601	dNTP mix for PCR (1 set of 4 dNTPs in 4 x 25 µl)
LCK-1602	dNTP mix for PCR (3 set of 4 dNTPs in 4 x 25 µl)
LCK-1603	dNTP mix for PCR (5 set of 4 dNTPs in 4 x 25 µl)
LCK-1604	dNTP mix for PCR (10 set of 4 dNTPs in 4 x 25 µl)
LCE-101	Taq DNA Polymerase Enzyme (100 Units)
LCE-102	Taq DNA Polymerase Enzyme (250 & 500 Units)
LCE-103	Taq DNA Polymerase Enzyme (1000-4000 Units)
LCE 104	Taq DNA Polymerase Enzyme (5000-50000 Units)
LCE 105	Taq DNA Polymerase Enzyme (60000 up to 90000 Units)
LCE 1000	Bulk packs more than 100000 units on enquiry

PMX 01	PCR Master Mix [100 Rxn (2 x 50)]
PMX 02	PCR Master Mix [250 Rxn (5 x 50)]
PMX 05	PCR Master Mix [500 Rxn (5 x 100)]
PMX 10	PCR Master Mix [1000 Rxn (5 x 200)]
PMX 1000	PCR Master Mix (On enquiry)
LCK1701	*M.tuberculosis* PCR detection kit (25 reaction kit)
LCK 1702	*M.tuberculosis* PCR detection kit (50 reaction kit)
LCK 20	Genomic DNA Isolation kit (50 reaction kit)
LCK 21	Genomic DNA Isolation kit (100 reaction kit)
LCK 22	DNA Isolation kit (Plasmid) (50 reaction kit)
LCK 23	DNA Isolation kit (Plasmid) (100 reaction kit)
LCK 24	DNA Gel Purification kit (50 reaction kit)
LCK 25	DNA Gel Purification kit (100 reaction kit)
LCK 26	PCR Product Purification kit (50 reaction kit)
LCK 27	PCR Product Purification kit (100 reaction kit)

Staff of JONAKI (as on 31-03-2020)

1. Ms Papia Hazra, OIC, RC HYDERABAD
2. Dr B.R. Varma, Manager
3. DR. T.K. Sankaranarayan, Manager
4. Mr N. Ambedkar
5. Mr M. Srineevasulu
6. Mr S. Srikanth
7. Mr T.K. Sudhir
8. Ms T. Raja Rajeswari
9. Mr M.B. Kumbhar10. Mr P.B. Morey
11. Mr Jagdish Chandra
12. Mr S. Venkatesh
13. Mr Yakub Ali

Order for all products can be directly placed with:
OFFICER-IN-CHARGE,
REGIONAL CENTRE, JONAKI,
BRIT, CCMB CAMPUS, UPPAL ROAD,
HYDERABAD-500 007

E mail: rcrhyderabad@britatom.gov.in