BOSE INSTITUTE

AN AUTONOMOUS INSTITUTE UNDER DEPARTMENT OF SCIENCE & TECHNOLOGY, GOVT. OF INDIA

ANNUAL REPORT

2023-24

THE 107TH FOUNDATION DAY

The 107th Foundation Day of Bose Institute was celebrated on November 30, 2023. **PROF. DR. PAOLO GIUBELLINO**, Scientific Managing Director, Facility for Antiproton and Ion Research in Europe GmbH (FAIR GmbH), GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany, delivered 84th Acharya J.C. Bose Memorial Lecture on "India and Big Science: A Success Path for the 21st Century". JÖRG BLAUROCK, Technical Managing Director, Facility for Antiproton and Ion Research in Europe GmbH (FAIR GmbH), GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany, presided over the programme.

BOSE INSTITUTE

(An Autonomous Institute under Department of Science & Technology, Govt. of India)

ANNUAL REPORT
2023-2024

Edited by the members of
Bose Institute

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Registrar, Bose Institute
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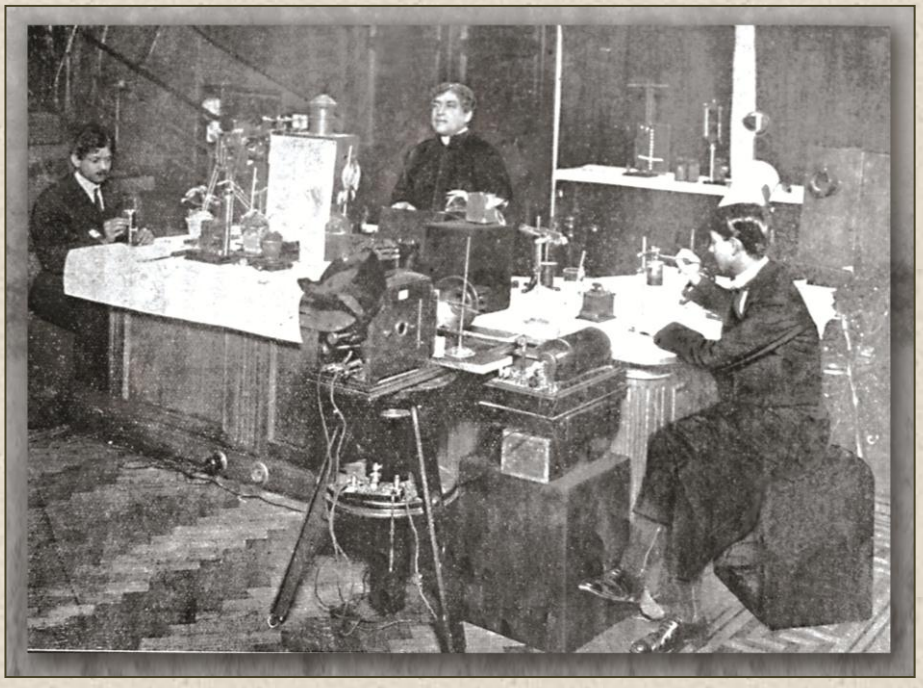
DIRECTOR'S MESSAGE



FROM THE DIRECTOR'S DESK

Bose Institute hosts more than 40 scientists across various disciplines and has the infrastructure and facilities to grow bigger. The depth and breadth of research areas of this century-old institute of higher learning reflect the insightful and forward-thinking vision of the institute's former leaders and scientists. The facilities developed to promote excellent research and valuable products by Bose Institute scientists are fruits of visionary thinking. Of course, in analogy to the famous 'Red Queen Hypothesis,' we must continuously adapt, evolve, and proliferate to survive and cater to the growing needs, unexpected newer challenges, and attain greater heights. Bose Institute fulfilled its promise for over a century and served as a melting pot of ground-breaking ideas and discoveries of great Indian scientists. Bose Institute's contributions to placing India as one of the top countries regarding scientific output are exemplary.

As Director of Bose Institute, I am determined to support and augment ongoing research activities and expand research on major contemporary societal issues by taking new initiatives. In addition to supporting ongoing research in Biological, Chemical, and Physical Sciences, I would like to establish an 'Interdisciplinary Research Centre' to bring together bright minds from areas such as medicine, computer science, and statistics to work on large contemporary problems of global concerns in collaboration with leading universities/ research centres of the world. Steps have been taken to implement projects that benefit from the application of artificial intelligence and machine learning (AI-ML) in areas such as energy, climate change, environment, agriculture, healthcare, drug discovery and even the origin of elements in the universe.

In addition, by combining efforts of the Departments of Biological Sciences and Chemical Sciences, we will identify thrust areas including age-related neurodegenerative diseases, air pollution-related pulmonary diseases, mental disorders, and encourage scientists to work on such areas in national mission-mode projects and international collaborations aligning with the vision of the Government of India. We take advantage of being a part of one of the largest clusters of scientific institutes in the country in Kolkata to share ideas and facilities by setting up collaborative projects with neighbouring institutes of higher learning and major hospitals and diagnostic centres.

A group of scientists from the Department of Physical Sciences are involved in ALICE experiment at CERN. Bose Institute serves as the nodal agency to co-ordinate the Indian participation not only in the construction of the upcoming multi-million-dollar Facility for Antiproton and Ion Research (FAIR), a multidisciplinary particle accelerator to be used in nuclear structure and reaction, high-energy physics, structure of hadrons, atomic and plasma physics but also in experiments using the machine. Scientists at this Institute are working on characterisation of the new prototype detectors for the Compressed Baryonic Matter (CBM) at FAIR.

Bose Institute has a rich legacy of disseminating knowledge to the nation for more than a century. In addition to the existing PhD programme, I would like to focus on integrated MSc-PhD programmes in Biological, Chemical, and Physical Sciences. Bose Institute scientists will continue to boost outreach activities to remote places, schools and colleges, especially to encourage less-privileged citizens and women to take research as a career and support them.

I envisage working closely with all my colleagues at Bose Institute and the Department of Science and Technology to uplift the institute to a new level. I strongly believe that the new campus, existing state-of-the-art facilities, and academic and administrative prowess have already created the basis, and with strong leadership, this goal could be achieved. Collaboration and open communication are the keys to success in any endeavour. I am also committed to fostering a safe, supportive and inclusive environment where all voices are heard and valued.

His excellency, German Ambassador Dr. Phillip Ackermann along with the German Consul General in Kolkata Ms. Barbara Voss and cultural attaché of the German Embassy in India visited Bose Institute on 13th October 2023.

Dr. Dipyaman Ganguly, Principal Scientist, CSIR-IICB and Shanti Swarup Bhatnagar Awardee 2022 presented a talk titled “Plasmacytoid dendritic cells and their role in diverse clinical contexts” organised by the Department of Biological Sciences, Bose Institute, Kolkata on October 18, 2023.

ABOUT
BOSE INSTITUTE

Prof. Sumantra Chattarji, Director, CHINTA, TCG Centres for Research and Education in Science and Technology (CREST), Salt Lake, Kolkata, delivered the Bose Institute Colloquium on “Astro”logy and Autism: New Insights from recordings in human brain cells” on May 8, 2023, organized by Prof. Dhruba Gupta and Prof. Shubhra Ghosh Dastidar.

Prof. Uday Chand Ghoshal, Professor and Head, Dept. of Gastroenterology, SGPGI, Lucknow, delivered a lecture titled "Pathogenesis of irritable bowel syndrome, a common bowel disorder, including the post COVID-19 IBS and the role of gut microbiota dysbiosis" on September 4, 2023

Bose Institute is awarded this year for recognition at the "Ananda Shiksha Samman 2023" for the top position (Ananda Shiksha Shrestha Samman 2023).

Professor Uday Bandyopadhyay, the Director of our Institute, received the certificate and memento on behalf of our beloved Institute on June 8, 2023 at Rangmanch, Swabhumi, Kolkata.

MANAGEMENT OF THE INSTITUTE

Bose Institute is a grant-in-aid autonomous institution under the Department of Science and Technology (DST), Ministry of Science & Technology, Government of India. It has a Governing Body. The management of the Institute is vested in Bose Institute Council. The Institute also has a Finance Committee responsible for the financial policies and management.

Bose Institute Governing Body

1. Prof. S.N. Chatterjee
2. Shri Somnath Sanyal
3. Prof. D. Banerjea
4. Dr. Anutosh Chatterjee
5. Dr. Manish Sekhar Chakraborty
6. Shri D. Mandal
7. Shri Dilip Bhattacharyya
8. Prof. Parul Chakrabarti
9. Prof. Bikash Sinha
10. The Director, Bose Institute – Secretary

Bose Institute Council

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   Honorary Professor, Molecular Biophysics Unit, IISc, Bangalore.
3. Prof. G. Balakrish Nair
   Distinguished Professor, RGCB Bio Innovation Center, Thiruvananthapuram, Kerala
4. Prof. Subodh R. Shenoy
   Visiting Professor TIFR, Hyderabad
5. Prof. Basanta Kumar Nandi
   Dept. of Physics, IIT Mumbai.
6. Secretary, DST or his nominee
7. Financial Adviser, DST
8. The Chief Secretary, Govt. of WB or his nominee
9. The Director, Indian Association for the Cultivation of Science, Kolkata
10. The Director, S. N. Bose National Centre for Basic Sciences, Kolkata
11. The Director, Bose Institute
12. The Registrar, Bose Institute – Non-Member Secretary

Members of the Finance Committee

The Chairman, Bose Institute Council, *Chairman*.

Secretary, DST,
Govt. of India or his nominee

Financial Advisor, DST,
Govt. of India or his nominee

The Director, Bose Institute

The Registrar, Bose Institute – Secretary

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Prof. Dipankar Nandi, Member
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IISc, Bangalore

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Department of Physical Science
IISER, Kolkata

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Indian Institute of Science Education
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Director, IISER, Thiruvananthapuram
Maruthamala PO, Vithura, Thiruvananthapuram

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ICMR – National Institute of Malaria
Research (Delhi Campus), New Delhi

Prof. Mahan Maharaj, Member
School of Mathematics,
Tata Institute of Fundamental Research, Mumbai

Registrar, Non-Member Secretary, Bose Institute, Kolkata

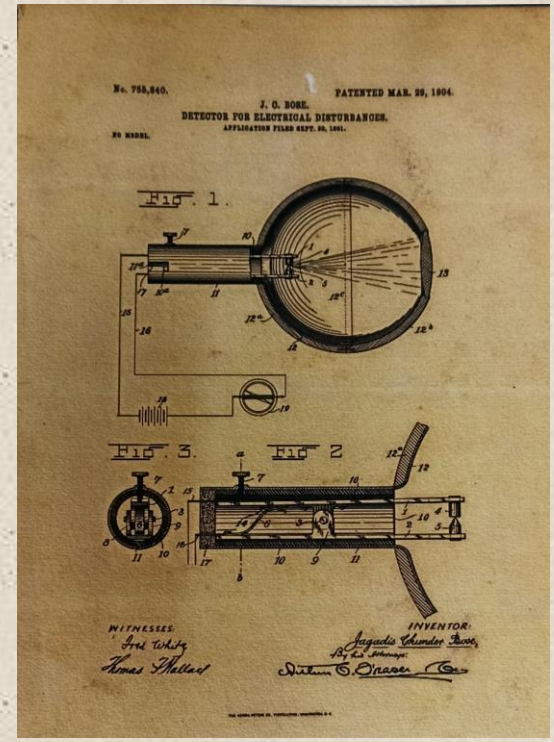
BOSE INSTITUTE

The doyen of modern science in India, Acharya Jagadis Chandra (J. C.) Bose was a pioneer in the real sense of the word. He was the first to demonstrate wireless transmission of signals. That research paved the way for radio communications, although Guglielmo Marconi received the Nobel Prize for the discovery. J. C. Bose was the first in the world to employ semiconductor technology, sixty years ahead of the times, in the words of the Nobel Laureate Sir Neville Mott. His seminal work on electrophysiology started the discipline of Biophysics.

Despite all these achievements, the scientific career of J. C. Bose was full of continuous struggles. The West promptly hailed his first discovery of wireless transmission, but they denied or often ridiculed his later works on 'living and non-living'. To prove his results, J. C. Bose fabricated his scientific instruments. The accuracy and ingenuity of those instruments amaze the scientific community until now. Since he had no institutional support until then, J. C. Bose acutely felt the need for an institute, which will cater to the need generations to come. He found generous support in his resolve from stalwarts like Rabindra Nath Tagore, Sister Nivedita, Gokhale, and Mahatma Gandhi, to name a few.

After retirement from Presidency College in Kolkata (then Calcutta), J. C. Bose devoted himself entirely to the establishment of this haven, Bose Institute. He committed the savings of his and his wife Lady Abala, and the inheritances to this task but that were, expectedly inadequate. Many patriots, some of whom named above, helped and contributed him at that time. J. C. Bose even

resorted to giving scientific demonstration-lectures all over India. The organizers charged the admission fees to help found the Institute. Thus, the establishment of Bose Institute is the manifestation of India's hope to establish the nation's self-esteem as an equal to the colonizing west. On 30th November 1917, which coincided with his birthday, J. C. Bose inaugurated Bose Institute at the premises located at 93/1, Upper Circular Road (now A. P. C. Road) adjacent to the Rajabazar Science College.


No. 755,840. PATENTED MAR. 29, 1904.

J. C. BOSE.

DETECTOR FOR ELECTRICAL DISTURBANCES.

APPLICATION FILED SEPT. 30, 1901.

NO MODEL.

FIG. 1.

FIG. 3. FIG. 2

WITNESSES: Fred White, Thomas Shellard

INVENTOR: Jagadis Chunder Bose, By his Attorneys: Dickson & Brewer

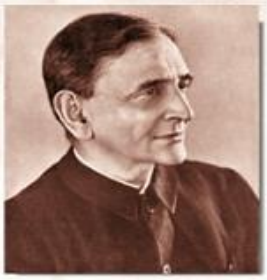
J. C. Bose encouraged his followers to pursue *the investigation of the ever-opening problems of developing science. In his own words "which includes both Life and Non-Life...The advance of science is the principal objective of this Institute and also the diffusion of knowledge.. to associate the advancement of knowledge with the widest possible civic and public diffusion of it, and this without any academic limitations, henceforth to all races and languages, to both men and women alike, and for all the time coming.. Thus the lines of physics, physiology and psychology converge and merge. And here will assemble those who would seek oneness amidst the manifold".* These are indeed prophetic words, motivating the pursuit of seamless science, or inter-disciplinary scientific research, as we call it today.

With this lofty ideal, Bose Institute is striving for the past hundred years to justify the expectation of its illustrious Founder. After his demise in 1937, his nephew, Dr. Debendra Mohan (D. M.) Bose, then Sir Rashbehari Ghose Professor of Physics at the University of Calcutta, was prevailed upon by Rabindra Nath Tagore to take over the reins of Bose Institute as Director. During his leadership of 30 years, Bose Institute progressed to a modern laboratory to compete in the international scientific scene. Under his tutelage, the research in high energy physics and nuclear physics started for the first time in India. D. M. Bose and his student Biva Chowdhury succeeded in detecting a new elementary particle, the mu meson, by exposing photographic emulsions at mountain altitudes. The Nobel Prize also eluded them for this profound discovery. It is a matter of ill-fate since they needed some emulsion of more acceptable resolution than the ones they were using, quantifying their results conclusively but were unable to procure such films because of the raging Second World War at the time.

Meanwhile, C. F. Powell independently succeeded in discovering with the required accuracy and bagged the Noble Prize for it. In his Nobel Lecture, however, Powell did acknowledge the original work of Bose and Chowdhury. After J. C. Bose, that was another occasion of Bose Institute, and India, being deprived of a well-deserved Nobel Prize.

D. M. Bose set Bose Institute on a course of an international contemporary and competitive programme. He established the first Microbiology Department in India at Bose Institute. D. M. Bose initiated research in understanding the observations of J. C. Bose in plant electrophysiology from the standpoint of biochemical processes. He paved the way for establishing the discipline of molecular biology in India. Bose Institute was one of the first institutions in India to embark on such studies and earned an enviable reputation in the area. Another significant discovery, worthy of a Nobel

CONTRIBUTION OF PROF. D.M. BOSE
WITH HIS YOUNG COLLABORATOR DR. BIVA CHOWDHURY



Prof. D.M. Bose

Prof. D. M. Bose pioneered cosmic ray research in India. In early forties, D. M. Bose and Biva Chowdhuri made a pathbreaking contribution by identifying a cosmic particle having mass close to 200 times the mass of electron (later known as pi-meson) by exposing photographic emulsions at high altitudes in Darjeeling and Sandakphu.

Dr. Biva Chowdhury

This work laid the basis for more precise determination of the mass of pi-meson by Prof. C. F. Powell who was awarded the Nobel Prize in 1950.

Prize, was carried out in the Chemistry laboratory of Bose Institute, the seminal discovery of the Cholera endotoxin, by Prof. Sambhu Nath De, a professor of pathology at Calcutta Medical College. Nobel Laureate Joshua Lederberg did nominate De for the Nobel Prize on more than one occasion, but unfortunately without success.

The later generations of scientists at Bose Institute have followed in these lofty paths, if not with similar achievements but with intense dedication and commitment and commendable success. They can boast of significant contributions in plant genetics and biotechnology, structural and computational biology, microbiology, systems biology, molecular medicine, astroparticle, particle and quantum physics, and the environmental sciences. The Bose Scientists have collaborated in several international endeavours both in physical and biological sciences.

Faithful to the exhortation of the Founder, Bose Institute undertakes extensive social outreach programmes in rural biotechnology, aiming at bringing the fruits of science and technology to the economically weaker section. Bose Institute conducts regular science camps for school children and science teachers, especially from the North-Eastern states of India through the hands-on programme. The Institute also runs an integrated MSc- PhD programme in Physical and Life Sciences besides training of a large number of doctoral and post-doctoral students. The activities of Bose Institute encompass over seven academic campuses, and experimental field stations spread all over the state of West Bengal.

Acharya J. C. Bose was an ardent nationalist who desired India to rediscover its glorious heritage and reclaim its leading position in the world of science and technology. Bose Institute indeed is fortunate to inherit his great legacy and tries to prove itself worthy of this inheritance. To keep the spirit of inquiry alive and fulfil the Founder's dream, the Institute plans to embark on some new directions of research in the coming years, which would build on the present expertise and take on new challenges.

MANDATE

The Mandate of Bose Institute is basic research in emerging areas of Biology, Physics and Chemistry as well as Rural Biotechnology Programme of direct societal benefit.

MISSION

The core mission of Bose Institute can be summarized in the words of our founder, Acharya J. C. Bose, "The advancement of science and also the diffusion of knowledge are the principal objectives of the Institute". Our mission is to provide a unique platform for cutting edge interdisciplinary scientific research, both basic and applied, its dissemination among the society and human resource development for a modern India. By encouraging interdisciplinary sciences, Bose Institute strives to perform seamless research, as perceived by our founder and the first inter-disciplinary scientist, which could lead to complete and in-depth understanding of scientific problems.

VISION

The vision of Bose Institute, is best captured in the declaration of the Acharya J.C. Bose's foundation day speech in November 30, 1917, "I dedicate today this Institute – not merely a laboratory but a temple". Acharya's dream vision was to set up a research institute where Indians could carry out scientific research, the backbone of any modern society, unhindered by the colonial masters. The vision was not only the advancement of science by Indian scientists, but also the diffusion of the generated knowledge among the larger society, to build a self-reliant and modern India.

OBJECTIVES

The objectives of Bose Institute, Kolkata as laid down in the Memorandum of Association are as follows:-

1. Advancement of knowledge by means of research.
2. The diffusion of knowledge by organizing discourses, demonstration and lectures to be given by original workers in it and thinkers.
3. To do all such things as are incidental or conducive to the attainment of the above objects or any of them.

Areas of focus: Physical, Chemical, and Biological Sciences

Bose Institute carries out cutting age research in basic sciences. In addition it pursues research for augmentation of fundamental knowledge-base and developing solutions to selected problems of national importance in the areas of healthcare, food security, environmental pollution and climate change. Taking advantage of the diverse and complementary research expertise of the faculty, coherent and synergistic multi-disciplinary research approaches focus on achieving scientific goals that are completely aligned with the mandate of the Department of Science and Technology, Government of India.

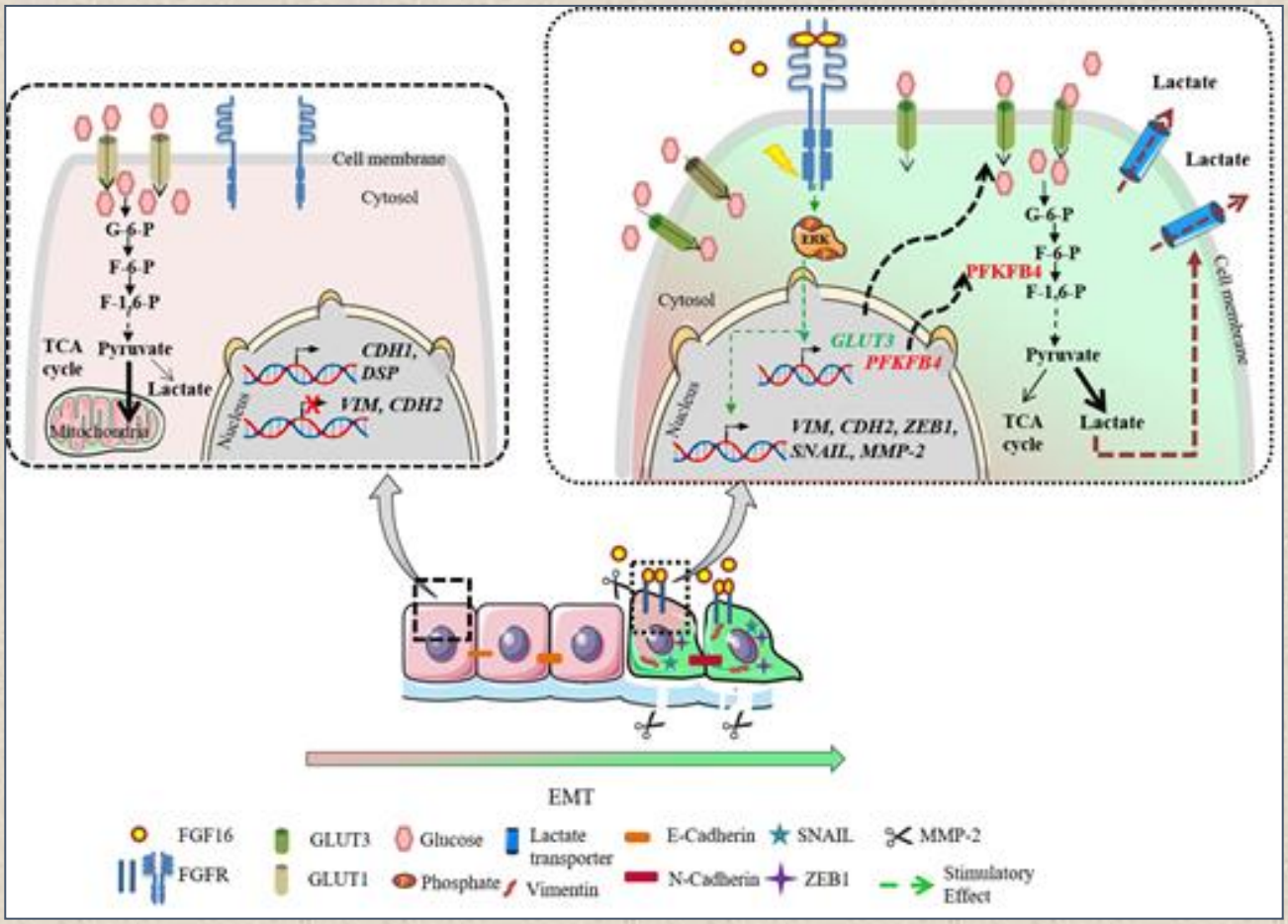
Research is pursued in following areas:

- High Energy and Nuclear Astrophysics – Quantum Chromodynamics and Quark-Gluon-Plasma
- Quantum gravity; Quantum Information and Computation
- Quantum Materials and Devices
- Plant response under Biotic and Abiotic Stress
- System and Synthetic Biology
- Environmental Microbiology and Climate Change
- Structure and Functions of Macromolecules; Bioinformatics
- Bioorganic Chemistry for Drug Development
- Identification of Drug Target and Validation of Bioactive Molecules for Therapeutic Intervention
- Atmospheric dynamics and air pollution

MAJOR ACCOMPLISHMENTS AND IMPORTANT HIGHLIGHTS OF PROGRAMMES

MAJOR ACCOMPLISHMENTS:

- Classified a subset of the Calabi-Yau geometries suitable for string phenomenology which is necessary for scanning the landscape of flux vacua. This marks a significant progress towards constructing a unifying theory of quantum gravity.
- Identified 14-3-3 protein as a molecular switch in regulating cellular signaling between MAPK and PKA. Since, 14-3-3x protein interacts with phosphodiesterase 8A (PDE8A) and reduces the catalytic activity of PDE8A, intracellular cAMP pool is enhanced, thereby sustaining PKA signaling while downregulating MAPK signaling.
- A simple method for the iodination of unsaturated sugars to form sugar vinyl iodides was developed under oxidant-free conditions using NaH/DMF/iodine as a reagent system at ambient temperature.
- A facile synthesis of C1-C2 interlinked disaccharides was achieved from readily available iodo-glycals and unsubstitutedglycals.
- Working on cancer cell-specific CRISPR- based gene-editing and transcriptional regulation to reduce on-target genotoxicity in gene-therapy, BI scientists have now developed a method for targeted genome engineering. They have also developed a method for small molecule presentation on CRISPR- enzyme.
- Identified a few potent chemicals, of which Epigallocatechingallate(EGCG) from green tea is the most promising.
- An antimicrobial peptide was isolated from Pseudomonas aeruginosa species. The purified peptide was characterized by mass spectrometric analyses. The characterized pentapeptide revealed a broad-spectrum antimicrobial activity. The peptide was found to be stable at wide ranges of pH and temperature. The peptide also exhibited antibiofilm activity. This pentapeptide, may find use as a potential biocontrol agent in various commercial applications
- Fibroblast growth factors (FGFs) are expressed in developing and adult tissues and play important roles in embryogenesis, tissue homeostasis, angiogenesis, and neoplastic transformation. The elevated expression of FGF16 in human breast tumor and its potential involvement in breast cancer progression have been investigated. The present findings support potential clinical intervention of any of the members of FGF16-GLUT3-PFKFB4 axis to control the invasion of breast cancer cells.
- Identified oncogenic ID1 as a putative target for the tumor suppressor miR-615-5p in tumorigenesis.
- Standardized the protocol for dCas9-guided targeting and immune-precipitation of the GM2-synthase TSS using “enChIP” assay, in an effort to unravel the proteome associated with the transcription start site (TSS) of the GM2-synthase gene.
- Ganglioside GM2 modulates the HIPPO-YAP/TAZ transcriptional program to induce EMT and Metastasis.
- GM2 mediated ERK-EGR1 axis is critical for promoting invasion and inducing EMT in tumor cells.



FGF16 rewires the whole cell transcription and metabolism to instigate EMT

IMPORTANT HIGHLIGHTS MAJOR PROGRAMMES

- An antimicrobial peptide, isolated from Pseudomonas aeruginosa species, revealed a broad-spectrum antimicrobial activity, was found to be stable at wide ranges of pH and temperature, and exhibited antibiofilm activity, and could find use as a potential biocontrol agent in commercial applications.
- Profiles of aerosols and cloud layers have been investigated over a high-altitude urban atmosphere in the eastern Himalayas in India. For the first time, using a Raman LIDAR. LIDAR range corrected signal has been used to understand the growth of precipotation layer.
- Identified oncogenic ID1 as a putative target for the tumor suppressor miR-615-5p in tumorigenesis.
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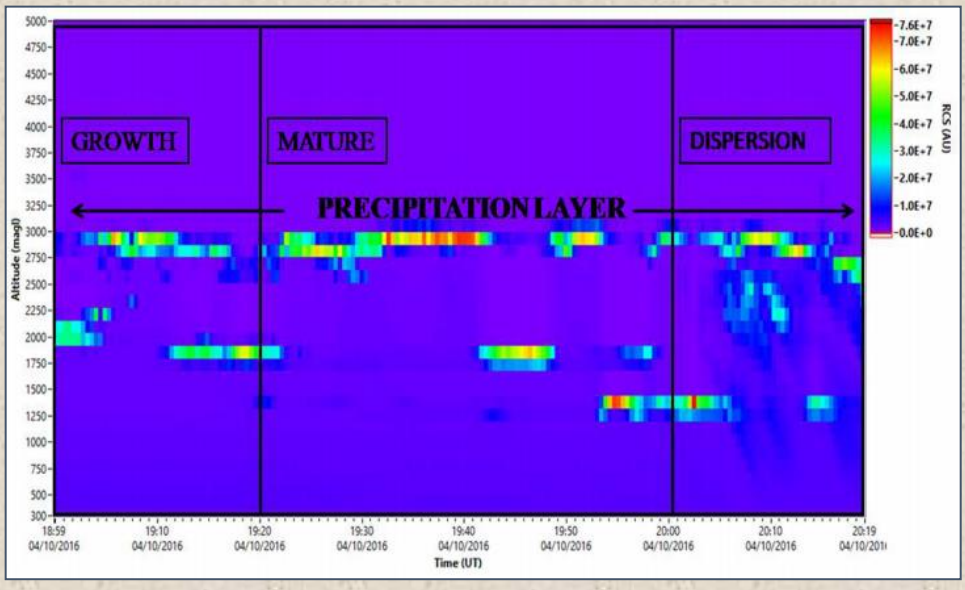

The variation of $RCS355$ shows the precipitation layer from the growth to dispersion stage of its total life cycle

- A machine learning based prediction tool LncRTPred for longnoncoding RNA target prediction, which can be used to predict RNA-RNA mode of interaction mediated by lncRNA, has been developed. This can be used by the scientific community globally.
- Sequencing of microbiomes associated with six different freshwater sponges of Sundarbans have been achieved.
- Pilot experiments to achieve enrichment of desired genetic locus by pulldown for proteome identification have been successfully performed.
- The gene-specific primers to validate promising lignin-related pathway genes through qRT-PCR have been designed.
- Successfully demonstrated using co-immunofluorescence that a component of the Giardia lamblia proteasome also localizes to the mitosomes of this human parasite. This will help in furthering our understanding of how these rudimentary mitochondrial equivalents function and their role, if any, in the survival of this pathogen.
- Developed a redox-sensitive YFP sensor for the detection of intracellular reactive oxygen species (ROS) in planta.
- Developed a method for targeted genome engineering as well as for small molecule inducible CRISPR system.
- Presented an “AI-based tool for Multiclass Classification of Drug Resistance in MTB clinical isolates from whole genome sequencing data” at 2nd Innovative TB Health Technologies sharing platform on 16th February 2024 at Department of Health Research, ICMR, New Delhi.
- Role of Plant Architectural protein, ARID-HMG, in Pollen Development: ARID-HMG regulates JA pathway and tapetal Programmed Cell Death during viable pollen formation.
- Rice Trithorax protein ULTRAPETALA regulates the growth and development of the plant to promote stress resilience.

TOP TEN GOALS

- Understanding plant intelligence and information processing in response to environmental stimuli.
- Unravelling the inherent complexities in key cellular processes and their implications in disease biology.
- Exploring microbiomes to reveal biosphere functions, manage pollution, and improve lives.
- Employing multimodal approaches to understand pathogen biology and hostpathogen interactions for designing novel intervention strategies against infectious diseases.
- Developing and deploying computational tools, data mining, database management, statistical analysis, etc. for a holistic understanding of stem cell bioinformatics and regulatory RNAs, oncogenomics, proteomics, drug design, structural bioinformatics and macromolecular dynamics and for applications in healthcare.
- Application of sub-micron physics to understand macro physics: Universe to biological systems.
- Microscopic origin of elementary matter in the universe .
- Microscopic processes in natural environment.
- Mesoscopic systems: Light matter interactions.
- Microscopic systems-Quantum information in many-body systems: Entanglement properties and Quantum networks.

BIOLOGICAL SCIENCES

Dr. Abbrajyoti Ghosh

- Heat shock response in thermoacidophilic crenarchaeon Sulfolobus acidocaldarius and first implications for cross-stress adaptation: insights from transcriptome analysis.
- Investigating the role of heat shock proteins and type-II toxin-antitoxin systems in the adaptation of archaeal model organism under stress conditions.
- Understanding the cross-talk between microbes in the environment and their hosts in natural and managed ecosystems with a history of anthropogenic disturbances.

Prof. Ajit Bikram Datta

- Structural and mutational analyses of Uba6 to delineate its domains/regions that confer E2 specificity.
- Interaction Network amongst amino acids located in various regions of the UBC domains in ubiquitin conjugating enzymes that regulate their enzymatic activity.
- Basis of substrate selectivity and chain type specificity of non-canonical Ubiqutiin conjugating enzymes.

Dr. Anupama Ghosh

- Investigating the involvement of U. maydis small heat shock proteins in the endomembrane trafficking system of the fungus.
- Investigating the extracellular RNA repertoire of maize in relation to defending U. maydis infection.
- Functional characterization of a candidate GPI anchor cell wall protease from U. maydis and to determine its involvement in the pathogenic mechanisms of the fungus.

Prof. Atin Mandal

- Unraveling the role and regulatory mechanisms of Praja1 (PJA1) ubiquitin ligase in sustaining cellular integrity.
- Functional role of DNAJ (Hsp40) proteins in progression of cancer.
- Alteration of proteostasis network in amylin (hIAPP) amyloidosis in diabetes.

Dr. Basudeb Maji

- Targeted Protein Degradation to Inhibit EMT in Tripple Negative Breast Cancer.
- Developing novel therapeutic strategies by combining biological, chemical, and genome engineering tools.

Prof. Gaurab Gangopadhyay

- Understanding the molecular mechanism behind Phytoplasma-induced phyllody disease tolerance in Sesame.
- To look for salt tolerance in sesame genotypes to grow them in marginal and coastal lands.

Prof. Kaushik Biswas

- Mapping the miR-615-5p/ID1 interaction and its outcome in carcinogenesis.
- Unraveling the proteome associated with the TSS of the GM2-synthase gene.
- Mapping GM2-mediated HIPPO-YAP/TAZ signaling axis in regulation of EMT and metastasis.
- Identifying the gene expression signature of primary fibroblasts in response to GM2.
- Design and synthesis of Proteolysis Degrading Chimera (PROTAC) targeted against select onco-protein(s) will be done in collaboration with Prof. Debraj Mukherjee, Dept. of Chemical Sciences, Bose Institute.

Dr. Nirmalya Sen

- Study ERG interactome and metabolite niche that regulates metabolic reprogramming and development of CRPC.
- Device nano-luciferase-based assay system to study ERG/ETV1 protein vulnerabilities using small molecule inhibitor screens.
- Study upstream regulatory kinase of ETS1 that can alter ETS1-driven drug resistance and metastasis in TNBC. 4) Identify coregulatory factors of ETS1 that are crucial for TNBC resistance using transcriptomic profiling from patient samples.

Prof. Pallob Kundu

- Investigate the role of mediators of cell death and their small RNA regulators in necrotrophic disease development.
- Exploration of the roles of small RNAs in shaping tomato thermal stress-response.
- Generation of stress-resilient crops by biotechnological approaches.

Prof. Shubho Chaudhuri

- Characterisation of MYC regulated JA signalling during pollen development
- Role of plant Trithorax protein ULTRAPETALA in the development of rice plant.
- Studying the epigenetic variation mainly in DNA methylation patterns could be one of the potential approaches to understand cold tolerant phenotype of CB1. The knowledge of stable and heritable epigenetic variations can be used as a new approach in crop-breeding programs to generate climate-smart crops that are resistant to different environmental changes.

Prof. Shubhra Ghosh Dastidar

- Discovering how the sequence codes the capacity of allosteric responses.
- Developing pipelines for prediction of key allosteric sites on Kinases.
- Design of allosteric inhibitors.

Dr. Smarajit Polley

- To determine the structure of Ets2:GoF-p53 complex.
- To investigate the role of Ets2 phosphorylation on its interaction with DNA and p53.
- To determine the structure of the Ets2:nucleosome complex.

Prof. Srimonti Sarkar

- Understanding vesicular trafficking and proteasome-mediated protein degradation in Giardia lamblia.
- Assessing the role of the Saccharomyces cerevisiae vacuole in cellular response to ethanol stress.

Dr. Subhash Haldar

- Studies on epigenetic changes and metabolic alterations in chemotherapy resistant breast cancer.
- Understanding the role of NLRP3 mediated inflammasome in chemotherapy drug resistant cancer.

Prof. Subrata Sau

- Construction, purification and characterization of a RsbW mutant harboring an Ala residue in place of Arg 32.
- Construction, purification and characterization of a RsbW mutant carrying an Ala residue in place of Lys 44.

Dr. Sudipto Saha

- To develop two databases on i) the human gut-lung microbiome of respiratory diseases and ii) mitochondrial proteins associated with diseases.
- To develop AI-based models to predict the severity of asthmatics and COPD patients using respiratory microbiome and metabolome data.
- To validate the role of predicted microbial metabolites in in-vitro lung epithelial and macrophage cell lines.
- To perform an in-vivo study on asthmatic mice models to understand the role of the specific lung microbes and mitochondrion proteins using a multi- OMICS-based study.

Prof. Wriddhiman Ghosh

- Psychrophilic copiotrophic microorganisms that can efficiently remineralize organic carbon at zero to sub-zero temperatures.
- The syntrophic relationships and community metabolism networks that exist within the cold and frigid microbiomes.
- The geochemical drivers of ecosystem functioning at extremely low temperatures.

Prof. Zhumur Ghosh

- Validating the presence of common and or exclusive SNPs within lncRNA loci in ovarian, breast and cervical cancer.
- Developing a machine learning based prediction tool to predict the presence of oncogenicity within induced pluripotent stem cell derivatives corresponding to the three germ layers. And validating the expression of miRNAs and their targets comprising of the feature set used to develop the prediction protocol.

- Validating the expression profile of the essential set of noncoding RNAs and their target mRNAs playing important role in pre and post fertilization stages (upto zygotic genome activation stage) of mouse development.
- Studying the role of noncoding RNAs in neurodegeneration

CHEMICAL SCIENCES

Prof. Abhijit Chatterjee

- Study on the light absorption efficiencies of Brown Carbon vary with the seasons.
- Assessing the nature (primary or secondary) and major sources of Brown Carbon aerosols.
- Study on the regional and the long-range transport of pollution plume affect the light absorption of Brown Carbon.
- To investigate radiative forcing is imparted by the BrC aerosols relative to another most absorbing aerosol, elemental carbon.
- The syntrophic relationships and community metabolism networks that exist within the cold and frigid microbiomes.

Prof. Anirban Bhunia

- Assessing the rationally designing of peptide hydrogel.
- Study on hydrogel characterization.
- Determining the efficacy of the hydrogels for various biomedical application.

Dr. Anup Ghosh

- Study from nanoparticles, anisotropic NPs such as nanostars will be explored for their hybridized plasmon resonances at lower frequencies and a much larger localized surface enhancement of the electric field at the tips that enables strong sensitivity to even a few adsorbed molecules.
- Analyze the surface structure of the peptides on nanoparticles and how that surface structure perturbed in presence of physiological salt concentration and pH. A peptide library is necessitated to identify an appropriate peptide that adopts different conformations upon a slight change in pH. This kind of tuning can then be used to study drug loading and unloading, essential to control the targeted release of drugs at sites-of-interest.

Prof. Anup Kumar Misra

- A series of oligosaccharides motifs (Figures 2-5) found in the O-antigens of the cell wall polysaccharides of P. alcalifaciens strains O28, O44 and O6 as well as P. Stuartii O47 strain will be chemically synthesized.
- The oligosaccharides will be synthesized as their 2-aminoethyl glycosides so that they could be easily linked to a spacer linker and then to a suitable protein (Tetanus toxoid, TT) to furnish glycoconjugate derivatives.

Prof. Debaraj Mukherjee

- Conversion of Natural occurring flavanone to high value Anticancer lead and Its Nano formulation for Improved bioavailability.
- Rational design and synthesis of engineered Proteolysis-targeting chimeras(PROTAC) for Yes-associated protein (YAP)/ transcriptional co-activator PDZ-binding motif (TAZ) degraders as anti-cancer agent.

- Development of novel analogs of 3'-5'-linked C-di-Nucleotides (CDNs) as a potential vaccine candidate for mycobacteria tuberculosis.
- Development of a preclinical lead candidate against JEV that targets the viral RNA-dependent RNA polymerase.

Prof. Jayanta Mukhopadhyay

- Devise NovelStrategies toCombat Lifestyle aswell as Emerging Re-Emerging InfectiousDiseases.
- Structural analysis of gene regulatory complexes.
- Identification of small molecule inhibitors for bacteria.
- Prof. Suman Kumar Banik
- Noise and information propagation in the two-component system.

PHYSICAL SCIENCES

Prof. Achintya Singha

- Light-matter interactions in 2D semiconductors.
- Lattice dynamics and optical properties in quantum materials
- Spin- valley physics in 2D quantum materials.

Prof. Dhruba Gupta

- Coulomb breakup of ^{9}Li in the context of inhomogeneous nucleosynthesis
- Coulomb breakup of ^{7}Be and transfer reaction study of ^{6}Li(^{3}He,d)^{7}Be in the context of big-bang nucleosynthesis
- Breakup and transfer reactions of ^{17}Ne + ^{64}Zn.

Dr. Pramod Kumar Shukla

- To this aim, Our plan is to look for Calabi-Yau orientifolds (CY/O) with a small number of complex structure and Kähler moduli from the Kreuzer's list.
- Scanning the relevant del-Pezzo surfaces from the CYs available in the Kreuzer's list and defining appropriate holomorphic involutions.
- Searching (all) the possible instantons in a given setup that can give contribution to the superpotential.
- To compute the holomorphic pre-factors for concrete and simple Toroidal/CY orientifold examples and to explore the flat directions and revisit the inflationary aspects, e.g. towards global embedding of Higgs-otic inflation.
- To study them with global F-theory aspects via the geometry of the CY fourfold. These odd-axions along with the open-string axions can be utilized for looking at axion-monodromy/large-field inflation as well as towards concrete string- theoretic embedding of Dark energy or Quintessence models.

Dr. Saikat Biswas

- Research and development of Gas Electron Multiplier (GEM), Resistive Plate Chamber (RPC) and Straw tube detectors for the CBM experiment which includes mainly the ageing and stability studies.
- Development of gaseous detectors for imaging.
- Study of cosmic ray using scintillation detectors and cosmic neutron monitor

Dr. Sanat Kumar Das

- To investigate over the Himalayas, Easter part of Indo-Gangetic Basin, East-coast, West-Coast region and Marine regions to fulfill the above-mentioned objectives using mobile observatory with a few existing instruments and new purchased instruments. A new method will be applied to investigate air-borne aerosols with drone-based small sensors over the above said measurement sites. A mobile observatory is also proposed for campaign studies at coastal for the simultaneous observations at Ship-borne measurements over marine regions.

Dr. Sidharth Kumar Prasad

- To find solutions to the three research problems, viz., insensitivity of jet nuclear modification factor to collision energies, contradictory observations of jet quenching effects in Pb-Pb collisions and the possibility of jet quenching effects in small collision systems (pp and p-Pb collisions). A proper understanding of the implementation of jet quenching effects in the available theoretical MC models is therefore important.
- To address the problem regarding the insensitivity of jet RAA to collision energies, new observables which quantify the energy loss in a more direct way and are more robust against the change of the spectral shape.
- The possibility of QGP formation in small collision systems will be investigated with various jet observables, including jet mass, angularities, N-subjettiness, energy-energy correlator, which are sensitive to both the perturbative and non-perturbative aspects of partonic evolution in small collision systems (pp and p-Pb collisions), unlike the recent study where conventional observables were used. The study will be performed for both the groomed and ungroomed jets as well as for tagged jets (photon-tagged, quark-tagged and gluon-tagged jets). Similar measurements of those observables will also be performed for heavy-ion collisions (Pb-Pb) and compared with the results of the small collisions.

Prof. Soumen Roy

- Formulate an ab initio approach, grounded in physics and information-theory to study proteins and protein-ligand interactions, and examine the agreement of this approach with existing experimental results in diverse proteins.
- Explore percolation in quantum networks.
- Understand various aspects of phage-bacteria interactions combining both theoretical and experimental approaches.

IMPORTANT COLLABORATIONS (NATIONAL AND GLOBAL) ESTABLISHED

1. Project titled "India's participation in the construction of the Facility for Antiproton and Ion Research (FAIR) at Darmstadt, Germany" - Bose Institute is the share holder Institute. It is the nodal centre to coordinate all the present activities including the supply of In-Kind item, made in India, to FAIR.
2. CBM-MUCH project: Bose Institute is one of the Institute fom India participating in research and development of the gas-electron multiplier (GEM) detector for the Compressed baryonic matter (CBM) experiment to be performed at FAIR.
3. Project ALICE - A large Ion-Collider experiment) - Bose Institute is a one of the participating Institute in the ALICE-INDIA project. This experiment is being performed at Large Hadron Collider (LHC) at CERN, Switzerland.
4. National Clean Air Mission: Bose Institute is the "Institute of Repute" and Dr. Abhijit Chatterjee, Bose Institute, is working as the Nodal Scientist and Knowledge Partner for the state of West Bengal under this national mission.
5. DBT: Multi-dimensional research to enable systems medicine: acceleration using a cluster approach at Kalyani, West Bengal.
6. Indo-Swiss: Next generation advanced therapies for fight b-hemoglobinopathies via rational intervention in g-globin regulatory network.
7. Funded by SERB, Bose Institute is setting up a state-of-the-art CryoEM Regional/National facility in Eastern Region. Transforming the structure-guided drug discovery and therapeutics research landscape in India.
8. National Carbonaceous Aerosols Programme (NCAP): Carbonaceous Aerosols Emissions, Source appointment and Climate effects with IIT Bombay and other institutions.
9. DST: Improvement and broad-scale implementation of different biotechnology-oriented programmes for the socio-economic upliftment of Scheduled Tribe community of West Bengal.
10. DBT: Continuation of the existing Centre of Excellence in Bioinformatics and expanding it as a datacenter involving newer direction of research to address the healthcare and environmental issues of national need - BIC at Bose Institute.

ACADEMIC INPUTS

Papers in refereed journals	234
Books	01
Chapters in books	22
Papers in conferences	18
Number of PhDs produced/thesis submitted	18
Indian patents filed/Granted	01
Technical manpower trained	21
Research Manpower trained (other than Ph.D)	102
B.Tech/UG Project guided	10
M.Tech/M.Sc/M.Phil. project guided	40

FINANCIAL INPUTS

(Rupees in Lakh)

DST GRANT RECEIVED 2023-24	9000
EXTRA MURAL GRANT RECEIVED 2023-24	13,18,12,527
NO. OF ON-GOING EXTRA MURAL PROJECTS 2023-24	36

LIST OF PERSONNEL

ADMINISTRATION

Prof. (Dr.) Uday Bandyopadhyay, Director, Prof. Rajarshi Ray, Registrar (Officiating), Noreen Bhattacharjee, Deputy Registrar, Sougato Banerjee, Assistant Registrar, Achintya Mukherjee, Accounts Officer, Vikash Kumar, Audit & Finance Officer, Mantu Bhattacharya, Tarun Kumar Maji, Supriya Das, Kamal Sing, Vineet Kumar Tandon, Debdas Nandi, Somnath Das, Nilanjana Bhattacharjee, Ananya Malgope, Nitin Sharma , Satyaswaroop Behara, Arjun Das, Babli Marrick, Ruby Sarkar, Sudam Ch. Jana, Ananya Raha, Sumita Dey, Sumanta Ghosh, Ishani Chatterjee, Gopa Dasgupta, Animesh Jana, Arpita Bose, Tanusri Bhattacharyya, Ratan Saha, Shaubhik Ghosh, Atanu Deb, Tuhin Saha, Angshuman Bhowmik, Debasish Koley, Sujata Roy, Biplab Malakar, Sujit Kumar Basu, Sk. Md. Kalu (Retd on 30.9.2023), Sarda Devi, Kanai Hazra, Prafulla Bhuiya, Md. Khairul B. Mollah, Sukanta Chakraborty , Tapas Chakraborty, Sanat Kumar Dhara, Duryodhan Nayak, Bipul Kr. Nag, Sachchidananda Ram, Bablu Mondal, Mahesh Dasgupta, Rajbrat Ram, Kalyan Das, Raj Kumari Balmiki, Hemanta Kr. Sahoo, Goutam Behera, Gourango Paramanick.

DEPARTMENT OF BIOLOGICAL SCIENCES

Faculty Members: Prof. Subrata Sau, Prof. Srimonti Sarkar, Prof. Shubho Chaudhuri, Prof. Gaurab Gangopadhyay, Prof. Pallob Kundu, Prof. Kaushik Biswas, Prof. Atin K Mandal, Prof. Shubhra Ghosh Dastidar, Prof. Ajit Bikram Datta, Prof. Subhrangsu Chatterjee, Prof. Wriddhiman Ghosh, Prof. Zhumur Ghosh, Dr. Abhrajyoti Ghosh, Dr. Sudipto Saha, Dr. Anupama Ghosh, Dr. Debjani Roy, Dr. Smarajit Polley, Dr. Nirmalya Sen, Dr. Subhash Haldar, Dr. Basudeb Maji, Dr. Kuladip Jana.

Non-Academic Staff: Uttam Kumar Ghosh, Chaitali Roy, Kaberi Ghosh, Jadab Kumar Ghosh, Sujata Roy, Sanjib Kumar Gupta, Prabir Kumar Haldar, Ashim Kumar Nath, Shanghamitra Das, Sourav Samanta, Jayasish Ghosh, Atanu Pramanik, Basudeb Marrick (Retd. on 31.10.2023), , Debasish Sarkar, Nadiram Kayal, Shankar Prasad Bari, Rabin Paul, Narayan Patali, Moumita Mondal Basu Roy.

DEPARTMENT OF CHEMICAL SCIENCES

Faculty Members: Prof. Anup Kumar Misra, Prof. Suman Kumar Banik, Prof. Jayanta Mukhopadhyay, Prof. Anirban Bhunia, Prof. Debraj Mukherjee, Prof. Abhijit Chatterjee, Dr. Anup Ghosh (Joined on 18.03.2024).

Non-Academic Staff: Debashis Mazumder, Dipak Chandra Konar, Mrityunjoy Kundu, Debarati Kanjilal, Sudhir Turi, Asoke Kumar Maity.

DEPARTMENT OF PHYSICAL SCIENCES
***Faculty Members*:** Prof. Sanjay Kumar Ghosh (Retd. on 31.12.2023), Prof. Rajarshi Ray, Prof. Somshubhro Bandyopadhyay, Prof. Dhruba Gupta, Prof. Supriya Das, Prof. Achintya Singha, Prof. Soumen Roy, Dr. Sidharth Kumar Prasad, Dr. Saikat Biswas, Dr. Sanat Kumar Das, Dr. Pramod Kumar Shukla.
***Non-Academic Staff*:** Anandamay Adak, Subhasish Banerjee, Shyam Sundar Mallick, Manas Datta, Subrata Das, Kaushik Maiti, Raj Kumar Mourya, Amar Nath Hela, Kanak Baran Hazra.

CENTRAL INSTRUMENTATION FACILITY
Non-Academic Staff: Smriti Ranjan Maji, Ranjan Kumar Dutta, Souvik Roy , Mrinal Das, Swaroop Biswas, Sheolee Ghosh Chakraborty, Soumya Shankha Biswas, Amarendra Nath Biswas, Gaurab Kr. Roy, Tanmoy Debnath, Pallab Chakraborty, Swapan Jogsharma Alpana Chattopadhyay.

MADHYAMGRAM EXPERIMENTAL FARM
Non-Academic Staff: Pulak Kr Roy (Retd. On 29.02.2024), Asis Kumar Dala, Laxmi Kanta Pradhan, Bhanu Kisku.

CENTRE FOR TRANSLATIONAL ANIMAL RESEARCH, MADHYAMGRAM
Non-Academic Staff: Arindam Basu, Ranjit Das.

SHYAMNAGAR EXPERIMENTAL FARM
Non-Academic Staff: Barun Kumar Mazumder, Barindra Kumar Bari.

M.Sc. Ph.D.
Non-Academic Staff: Binoy Krishna Modak.

DARJEELING CAMPUS
Non-Academic Staff: Yasodhara Yadav, Jaganath Das.

WORKSHOP
Non-Academic Staff: Raju Chandra Paul, Workshop Superintendent, Pranab Banerjee (Retd. on 30.4.2023), Baidya Nath Murmu, Sanjoy Santra, Prabir Halder, Purnendu Manna.

PH.D. AWARDED

BIOLOGICAL SCIENCES

- **Debadrita Basu** (University of Calcutta) Title of the Thesis: Effects Of Small Molecules On The Structural And Dynamic Behaviour Of α,β-tubulin. Supervisor: Shubhra Ghosh Dastidar
- **Abhirupa Ghosh** (University of Calcutta) Title of the Thesis: In-Silico Analyses of Drug-Resistant Gene-Mutations In *Mycobacterium Tuberculosis*, ESKAPE and other Bacterial Species. Supervisor: Dr. Sudipto saha
- **Saran N** (University of Calcutta) Title of the Thesis: Dissecting The Role of Mycobacterial Fluroquinolone Pentapeptide (Mfp) Proteins Conferring Drug Resistance In Mycobacteria. Supervisor: Dr. Sudipto Saha.
- **Shreya Chowdhury** (University of Calcutta) Title of the Thesis: Impact of dynamic interaction between miR398 and a Copper/Zinc Superoxide dismutase on stress physiology of tomato plan. Supervisor: Dr. Pallob Kundu.
- **Shrabani Basak** (University of Calcutta) Title of the Thesis: Intracellular interaction dynamics of metacaspases during disease response in Solanum lycopersicum. Supervisor: Dr. Pallob Kundu.
- **Udita Acharya** (Calcutta University) Title of the Thesis: Evaluating rice proteases and protease inhibitors as potential defence proteins against sheath blight infection. Supervisor: Dr. Anupama Ghosh.
- **Subhasish Mukherjee** (Calcutta University) Title of the Thesis: Investigating the role of extracellular proteases of *Ustilago maydis* in the pathogenesis of the fungus. Supervisor: Dr. Anupama Ghosh.

CHEMICAL SCIENCES

- **Pradip Shit** (University of Calcutta) Title of the Thesis: Synthetic Studies on Carbohydrate Derivatives and Oligosaccharides of Biological Significance. Supervisor: Prof. Anup Kumar Misra.
- **Shruti Mukherjee** (University of Calcutta) Title of the Thesis: Molecular Characterisation of Antimicrobial and Antiviral Agents for the Development of Targeted Therapeutics. Supervisor: Prof. Anirban Bhunia.
- **Dibakar Sarkar** (Jadavpur University) Title of the Thesis: Investigations on the Structural and Kinetic Features of Amyloid Aggregation. Supervisor: Prof. Anirban Bhunia.
- **Md. Sorique Aziz Momin** (University of Calcutta) Title of the Thesis: Theoretical Study of Information Processing in Some Recurrent Biological Network Motifs. Supervisor: Prof. Suman Kumar Banik.
- **Swarnali Kar** (Jadavpur University) Title of the Thesis: lmplication of Epigenetic Modulations and Metabolic Alterations in Tumorigenesis. Supervisor: Prof. Jayanta Mukhopadhyay.

PHYSICAL SCIENCES

- **Sk. Mustak Ali,** (University of Calcutta) Title of the Thesis: Study of Nuclear Reactions Related to the Cosmological Lithium Problem. Supervisor: Prof. Dhruba Gupta.
- **Sayak Chatterjee** (University of Calcutta) Title of the Thesis: Performance studies of Gas Electron Multiplier detector for the Muon Chamber of high rate CBM experiment at FAIR. Supervisor: Dr. Saikat Biswas.
- **Arindam Sen** (University of Calcutta) Title of the Thesis: Development of Resistive Plate Chamber for the CBM Experiment at FAIR and other Application of Radiation Detector. Supervisor: Dr. Saikat Biswas.
- **Sreyan Raha** (University of Calcutta) Title of the thesis: Vibrational and Optical Properties of SemiconductorNanostructured Materials using Raman and Optical Spectroscopy. Supervisor: Prof. Achintya Singha.
- **Himadri Sekhar Tripathi** (University of Calcutta) Title of the thesis: Transition Metal Oxide (TMO) Electrode base Supercapacitor for Efficient Energy Storage Applications. Supervisor: Prof. Achintya Singha.

AWARDS/HONOURS/MEMBERSHIP

BIOLOGICAL SCIENCES

- **Dr. Anupama Ghosh** Received Fulbright Nehru Academic and Professional Excellence Fellowship 2023.

CHEMICAL SCIENCES

- **Prof. Abhijit Chatterjee:** (i) Executive member of the "Indian Aerosol Science and Technology Association". (ii) Expert member of the "Kolkata Climate Action Plan", Govt. of West Bengal. (iii) Advisor to the Govt. of West Bengal for Air Quality management over polluted cities in West Bengal. (iv) Resource person in the "Parliamentary Group of Clean Air". (v) Editorial Board member of "earth and Space Chemistry" under American Chemical Society.
- **Prof. Debaraj Mukherjee:** (i) Invited to join as an editorial board member in the prestigious Journal of Carbohydrate Chemistry (JCC), Taylor & Francis in 2023 for five years. JCC has been serving the community of carbohydrate chemists over the past 40 years. (ii) Received "CRSI Bronze Medal-2023" by Chemical research society of India.
- **Prof. Anup Kumar Misra:** Editorial Board member of Elsevier Journals: Tetrahedron, Tetrahedron Letters and Carbohydrate Research.
- **Miss Karishma Biswas** was awarded a scholarship by the Technical University of Münich, Germany to conduct MAS solid-state NMR experiments at the same university. Supervisor: Prof. Anirban Bhunia.
- **Dr. Aritreyee Datta** received best poster award at "Special Symposium on Clinical Application of NMR/MRI & 29th Annual meeting of National Magnetic Resonance Society (NMRS) of India in association with ISWRM, Indian Chapter". Supervisor: Prof. AnirbanBhunia.

PHYSICAL SCIENCES

- **Sk Mustak Ali** gets a Research Associate position at FRIB, Michigan State University, USA.
- **Kabita Kundalia** gets a Postdoctoral position at Extreme Light Infrastructure - Nuclear Physics (ELI-NP), Romania.
- **Arindam Sen** received the Full sponsorship to attend the EURIZON detector school, Wuppertal, Germany, 17-28 Jul 2023.
- **Anjali Sharma** received "One of the best Thesis Presentation" award in 67th DAE Symposium on Nuclear Physics at IIT Indore, MP, from December 9-13, 2023. Title of the thesis: Investigation of Elliptic Flow and Chiral Magnetic Effect in Pb-Pb collisions in ALICE at LHC.
- **Prof. Soumen Roy:** (i) Patent Granted: A system and method for analyzing videos of application or function for feature identification of the videos and related application or function [Patent No. 472279 (2023)], Soumen Roy et al. (ii) Editorial Board member of: (1) PLOS ONE, (2) Indian Journal of Physics (Springer), (3) Frontiers in Physics. (iii) Reviewer, (Mathematics & Computer Science Panel), National Research, Development and Innovation Office, Hungary.

- **Prof. Achintya Singha**: (i) Member of the Expert Committee of Teachers Associateship for Research Excellence (EC-TARE), Science and Engineering Research Board (SERB), Government of India, from July 2021 to present. (ii) Member of the Empowerment and Equity Opportunities for Excellence in Science (EMEQ)-Task Force Committee, Science and Engineering Research Board (SERB), Government of India, October 2023 to present. (iii) Member of the Board of Studies (PG), Department of Physics, Midnapore College, from 15/02/2020 to present.
- **Suvadip Masanta** received the excellent Oral Presentation award in Students Symposium on 'Recent Trends in Natural Sciences 2023' at Bose Institute, Kolkata, India.
- **Chumki Nayak** received the excellent Poster Presentation award in Students Symposium on 'Recent Trends in Natural Sciences 2023' at Bose Institute, Kolkata, India.
- **Dr. Sidharth Kr. Prasad** (i) serving as the Deputy Spokesperson of the India-ALICE-STAR Collaboration, (ii) serving as one of the conveners of the Physics Analysis Working Group – Jet substructure (PAG-JSUB) in the ALICE Collaboration at CERN, (iii) serving as one of the Internal Review Committee (IRC) members for reviewing the analysis entitled "Medium-induced modification of the groomed and ungroomed jet mass and angularities in Pb-Pb and pp collisions at 5.02 TeV" in the ALICE Collaboration, (iv) appointed as one of the Internal Review Committee (IRC) members in the ALICE experiment for reviewing the ALICE paper "Measurements of jet angularities and jet mass in PbPb collisions at 5.02 TeV with ALICE", (v) served as one of the Analysis Review Committee (ARC) members for reviewing the analysis entitled "Time reclustering for jet substructure" in the ALICE Collaboration.
- **Mr. Abhi Modak** (working under Dr. Sidharth Kr. Prasad) has served as one of the Analysis Review Committee (ARC) members for reviewing the analysis entitled "Entropy measurements in pp collisions" in the ALICE Collaboration.
- **Ms. Debjani Banerjee** (working under Dr. Sidharth Kr. Prasad) has served as one of the Analysis Review Committee (ARC) members for reviewing the analysis entitled "Projected 3-point Energy Correlator measurements in jets in p-p at 13TeV with ALICE" in the ALICE Collaboration.
- Measurement of inclusive photon multiplicity and pseudorapidity distributions in proton-proton and proton-lead collisions at a center-of-mass energy of 5.02 TeV using indigenously built Photon Multiplicity Detector of ALICE experiment is highlighted in the prestigious CERN Courier in July/August 2023 edition. PAs: Abhi Modak, Sudipan De, Sidharth Kr Prasad.
- **Prottoy Das** (working under Dr. Sidharth Kr. Prasad) served as a member of the ARC for one of the ALICE analysis on "Jet substructure correlation of the soft drop θ_{g,SD} and Z_{g,SD} observables in pp and Pb–Pb collisions at √sNN = 5.02 TeV".

1.	Acharya, S., Adamová, D., Adler, A., Aglieri Rinella, G., Agnello, M., Agrawal, N., . . . Zurlo, N. (2023). Constraining the K ¯ N coupled channel dynamics using femtoscopic correlations at the LHC.	*European Physical Journal C, 83*(4). doi:10.1140/epjc/s10052-023-11476-0	4.994
2.	Bhardwaj, M., & Mukherjee, D. (2023). Regio and Stereoselective One-Pot Synthesis of 2-Deoxy-3-thio Pyranoses and Their O-Glycosides from Glycals.	*Journal of Organic Chemistry*. doi:10.1021/acs.joc.3c00146	4.198
3.	Bhattacharyya, M., Dhar, R., Basu, S., Das, A., Reynolds, D. M., & Dutta, T. K. (2023). Molecular evaluation of the metabolism of estrogenic di(2-ethylhexyl) phthalate in Mycolicibacterium sp.	*Microbial Cell Factories, 22*(1). doi:10.1186/s12934-023-02096-0	6.496
4.	Laskar, P., Hazra, A., Pal, A., & Kundu, A. (2023). Deciphering the role of alternative splicing as modulators of defense response in the MYMIV–Vigna mungo pathosystem.	*Physiologia Plantarum, 175*(3). doi:10.1111/ppl.13922	5.081
5.	Lepcha, T. T., Kumar, M., Sharma, A. K., Mal, S., Majumder, D., Jana, K., . . . Kundu, M. (2023). Uncovering the role of microRNA671-5p/CDCA7L/monoamine oxidase-A signaling in Helicobacter pylori mediated apoptosis in gastric epithelial cells.	*Pathogens and disease, 81*. doi:10.1093/femspd/ftad006	3.951
6.	Navinya, C., Kapoor, T. S., Anurag, G., Lokhande, P., Sharma, R., Prasad Sv, L., . . . Phuleria, H. C. (2023). Heating and lighting: understanding overlooked energy-consumption activities in the Indian residential sector. *Environmental Research Communications, 5*(4). doi:10.1088/2515-7620/acca6f Published 19 April 2023Impact Factor:3.237	*Environmental Research Communications, 5*(4). doi:10.1088/2515-7620/acca6f	3.237
7.	Roy, D., Maity, N. C., Kumar, S., Maity, A., Ratha, B. N., Biswas, R., . . . Bhunia, A. (2023). Modulatory role of copper on hIAPP aggregation and toxicity in presence of insulin.	*International Journal of Biological Macromolecules, 241*. doi:10.1016/j.ijbiomac.2023.12447	8.025
8.	Mukherjee, S., Saha, G., Roy, N. S., Naiya, G., Ghosh, M. K., & Roy, S. (2023). A small HDM2 antagonist peptide and a USP7 inhibitor synergistically inhibit the p53-HDM2-USP7 circuit.	*Chemical Biology and Drug Design*. doi:10.1111/cbdd.14255	2.873

9.	Maity, A., Mondal, A., Kundu, S., Shome, G., Misra, R., Singh, A., . . . Maiti, N. C. (2023). Naringenin-Functionalized Gold Nanoparticles and Their Role in α-Synuclein Stabilization.	*Langmuir, 39*(21), 7231-7248. doi:10.1021/acs.langmuir.2c03259	4.331
10.	Acharya, S., Adamová, D., Adler, A., Aglieri Rinella, G., Agnello, M., Agrawal, N., . . . Zurlo, N. (2023). W±-boson production in p–Pb collisions at √sNN = 8.16 TeV and Pb–Pb collisions at √sNN = 5.02 TeV.	*Journal of High Energy Physics, 2023*(5). doi:10.1007/JHEP05(2023)036	5.4
11.	Acharya, S., Adamová, D., Adler, A., Aglieri Rinella, G., Agnello, M., Agrawal, N., . . . Zurlo, N. (2023). Σ (1385) ± resonance production in Pb–Pb collisions at √sNN=5.02 TeV.	*European Physical Journal C, 83*(5). doi:10.1140/epjc/s10052-023-11475-1	4.994
12.	Borah, S., Mishra, R., Dey, S., Suchanti, S., Bhowmick, N. A., Giri, B., & Haldar, S. (2023). Prognostic value of circulating mitochondrial DNA in prostate cancer and underlying mechanism.	*Mitochondrion, 71*, 40-49. doi:10.1016/j.mito.2023.05.005	4.534
13.	Chatterjee, S., Sen, A., Paul, R., Sahai, S., Das, S., & Biswas, S. (2023). Observation on the bias current variation of a single mask triple GEM chamber.	*Journal of Instrumentation, 18*(5). doi:10.1088/1748-0221/18/05/C05002	1.121
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235.	Nayak, C., Masanta, S., Monga, S., Paul, S., Bera, S., Mondal, S., . . . Singha, A. (2024). Tailoring photoluminescence in MoSSe alloys through gold nanostructure coupling: Influence of midgap states and localized surface-plasmon resonance.	*PHYSICAL REVIEW B, 109*(12). doi:10.1103/PhysRevB.109.125306	3.7
236.	Rana, A., & Kumar Misra, A. (2024). Synthesis of the Pentasaccharide of the K14 Capsular Polysaccharide of Antibiotic Resistant ST25 Acinetobacter baumannii isolate, D46 and O-Polysaccharide of Acinetobacter baumannii O11.	*ChemistrySelect, 9*(12). doi:10.1002/slct.202400654	2.1
237.	G. K. Leontaris and P. Shukla (2023) Taxonomy of scalar potential with U-dual fluxes	***Physical Review D*** *(PRD) 108, 126020 (2023)* *DOI: http://dx.doi.org/10.1103/PhysRevD.108.126020*	4.3

238.	G. K. Leontaris and P. Shukla (2023) Seeking de-Sitter Vacua in the String Landscape	***Proceedings of Science***: *PoS(CORFU2022)058* *DOI: http://dx.doi.org/10.22323/1.436.0058*	
239.	Madhurima Khamaru, Deep Nath, Devrani Mitra*, and, Soumen Roy* (2024) Assessing combinatorial diversity of Aureochrome bZIPs through genome-wide screening,	*Cells Tissues Organs [Karger], 213, 133-146 DoI: 10.1159/000527593*	

Review Articles:

- "A succinct description on the synthesis of modified C-nucleosides of therapeutic significant". N. Hudait, N. Sikander, S. Kundu, B. Rasool, J. Sengupta, D. Mukherjee*. Synlett,2024; 35, 635-648. DOI: 10.1055/a-2202-8808
- "Recent Advances in the Synthesis of C-Glycosides from Glycals". Ramanand Das , Malati Das,Debaraj Mukherjee*and T. Kundu.Synthesis,2024; 56(07), 1070-1096. DOI: 10.1055/a-2223-1303.

Book Chapters:

- "Synthetic Strategies in Carbohydrate Chemistry" Chapter 10 "Vinyl sugar enol ethers in Organic Synthesis.J. S.Banday, I. A.Zargar,N.Hudait and D. Mukherjee*. Publisher: Elsevier, Editor: Vinod Kumar Tewari, Paperback ISBN: 9780323917292
- "The Role of Chromenes in Drug Discovery and Development." P. Grover, H. K. Gulati, J. M. H. Anal and D. Mukherjee*. Publisher: Bentham Science Publishers Pte. Ltd. Singapore. Editors: A. K. Dash, D. Kumar. ISBN (paperback): 9789815124354

Conference Proceedings

- The Nuclear Physics Aspect of the Cosmological Lithium Problem (Invited Plenary Talk) D. Gupta, Proceedings of the DAE-BRNS Symposium on Nuclear Physics 67, 15 (2023).
- Study of α-cluster transfer reactions with 7Be (Thesis presentation) K. Kundalia (Supervisor: D. Gupta), Proceedings of the DAE-BRNS Symposium on Nuclear Physics 67, 1425 (2023).
- Breakup of 7Be on 12C at 5 MeV/u; R. Mitra, D. Gupta, S. Maity, K. Kundalia, Sk M. Ali, Swapan K. Saha, O. Tengblad, A. Perea, I. Martel, J. Cederkall, A.M. Moro, Proceedings of the DAE-BRNS Symposium on Nuclear Physics 67, 379 (2023).
- Breakup of 7Be from 7Be + d reaction at 5 MeV/u; S. Maity, D. Gupta, Sk M. Ali, K. Kundalia, R. Mitra, S. Samanta, Swapan K. Saha, O. Tengblad, A. Perea, I. Martel, J. Cederkall, and A. M. Moro
- Proceedings of the DAE-BRNS Symposium on Nuclear Physics 67, 469 (2023).
- Transfer reactions with 7Be + 12C at 5 MeV/u, D. Gupta on behalf of IS 554 collaboration ISOLDE Workshop and Users Meeting, CERN, Geneva, Switzerland (2023).

SL. NO.	FUNDING AUTHORITY	DATE OF COMMENC-EMENT	DATE OF TERMINATION	PRINCIPAL INVESTIGATOR	TITLE OF THE PROJECTS
1	MoEFCC	30-Mar-16	29-Mar-24	Prof. Abhijit Chatterjee	National Carbonaceous Aerosols Programme (NCAP) WGIII: Carbonaceous Aerosols Emmissions, Source appointment and Climate effects
2	CSIR	12-Jan-21	11-Jan-24	Dr. Abhrajyoti Ghosh	Diversity and Distribution of Antibiotic Resistance Genes in the Sundarban mangrove estuary : coordination of anthropogenic and evolutionary influences
3	SERB	18-Dec-20	17-Dec-25	Dr. Smarajit Polley Prof. Atin K. Mandal Prof. Jayanta Mukhopadhyay	Setting up a State-of-the-Art CryoEM Regional/National Facility in Eastern Region at Bose Institute: Transforming the Structure-guided Drug Discovery and Therapeutics Research Landscape in India
4	DBT-WB	17-Mar-21	16-Mar-24	Prof. Atin Kumar Mandal	Characterizing the interaction between Phosphodiesterase 8 (PDE8A) and 14-3-3 with CRAF: Gaining insights into CRAF regulation.

5	DST	30-Mar-21	29-Mar-24	Prof. Pallob Kundu	Improvement and broad-scale implementation of different biotechnology-oriented programmes for the socio-economic upliftment of Scheduled Tribe community of West Bengal
6	DST & DAE		31-Mar-26	DIRECTOR, BOSE INSTITUTE	India's participation in the construction of the Facility for Antiporton and Ion Research (FAIR) at Darmstadt, Germany
7	SERB	21-Jan-22	20-Jan-25	Prof. Kaushik Biswas	Mechanism of ganglioside GM2-mediated regulation of miR-615-5p in targeting oncogenic ID1 to mediate tumorigenesis
8	SERB	24-Jan-22	23-Jan-25	Dr. Anupama Ghosh	Investigating the role of HSP20 in the pathogenic development of Ustilago maydis
9	DBT	23-Mar-22	22-Mar-27	Prof. Subhra Ghosh Dastidar & Dr. Zhumur Ghosh	Continuation of the existing Centre of Excellence in Bioinformatics and expanding it as a datacenter involving newer detection of research to address the healthcare and environmental issues of national need – BIC at Bose Institute, Kolkata
10	DST-DAE	03-Nov-21	31-Oct-26	Prof. Supriya Das	Indian Participation in the ALICE Experiment at CERN
11	SERB	25-Mar-22	24-Mar-25	Dr. Sanat Kr. Das	Revealing bioaerosol movements within the area spanning eastern Himalayas and coastal Bay of Bengal
12	SERB	30-Nov-21	29-Nov-24	Prof. Debaraj Mukherjee	A Novel Approach to the Construction of N-alkylated HydroxylaminoInterglycosidic Linkages from glycal epoxides : Application in the synthesis of esperamicin-calicheamicin cores
13	ICMR	01-Apr-23	31-Mar-26	Dr. Sudipto Saha	Epidemiological Survey on Tribal Communities of Dinajpur District in North Bengal to Develop a Knowledgebase on Disease Predisposition for Estimating Disease Etiology
14	SERB	28-Jun-23	26-Jun-26	Prof. Shubho Chaudhuri	Molecular Characterization of factors(s) regulating transcription of MYB21 and MYB24 genes in Jasmonic acid signalling pathway during pollen development
15	Velus Stiftung (Switzerland)	01-Aug-23	31-Mar-27	Prof. Anirban Bhunia	Rational design and structure-function analysis of antimicrobial peptides tailored to treat fungal Ocular infections

16	SERB	12-Dec-21 (transferred from Ashoka University to Bose Institute 29.12.2022)	31-May-2024	Dr. Basudeb Maji	Cancer Cell-specific CRISPR-based Gene-Editing and Transcriptional Regulation to Reduce on-target Genotoxicity in Gene-therapy
17	SERB	10-Oct-2023	09-Oct-2026	Prof. Srimonti Sarkar	Deciphering the cellular functions of the multiple paralogues of GINSF and GlaSNAPs of Giardia lamblia
18	DBT	29-Sep 2023	28-Sep-2027	Prof. Subhrangsu Chatterjee	Transcriptional regulation of human Telomerase (hTERT) by chromatin remodelling protein SMAR1
19				Prof. Gaurab Gangopadhyay	Collaborative project (between Bose Institute and the Tea Board of India) entitled "The mystic flavor of the Darjeeling tea: Exploring the role of Phytobiome in regulation of biosynthetic pathways using omics approach" -
20				Prof. Subrata Sau	Studies on the structure, function, stability of the virulence factors/regulators involved in bacterial pathogenesis
21				Dr. Saikat Biswas	Research and Development of micro-pattern gaseous detectors (MPGD) for the CBM experiment at FAIR.
23				Prof. Dhruba Gupta	Breakup and transfer reactions involving the radioactive nucleus 7Be.
22				Dr. Siddharth K. Prasad	ALICE collaboration at CERN Study of photon and charged particle multiplicity distributions in pp, p-Pb and Pb-Pb collisions. Two particle azimuthal correlation in pp and p-Pb collisions

PARTICIPATION IN CONFERENCES/SYMPOSIA/ WORKSHOPS/INVITED TALKS DELIVERED

BIOLOGICAL SCIENCES

Dr. Abbrajyoti Ghosh

- International Conference on 'Physiology to Pathology: Finding the therapeutic roadmap' organized by Amity Institute of Biotechnology, Amity University, Kolkata, India (7-9 March 2024).
- International Conference on Biodiversity and Geochemistry of Deep and Extreme Earth Systems jointly organized by IIT Kharagpur in association with IISER Kolkata and NIT Durgapur, India (1-3 February 2024).
- 8th March 2024: Delivered an invited lecture entitled "VapBC4 Toxin-Antitoxin system of thermoacidophilic crenarchaeon Sulfolobus acidocaldarius regulates biofilm and persister cell formation under heat stress" at the International Conference on 'Physiology to Pathology: Finding the therapeutic roadmap' organized by Amity Institute of Biotechnology, Amity University, Kolkata, India (7-9 March 2024).
- 3rd February 2024: Delivered an invited lecture entitled "Influence of anthropogenic stress on microbial community and antibiotic resistome of the mangrove sediment of Sundarbans" at the International Conference on Biodiversity and Geochemistry of Deep and Extreme Earth Systems jointly organized by IIT Kharagpur in association with IISER Kolkata and NIT Durgapur, India (1-3 February 2024).
- 6th February 2024: Delivered an invited lecture at the Department of Biotechnology and Innovation and Entrepreneurship Development Cell (IEDC) organized by the Department of Biotechnology, UEM University, Kolkata, India.
- 19th September 2023: Delivered an invited lecture entitled "Mangrove Microbiome: Friend or Foe" at the Microbiology workshop "Exploration of the microbial world" to celebrate "World Microorganism Day" jointly organized by Department of Biological Sciences, Adamas University, India and Microbiology Society, United Kingdom.
- 1st September 2023: Deliver an invited lecture titled "Dynamics of the mangrove microbiome in the Anthropocene" in the national meeting on "Mangroves of the East Coast of India" held at Fairfield by Marriott Kolkata, and organized by IISER, Kolkata.
- 27th June 2023: Deliver an invited lecture titled "Mangrove microbiome & its dynamics in the backdrop of human intervention" to commemorate World Microbiome Day at NIBMG, Kalyani.
- 25th May 2023: Deliver an invited lecture titled "Mangrove microbiome: the good, the bad and the ugly" in the one-day symposium held at NCCS, Pune, under the aegis of AMI Pune Unit, INYAS, and the National Centre for Microbial Resource, Pune.
- 12th May 2023: Deliver an invited lecture titled "Anthropogenic impact accelerates engineering of the microbiome and antibiotic resistome of Sundarban mangrove" in the one-day symposium "Bio Nexus: A new Axis for advanced biological sciences 2023" held at The Neotia University.

Prof. Atin Mandal

- Delivered invited talk at International Conference BioNext 2023: Translational Research towards attaining "Good Health & Well Being" on 4th -6th October, 2023, Adamus University; Barasat.
- Delivered invited talk at International seminar on "Microbes and Social Equity" on 22-23 December, 2023. Dept. of Microbiology & IQAC, Bankura Sammilani College, Bankura.

Dr. Basudeb Maji

- Participated at Frontiers of Chemical Biology and Organic Materials. Indian Institute of Science, Bangalore, 21 July 2023.
- Participated at 92nd Annual Meet of the Society of Biological chemists. BITS Pilani Goa, 18-20 December, 2023.
- Participated in a programmable One-Pot Synthesis of Heparin Sulfate and Heparin-derived commercial Anticoagulants by Dr. Supriya Dey from Eli Lilly, USA, on October 31, 2023.

Prof. Gaurab Gangopadhyay

- Invited as a distinguished speaker in the "Hackathonon Geographical Indication and Related Traditional Knowledge and Traditional Cultural Expression from 8th to 12th March 2024 at WBNUJS, Kolkata": Delivered a talk entitled GI, TK, TCEs and Technological Advancement: The role of a plant scientist: My perception" in the Technical Session V, Day 3, 10.03.2024.
- Delivered a talk entitled "Technologies developed in Bose Institute: The advancements in Plant Science research" in the Mini Symposium on "Technologies developed in Bose Institute" on the National Science Day (28.02.2024).
- Delivered a talk entitled "The legacy of Acharya J C Bose: A Glimpse into his Biological Research" in the auspicious programme for unveiling the statue of Acharya JC Bose at the UAC, BI on 05.09.2023.
- Coordinated the visit (study tour) of the undergraduate students of the Assam Agricultural University at the UAC, Bose Institute on 12.02.2024; delivered a lecture on the topic entitled "Molecular marker-assisted breeding of sesame, an emerging oilseed crop".
- Coordinated the visit of the students of M.Sc. (Biotechnology), Gauhati University at the MC and UAC, BI on 25.01.2024.
- Coordinated the visit of the Botany Hons students of THK Jain College (CU), Kolkata to the UAC, BI on 11.01.2024.
- Coordinated the visit of the senior school students of the DPS (Howrah) to the UAC, BI on 01.09.2023.
- Coordinated the visit of Anjuman Islamia Girls' High School to the UAC, BI on 16.06.2023 under their summer project.
- Organized the field visit of the Botany undergraduate students of Shri Shikshayatan College, Kolkata to the Madhyamgram Experimental Farm of Bose Institute on 01.06.2023.
- Organized the visit of the under and post graduate students (Botany) of the RNLK Women's College, Midnapore, WB for a Study Tour at the UAC, Bose Institute on 18.04.2023; delivered a lecture on the topic entitled "Totipotency: The basis of developing Transgenic plants".

Prof. Kaushik Biswas

- Chaired a scientific session on Cell Signaling in the 2nd International conference titled "Physiology to Pathology: Finding the Therapeutic Roadmap" organized by Amity University, Kolkata during March 7-9, 2024.
- Delivered an Invited Lecture titled "De-repression of GM2- synthase Transcription by Sp1-HDAC1 in Cancer" in National Institute of Pharmaceutical Education and Research (NIPER)-Kolkata on Feb 28, 2024 on the occasion of National Science Day Celebration 2024.
- Participated as a invited panelist in a discussion themed "Developing the Triple Helix: Game plan to establish Centre of Excellence for Advanced Proteomics and Genomics Research" in the YIM-Kolkata Chapter
- Attended meeting during December 06-07, 2023 at Presidency University, Kolkata, organized jointly by the premier Research Institutes and Universities in West Bengal.
- Presented an invited talk titled "GM2-synthase transcriptional regulation in Cancer : The Sp1-HDAC1 story" in BIONEXT 2023 during October 4-6, 2023 organized by the School of Life Sciences & Biotechnology, Adamas University, Barasat.
- Presented an invited talk titled "Acetylation-mediated loss of Sp1-HDAC1 cause de-repression of the GM2-synthase gene in Cancer" as part of the ongoing SBC(I) Kolkata Chapter's online monthly seminar series on June 14, 2023.

Dr. Nirmalya Sen

- invited speaker for 43rd IACR (Indian Association for Cancer Research) annual conference at IISER, PUNE. from 19th January to 22nd January 2024. Title: Evolution of chemoresistance in Triple Negative Breast cancer.
- Organising member, Regional Young Investigator Meeting 2023 at Kolkata, in association with Scientists/faculties from IISER, IICB, CNCI, Jadavpur University and Presidency University.(December 2023).

Prof. Pallob Kundu

- Member of the organizing committee: One Day Bioinformatics Workshop on Artificial Intelligence in Healthcare, January 16, 2024, Bose Institute.
- Member of the organizing committee and delivered a lecture: National workshop on plant bioinformatics, Nov 7, 2023.
- September 2023, IISER Pune, Delivered a lecture on "Regulators of ROS-homeostasis and their impact on the pathophysiology of tomato".

Prof. Shubhra Ghosh Dastidar

- Invited talk and hands-on session during One Days symposium at Moulana Azad College, April 27, 2023.
- Distinguished popular lecture to celebrate the 162nd birth anniversary of Acharya Profulla Chandra Roy, at Adamas University, August 2, 2023.
- Chairing session in the symposium organized by Society of Biological chemist (I), Kolkata Chapter and National Institute of Biomedical Genomics, held at NIBMG, Kalyani during 1-2 September 2023.

- Invited talk at the 'International Conference BIONEXT 2023', at Adamas University, during 4th - 6th October, 2023.
- Invited Talk at GTHTM-2024, held at Dehradun, During March 15-17, 2024 organizer by GIPER, and Veer Madho Singh Bhandari Uttarakhand Technical University.
- Organized seminar by Dr. Amitava Roy, from University of Montana, USA, on February 16, 2024
- Organized One day National Workshop on Bioinformatics: AI in Healthcare on 16th January 2024.
- Organised One day National Workshop on Plant Bioinformatics on 7th November 2023.

Dr. Smarajit Polley

- Invited talk at the "Kolkata Biophysics Meet 2024" organized by Saha Institute of Nuclear Physics, Kolkata on April 02, 2024.
- Invited talk at the RACE-CB (Recent advances in Cryo-EM and Chemical Biology) organized by IIT Bombay, Bombay during March 7-9, 2024.
- Invited talk at the "International Conference on Renewable Energy Technologies and Bio Sustainability (TCRETBS-2024)", organized by the Mahishadal Raj College, Mahishadal, India during February 21-23, 2024.

Prof. Srimonti Sarkar

- Organised two Conferences (BESCON 2022 & ASCODD 2022) One meeting (2nd Biannual Meeting of the Yeast and Fungi Group, Kolkata 2024).
- Delivered invited talk at (i) Neotia University 2023; (ii) SBC Kolkata Chapter 2024; (iii) Neotia University 2024.

Dr. Subhash Haldar

- Attended Regional Young Investigators Meeting, Kolkata, 2023.
- Delivered a plenary lecture on 15.03.2024 at the DST-SERB Sponsored Two days National Workshop on "Tips & Tricks in writing Scientific Research Grants" Organized by the Integrative Biochemistry and Immunology Laboratory (IBIL), Dept. of Animal Science, Kazi Nazrul University.
- Organized seminar titled " Co-targeting fibroblasts and cancer epithelia, a better treatment strategy." by Prof. Neil Bhowmick, Professor, Department of Medicine and Biomedical Sciences of Samuel Oschin Cancer Institute in Cedars-Sinai, Los Angeles, USA on January 02, 2024.
- Organized seminar by Dr. Sumit Biswas, Professor, Department of Biological Sciences, BITS Pilani, K K Birla Goa Campus will be delivering a lecture on "Biofilms: Formation, Mechanism and Disruption" on 9th June 2023.

Prof. Subrata Sau

- A poster entitled 'Insights into a novel staphylococcal drug target involved in the biosynthesis of capsular polysaccharide' was presented in the symposiums held at Bose Institute (Unified Campus) and BITS Pilani (Goa) from 27-29 November and 18-20 December 2023, respectively.
- A poster entitled 'Mutations affecting the structure, function and stability of an anti-sigma factor from Staphylococcus aureus' was presented in the Annual Meeting of the Society of Biological Chemists held at the BITS Pilani during 18-20 December, 2023.

- A poster entitled 'A superbug under the radar: virulence factors and regulators contributing to pathogenicity in Staphylococcus aureus' was presented in India International Science Festival-Mega Science Expo, held at MANIT, Bhopal during 21-24 January 2023.
- A poster entitled 'Studies on the human disease-causing proteins of Staphylococcus aureus' was presented in Government Achievements and Schemes Expo - 2023 at Pragati Maidan, New Delhi.
- A poster entitled 'Studies on the human disease-causing proteins of Staphylococcus aureus' was presented in 26th National Exhibition" at Central Park, Karunamoyee, Kolkata, 24-27 August 2023.
- A poster entitled 'Studies on the human disease-causing proteins of Staphylococcus aureus' was presented in 10th Indian National Exhibition-cum-Fair 2023" at KMDA ground, Patuli, Kolkata-700094, 6 - 10 December 2023.

Dr. Sudipto Saha

- Delivered invited talk at Summer Symposium, organized by Institute of Pulmocare & Research at Empress Hall, Fairfield by Marriott, Newtown, Kolkata on "Omics in pulmonary diseases" on May 18, 2023
- Delivered invited talk at the Bioinformatics Workshop at Sikkim State Council of Science & Technology, Vigyan Bhawan, Gangtok, East Sikkim on "Study of Pulmonary diseases using bioinformatics and systems biology approaches" on June 27, 2023 (12).
- Invited talk at the International Conference on Bioinformatics (InCoB 2023) in Brisbane Australia on "MCDR-MTB: Multiclass Classification of Drug Resistance in MTB clinical isolates using WGS data" on November 13, 2023.
- Presented an "AI-based tool for Multiclass Classification of Drug Resistance in MTB clinical isolates from whole genome sequencing data" at 2nd Innovative TB Health Technologies sharing platform - An enabling on 16th February 2024 at Department of Health Research, ICMR, New Delhi.
- Organized One day National Workshop on Bioinformatics: AI in Healthcare on 16th January 2024.
- Organised One day National Workshop on Plant Bioinformatics on 7th November 2023.
- Organised Student Symposium "Recent Trends in Natural Sciences, 2023" from 27th -29th November 2023.

Prof. Wriddhiman Ghosh

- Convened and Co-chaired Session10h: Microbial metabolism of metals and non-metals through geologic time and space: from lithoautotrophy and coenzymes to pollutants and bioremediation, in the Goldschmidt Conference 2023 held at Lyon, France, between 09 and 14 July 2023, and presented the following lecture: "The enigmatic polythionate S4O62- as a key junction in the sulfur cycle of continental slope sediments".
- Delivered the A. K. Chandra Memorial Lecture at the Department of Botany, Calcutta University, on 23 August 2023

- One-day national workshop on Plant Bioinformatics Organized by the 'Bioinformatics Centre at Bose Institute' – A project Funded by the Department of Biotechnology, Govt. of India on 07 November, 2023, at Unified Academic Campus, Bose Institute, Kolkata.
- One-day national workshop on Bioinformatics: AI in Healthcare Organized by the 'Bioinformatics Centre at Bose Institute' – A project Funded by the Department of Biotechnology, Govt. of India on 16 January, 2024, at Unified Academic Campus, Bose Institute, Kolkata.
- Delivered the invited lecture titled "Life in the extremities of the Earth's biosphere: the biophysical extremes are not so intolerable after all" at International Conference on Biodiversity and Geochemistry of Deep and Extreme Earth Systems organized by IIT KGP between 01 and 03 February 2024;.

Prof. Zhumur Ghosh

- Delivered a talk on Opportunities and Challenges of Predictive Approaches involving Regulatory Noncoding RNomics - shaping modern day therapeutics at the 92nd Annual Meeting of the Society of Biological Chemists held at BITS Pilani K K Birla Goa Campus from 18th– 20th December, 2023.
- Delivered a talk on Predictive Approaches involving Coding and the Noncoding World: Shaping modern day therapeutics, at the workshop entitled "Contemporary perspectives in Computational Biology" from Feb 19-20 2024 organised by IMSc, Chennai.

CHEMICAL SCIENCES

Prof. Abhijit Chatterjee

- Delivered an invited lecture on "Kolkata's air quality: Current status" in a national meeting organized by Climate Trends on 17 April, 2023.

Prof. Anirban Bhunia

- Speaker at International Faculty Development Program-2024, organized by Guru Nanak Institute of Pharmaceutical Science and Technology (GNIPST) Kolkata.
- Four students attended the NMRS conference, which was held at CBMR Lucknow.

Prof. Debaraj Mukherjee

- Delivered Bronze medal lecture on 'Recent Development on the Construction of Various Aromatic Chiral Cores from Glycals' at Department of Molecular Medicine JNU, New Delhi.

Prof. Jayanta Mukhopadhyay

- Participated 21st Transcription Assembly Meeting on Mechanism of δ mediated transcription activation in Bacillus subtilis during July 21-24th, 2023, IISER Bhopal.

Prof. Suman Kumar Banik

- Attended conference on "Stochastic and Nonlinear Dynamics in Chemistry and Biology" at S N Bose National Centre for Basic Sciences, January 4-5, 2024.

PHYSICAL SCIENCES

Prof. Achintya Singha

- Presented a Plenary Lecture titled “2D Transition-Metal Dichalcogenide Alloy: Tunable Light-Matter Interaction and Photodetection Application” at two days International Conference on Macromolecules, Supramolecules and Nanotechnology on 23-24th February 2024 at L. J. University, Ahmedabad.
- Presented an invited talk at 2dMAT : A Discussion Meeting on 2D Materials, January 18-19, 2024 at Silver Jubilee Hall, S N Bose National Centre for Basic Sciences, Kolkata, India..

Prof. Dhruba Gupta

- Delivered an invited plenary talk titled “The Nuclear Physics Aspect of the Cosmological Lithium Problem”, at the DAE-BRNS Symposium on Nuclear Physics, IIT Indore, India, December 9-13, 2023.
- Delivered a talk titled “Transfer reactions with ^{7}Be + ^{12}C at 5 MeV/u” at the ISOLDE Workshop and Users Meeting, CERN, Switzerland, November 29 - December 1, 2023 (online).
- Delivered an invited talk on “The Cosmological Lithium Problem in Nuclear Astrophysics”, Colloquium at the School of Astrophysics, Presidency University, Kolkata, September 27, 2023.
- Delivered an invited plenary talk titled “Nuclear Astrophysics at Bose Institute” at the International Symposium on Nuclear Astrophysics, MAHE, Manipal, October 30 – November 2, 2023.
- Served as National Organizing Committee member of the “International Symposium on Nuclear Astrophysics (ISNA 2023)” at Manipal Academy of Higher Education (MAHE), Manipal, Karnataka, October 30 - November 3, 2023.

Dr. Pramod Kumar Shukla

- Participated and delivered an invited talk in the 'Indian String Meeting (ISM) - 2023' held at December 10-16, 2023 at IIT Bombay, Mumbai. The talk “A toolkit for global model building in string phenomenology" was delivered on December 10, 2023..
- Represented the Bose Institute in an important meeting regarding JEST-2024 held at Indian Institute of Space Science and Technology (IIST) Trivandrum during Dec 19-23, 2023.
- visited Harish-Chandra Research Institute (HRI), Prayagraj during March 18-20, 2024. The purpose of this visit was to participate as a PhD thesis defense examiner, and to have discussion with Professor Anshuman Maharana's local group.

Dr. Saikat Biswas

- Saikat Biswas visited CERN, Geneva, Switzerland during 2-6 April, 2023 for ALICE related discussions and meetings.
- Saikat Biswas as a member of Bose Institute organized and participated the "FAIR Industry Meet", 12-13 April 2023 at Bose Institute.
- Saikat Biswas attended FAIR-IKMG meeting (online) on 1st June 2023 and presented the status of Indian in-kind items.
- Saikat Biswas, along with other members of Bose Institute represented Bose Institute in the "Government Achievements and Schemes Expo - 2023" at Pragati Maidan, New Delhi and displayed posters on Indian in-kind items to FAIR along with other posters of Bose Institute. Bose Institute received the 2nd Prize for Excellent Achievements.
- Saikat Biswas along with members of Bose Institute represented Bose Institute in the "26th National Exhibition" at Central Park, Karunamoyee, Kolkata and displayed posters on Indian in-kind items to FAIR along with other posters of Bose Institute.

- Saikat Biswas delivered a lecture in an outreach program at Bose Institute on 1st September 2023 on Bose Institute's contribution to the European Organisation for Nuclear Research (CERN).
- Saikat Biswas delivered a lecture in the faculty colloquium on FAIR: The universe in the laboratory on 22nd September 2023 at Bose Institute.
- Saikat Biswas delivered an invited lecture in IIT, Jodhpur on FAIR: The universe in the laboratory on 6th October 2023.
- Saikat Biswas attended FAIR Council meeting 18-19 December 2023, FAIR-GSI, Germany and BI-FAIR Steering committee meeting 18 December 2023, FAIR-GSI, Germany. Saikat Biswas presented the status of the in-kind contribution from India to FAIR.
- Saikat Biswas presented an invited talk on “Gaseous Detectors from INO to CBM via STAR and ALICE” in “Meeting on the physics of ALICE, CBM and STAR" (MPACS) during 29-30 January 2024 at VECC, Kolkata.
- Saikat Biswas presented the status of Indian in-kind contribution to FAIR, Germany in the IKMG meeting at FAIR on 20 March 2024 (online).
- Saikat Biswas attended DST's 1st National Scientific & Technical Rajbasha Seminar 2024 at ARCI, Hyderabad during 21-22 March 2024. He delivered an invited talk titled "FAIR: Prayogshala me Brahmaand".
- **Arindam Sen** attended the EURIZON detector school at Wuppertal, Germany (17-28 Jul 2023). (Fully sponsored by the Organizers of EURIZON detector school, Wuppertal, Germany.)
- Arindam Sen, Subir Mandal, Somen Gope, Anjali Sharma, Saikat Biswas attended 42nd CBM Collaboration Meeting during 24-29 September 2023 (online).
- **Arindam Sen** joined Jefferson Laboratory, Ohio University in December 16 2023 as Post doctoral fellow after submitting thesis in the University of Calcutta, Kolkata.
- Subir Mandal, Arindam Sen, Somen Gope, Saikat Biswas presented poster in the "3rd International Conference on Detector Stability and Aging Phenomena in Gaseous Detectors" from 6-10 November 2023, CERN, Switzerland (online).
- **Subir Mandal** presented poster titled "Behavioural change in performance of GEM detector" in 67th DAE Symposium on Nuclear Physics at IIT Indore, MP, from December 9-13, 2023.
- Subir Mandal, Somen Gope, Anjali Sharma, Saikat Biswas attended 43rd CBM Collaboration Meeting at GSI, Germany, during 4-8 March 2024 (online).
- **Somen Gope** presented poster titled "Performance studies of CBM Time of Flight (TOF) detector and a few aspects of particle production at a FAIR energy" in 67th DAE Symposium on Nuclear Physics at IIT Indore, MP, from December 9-13, 2023.
- **Anjali Sharma** presented poster titled "Investigation of Elliptic Flow and Chiral Magnetic Effect in Pb-Pb collisions in ALICE at LHC" in 67th DAE Symposium on Nuclear Physics at IIT Indore, MP, from December 9-13, 2023.

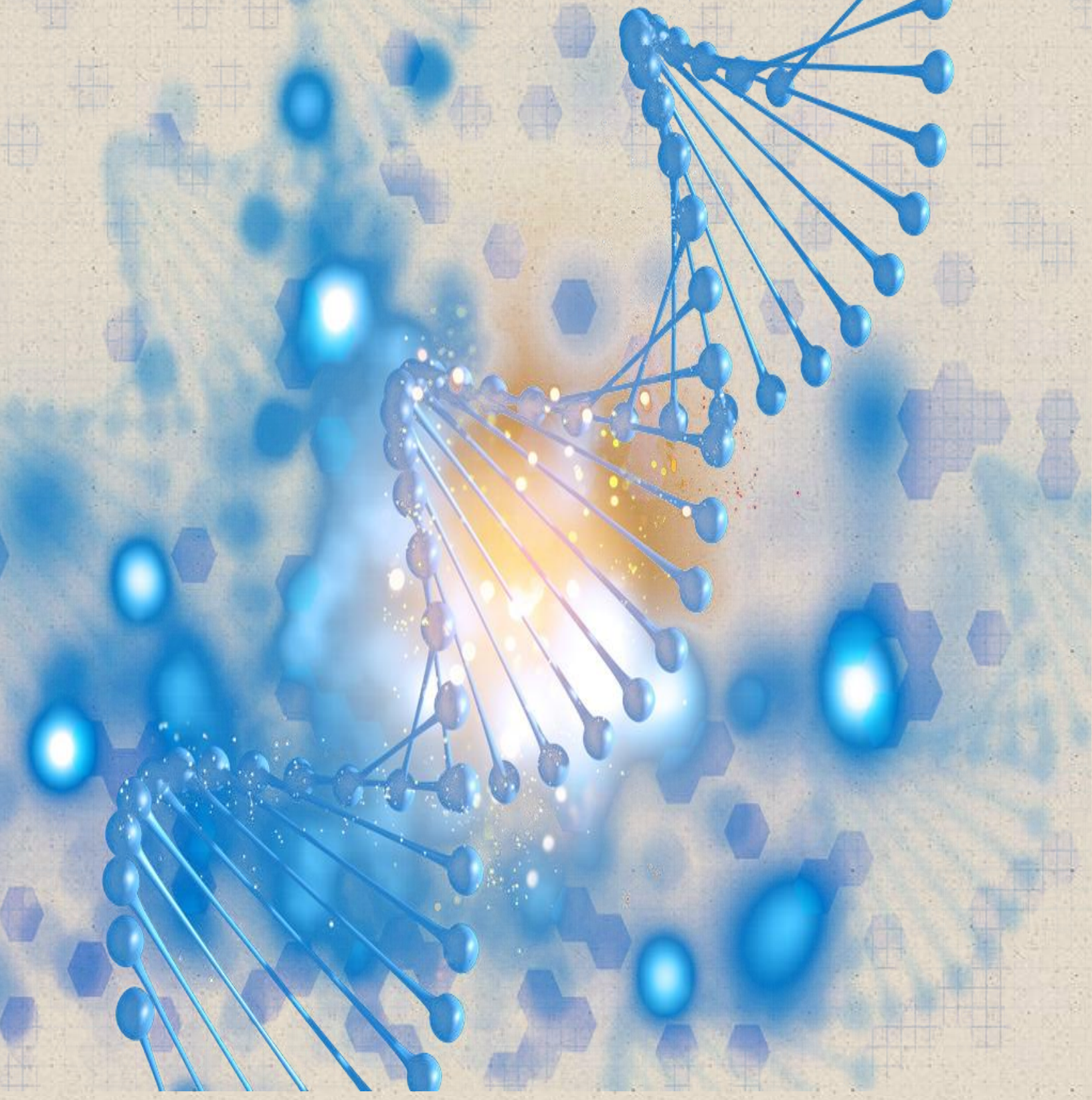
Dr. Sanat Kumar Das

- Presented paper entitled “A study on understanding the interaction between pollution and airborne microorganisms in foggy atmosphere over Central Indo-Gangetic Plain in India” in National Environment Conference-2024 organized by Environmental Science and Engineering Department, Indian Institute of Technology Bombay, Mumbai
- Presented paper entitled “A study on fog enhanced airborne bacteria detecting pathogenicity over Central Indo-Gangetic Plain, India”, at COSPAR 2024 conference.
- Participating 1st Indian winter Arctic Expedition from 17 Jan to12 Feb 2024 for investigation of pristine bioaerosols over North Pole.

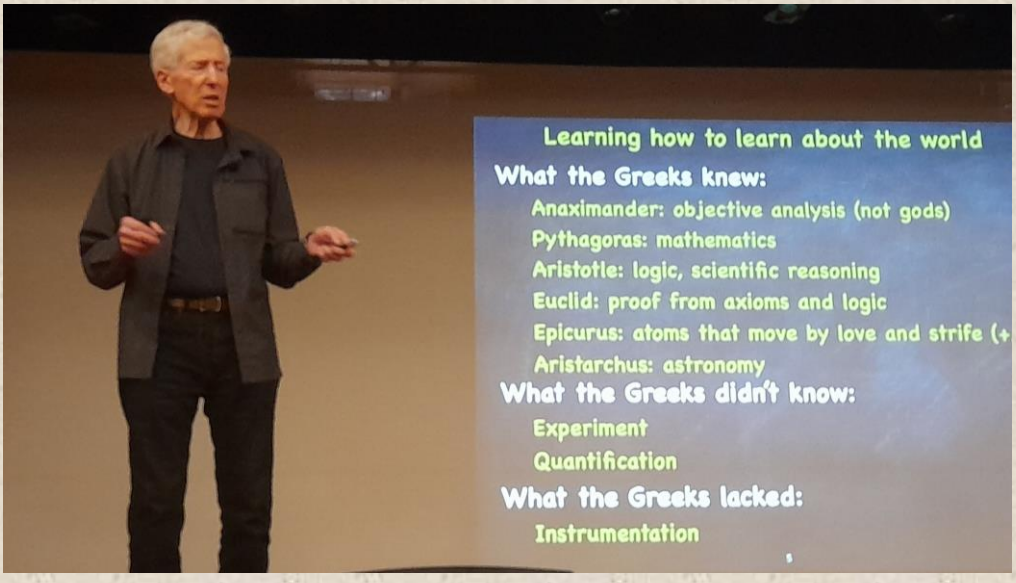
- Participating Indian Summer Arctic Expedition during 17 May to 20 June 2024 for investigation of airborne microorganisms over North Pole.
- Campaign from 6 to 9 Mar 2024 for collecting Airborne Microorganisms over Sundarban Mangrove Reserve Forest under the extramural project (CRG/2021/000619) funded by SERB, Govt. of India.
- Deliver an invited popular lecture to school students at Bedibhawan Rabitirtha Vidyalaya at Nadia, a rural distirct in West Bengal.
- **Shahina Raushan Saikh** (Senior Research Scholar) presented a paper entitled “A Study on the Enhancement of Airborne Bacteria and its Implication on Human Health Due to Fog over Central Indo-Gangetic Plain in India” at 2nd International Multidisciplinary Research Colloquium held on 13-14 July, 2024 organized by International Benevolent Research Foundation (IBRF), Kolkata and Confederation of Indian Universities (CIU), New Delhi;
- **Shahina Raushan Saikh** (Senior Research Scholar) presented a poster entitled "Structural variation in airborne bacterial communities enriched with pathogens in hazy, cloudy and clear winter days over New Delhi, India" at International Commission on Atmospheric Chemistry and Global Pollution (iCACGP), and International Global Atmospheric Chemistry (IGAC) during 9-13 September 2024 at Kuala Lumpur, Malaysia, fully sponsored by Aakash Project, Research Institute for Humanity and Nature (RIHN), Japan.
- **Shahina Raushan Saikh** (Senior Research Scholar) leads an abstract entitled "Alteration of urban airborne bacterial communities enriched with pathogens during winter: A study over New Delhi, India"" at the session 'Atmosphere-Biosphere Interactions via Bioaerosols' of 'Annual meeting of American Geophysical Union (AGU)' 2024 at Washington DC, USA.
- **Antara Pramanick** (Senior Research Scholar) leads an abstract entitled "Long-range transport of dust-associated microbes perturbing biodiversity: A study over Eastern Himalayas, India" at the session 'Atmosphere-Biosphere Interactions via Bioaerosols' of 'Annual meeting of American Geophysical Union (AGU)' 2024 at Washington DC, USA;
- **Antara Pramanick** (Senior Research Scholar) Delivered an invited talk on "Winter-time airborne bacterial communities enriched with pathogens in Urban Atmosphere: A study over New Delhi, India" in Aakash International Meeting 2024 during 26-30 August 2024, Research Institute for Humanity and Nature (RIHN), Kyoto, Japan, fully sponsored by Japan Society for the Promotion of Science (JSPS), Japan.

Dr. Sidharth Kumar Prasad

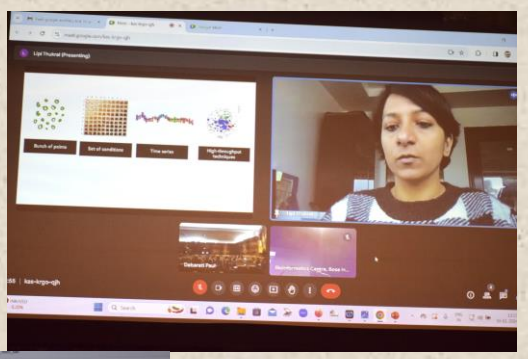
- Delivered an invited plenary talk titled “Recent results on jet measurements in p-p, p-A and A-A collisions at relativistic energies” in the “4th Heavy Flavor Meet” organized by IIT, Goa, during 02 - 04 November 2023.
- Delivered an invited plenary talk titled “jet measurements from small to large collision systems at LHC energy” in the 2nd Workshop on Dynamics of QCD organized by NISER Jatni during 07-09 October, 2023.
- **Mr. Mintu Haldar** (working under Dr. Sidharth Kr. Prasad) presented updates on analysis “study of two particle azimuthal correlation in pp and pPb collisions at 5.02 TeV in ALICE” in the ALICE-STAR-India collaboration meeting at IOP on 24th June 2024.
- **Mr. Prottoy Das** (working under Dr. Sidharth Kr. Prasad) delivered a multi-experiment talk entitled “Jet fragmentation and hadronchemistry” on behalf of the ALICE,ATLAS,CMS and LHCb collaborations at the LHCP 2024 conference in Boston,US during 3-7 June 2024.
- **Dr. Sanchari Thakur** gave a presentation on “Characteristics of correlation peaks using di-hadron correlation in pp collisions at 13 TeV in ALICE” in ALICE-STAR-India collaboration meeting on 23 November, 2023.



DEPARTMENT OF BIOLOGICAL SCIENCES



Prof. George D. Rose, Jubilee Chair Professor of the Indian Academy of Science, Bengaluru and Krieger-Eisenhower Professor Emeritus at the Department of Biophysics, Krieger School of Arts and Sciences, Johns Hopkins University, visited Bose Institute, Kolkata, Unified Academic Campus, Salt Lake Sector-V on November 22, 2023. This talk was jointly organized by the Indian Academy of Science, Bengaluru and Bose Institute, Kolkata. Prof. Rose is a highly engaging speaker, as was evident from his over an hour long talk followed by nearly an hour of exciting, informative, and thought-provoking discussions with a full-house audience. Prof. Gautam Basu chaired the session.



" 'National Workshop on Bioinformatics: AI in Healthcare' " was organized by the DBT funded Bioinformatics Centre at Bose Institute on January 16, 2024."

DEPARTMENT OF BIOLOGICAL SCIENCES

Overview:

Bose Institute has a storied history of making seminal contributions in diverse areas of life sciences, starting with our founder, Acharya Jagadish Chandra Bose. To enable better resource management and foster a strong collaborative environment, seven erstwhile departments engaged in life sciences research were amalgamated to create the Department of Biological Sciences.

The Department commenced its journey on the 15th of May, 2023, bringing together faculty members having diverse research interests and expertise. There is extensive collaboration between members, resulting in the emergence of creative problem-solving approaches towards finding solutions for various challenges faced by our nation. The faculty's interest can be broadly classified into four research domains: (i) Disease Biology, (ii) Microbiology, (iii) Plant Biology, and (iv) Structural Biology.

The Disease Biology team has adopted a concerted, multidimensional approach towards understanding several human diseases, including cancer, asthma, neurodegeneration, infectious diseases and infertility. Team members use synthetic biology approaches for designing therapeutic interventions and finding markers that will enable early detection of these conditions. They are also implementing computational approaches for designing better healthcare delivery systems.

The Microbiology team's interest encompasses all three domains of life: bacteria, archaea and eukarya. The initiatives include finding solutions to microbial diseases relevant to the Indian context, exploring biogeochemically important microbes towards solving environmental problems, and investigating how microbes sense environmental cues and what adaptation strategies they adopt to respond to these signals.

The mission of the Plant Biology team is to achieve fundamental knowledge in plant stress biology, plant-pathogen interaction, development biology, and genomics-assisted molecular breeding. They work on cereals, vegetables and oil seed crops, following the mandate of the National Action Plan on Climate Change (NAPCC), which aims to evolve and implement strategies to make Indian agriculture more resilient to climate change.

The Structural Biology team has expertise in experimental and computational approaches, and they aim to tease out details of the general principles governing life functions and system-specific nuances. They use cross-disciplinary techniques like cryo-electron and light microscopy, spectroscopy, X-ray crystallography, mass spectrometry, simulations and thermodynamic calculations, and other quantitative techniques to gain insights into the structural aspects of various cellular machinery and pathways as well as pathologies related to dysregulation of those systems.

The department proudly hosts two national network projects that unite members with diverse competencies. These are:

National CryoEM Facility: Cryo-EM has emerged as the preferred method for determining the shape and conformational details of macromolecules and their assemblages, close to their native states (hydrated state). Bose Institute is proud to be one of the four centres chosen through a competitive IRHPA scheme by the erstwhile DST-SERB (ANRF) to establish a National CryoEM Facility in India. This centre will foster complementary collaborative research to transform the structure-guided drug discovery and therapeutics research landscape in India. It will also enable researchers to seek answers to fundamental questions in biology, which cannot be addressed with any other technique.

Bioinformatics Centre: Bioinformatics is a theoretical and computational approach that adopts data-driven prediction methods to provide rapid and targeted solutions in diverse domains of biology, often complementing experimental methods. Bose Institute has been a pioneer in this research area since 1989, which continues with two DBT-funded projects to support the current initiatives. One is a multi-institutional National Network Project and another supports the core Bioinformatics Centre Facility. Researchers are adopting data analytical prediction method development and translating them into web-based applications with therapeutic relevance using upcoming methods like machine learning. The objective is to offer more precise and personalized therapeutic strategies. With the help of computer simulations, they are also analysing 'molecules in action' in atomistic detail towards developing strategies to modulate the functions of biomolecules for developing biotechnological solutions for national needs.

Dr. Abhrajyoti Ghosh

Associate Professor
Department of Biological Sciences

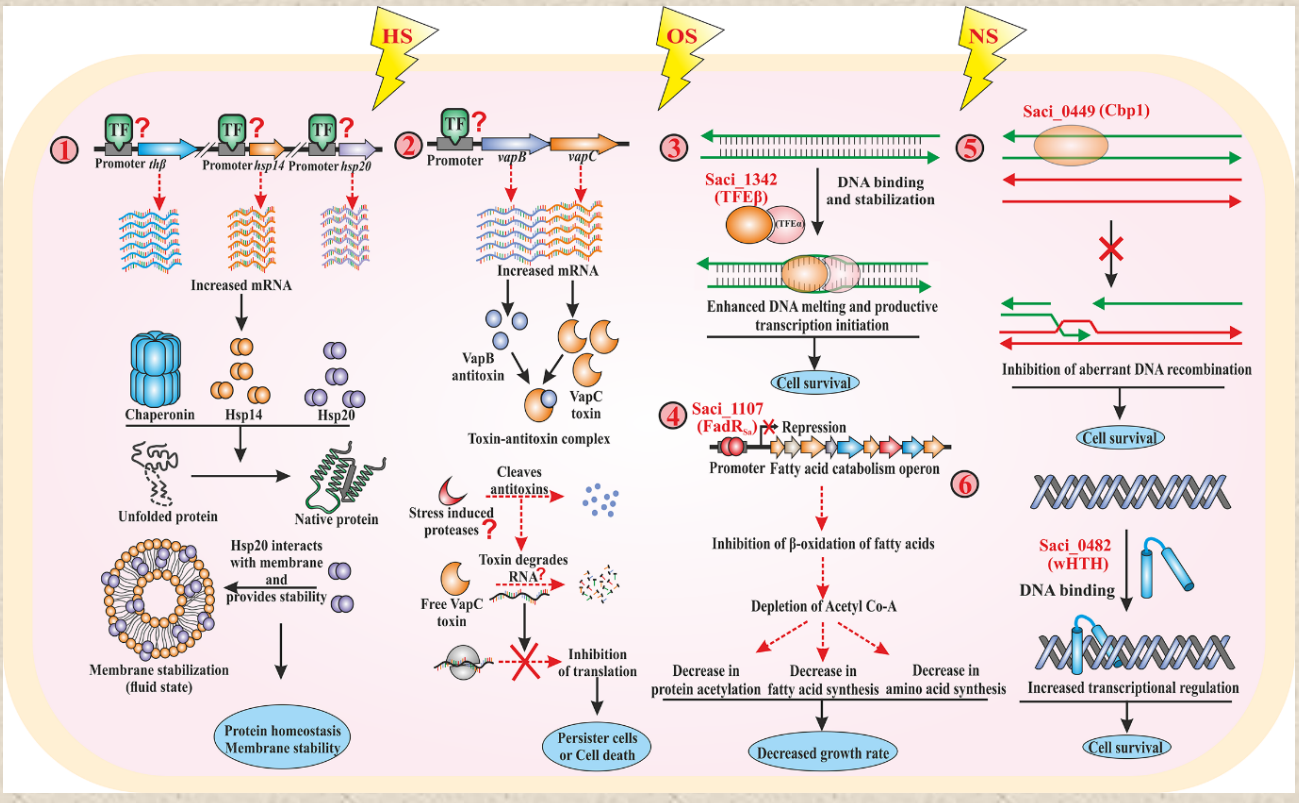
Name of the Participants:
Arghya Bhowmick, CSIR-*Adhoc*
Koustav Bhakta, Institute Fellow
Sangita Mondal, UGC-*Adhoc*
Jagriti Das, DBT-JRF
Agnita Acharya, INSPIRE Fellow
Sirsha Samanta, UGC-Fellow
Dr. Dhruba Bhattacharya, SERB-NPDF

Research Background and Vision:

The primary focus of the laboratory is to understand microbial adaptation under stress conditions. A changing environment creates conditions that can be stressful for microorganisms. To cope with environmental stress, microbes have a variety of evolutionary adaptations and physiological acclimatization mechanisms. Such adaptation and acclimatization strategies allow them to survive and remain metabolically active even when exposed to varied environmental stress. However, not all microorganisms are equally equipped with the necessary arsenals to adapt to the changing environment, and therefore a shift in microbial community composition is often documented under stress conditions. It is believed to be mainly due to a change in ecosystem-level carbon, energy, and nutrient flows that drive alteration in microbial dynamics. In contrast to conventional strategies of understanding specific organismal responses to environmental stress, our approach aims at developing a more reliable connection between microbial and ecosystem ecology. At Bose Institute, we study microbial stress response and adaptation strategies both at the organism level as well as at the microbial community or ecosystem level. We use a variety of techniques including biochemistry, microbiology, and genomics, to unravel the molecular players important in the adaptation and evolution of microorganisms under stress conditions.

Highlights of Research:

- Heat shock response in Sulfolobus acidocaldarius and first implications for cross-stress adaptation
- Minimal Yet Powerful: The Role of Archaeal thermosome in protein homeostasis.
- Host-microbe interaction and heat shock proteins.



The present model depicting the survival mechanism of Sulfolobus acidocaldarius in response to different stress.

1. During the stressed condition, some transcription factor might be involved in positively upregulating the expression of heat shock genes viz. thb, hsp20, and hsp14. Increased expression leads to an increased amount of mRNA which ultimately leads to an elevated amount of heat shock proteins inside the cells. These proteins together can convert an unfolded protein back to its native state. Also, Hsp20 can protect membranes from stress-induced damage. Together these proteins maintain protein homeostasis and membrane stability.

2. During the stressed condition, some transcription factor might be involved in positively upregulating the expression of type II toxin and antitoxin genes. In normal conditions, they together form a toxin-antitoxin complex which neutralizes the toxic effects of the toxin. During the stressed condition, stress-induced proteases cleave the antitoxin rendering the toxin free. The toxin can then cleave mRNA which brings translation to a halt. This strategy helps the cells to enter into a persister phase or can even cause cell death.

3. Saci_1342 (TFEb) was observed to be elevated in all three stresses. This protein acts as a general transcription factor that form heterodimeric complex with TFEa. TFEb when binds to DNA can cause enhanced DNA melting, stabilization of preinitiation complex and productive initiation of transcription. Overall, this might enable S. acidocaldarius to combat stress condition.

4. Saci_1107 (FadRSa) was observed to be elevated in all three stresses. FadRSa is a TetR family regulator that represses a 30 kb operon, containing fatty acid b-oxidation genes. The elevated levels of FadRSa signify that during stress conditions, the expression of fatty acid b-oxidation genes might

be repressed. Repression of fatty acid b-oxidation will lead to depletion of acetyl Co-A as this is the end product of the fatty acid b-oxidation pathway. Depletion of acetyl Co-A will result in decreased protein acetylation, fatty acid, and amino acid synthesis which will in turn lead to the decreased growth rate of cells. This might be an additional strategy of S. acidocaldarius cells to combat stress conditions. In the model the pathways or the processes that are hypothesized are depicted by red dotted arrows and red question mark.

5. Saci_0449 (Cbp1) was observed to be elevated in all three stresses. Cbp1 was predicted to exert inhibitory effects on aberrant recombination events involving repeat-bound sequences. Therefore, it is plausible to speculate that the upregulation of saci_0449 could potentially have a significant role in Sulfolobus cells, safeguarding their DNA from undergoing detrimental aberrant recombination processes.

6. Additionally, Saci_0482, a member of the wHTH (winged helix-turn-helix) family protein, was found to be upregulated in all three stress conditions. Proteins belonging to the helix-turn-helix family are known for their involvement in transcriptional regulation within cells. The increased abundance of this protein could potentially enable Sulfolobus cells to enhance their survival by upregulating the expression of other genes, thereby facilitating adaptive responses to the stressful conditions. (Bhowmick et al., Research in Microbiology, Nov-Dec 2023, Vol 174, Issue 8, 104106).

Prof. Ajit Bikram Datta

Professor
Department of Biological Sciences

Research Background and Vision:

Our laboratory primarily focusses on understanding specificity and plasticity in the interactions of various proteins involved in ubiquitination, namely ubiquitin activating enzyme E1, conjugating E2s and ubiquitin E3 ligases. Last year, most of our research work was directed towards understanding the E2 specificity of non-canonical vertebrate E1 known as Uba6. Uba6 had been found to transfer the activated ubiquitin moiety to a subset of E2s some of which were also recognized by Uba1. We alleviated the hurdles in purification of recombinant human Uba6 by employing a synthetic gene approach and also deleted a small region of the protein that does not seem to have any functional role. We also obtained the second UbL FAT10 that is activated by the Uba6 in sufficient quantity and purity. We have also started investigating on the ubiquitin chain building preference of E2s, which appears to be an intrinsic property of the Ubc domains. Work on obtaining residue level understanding is ongoing.

Field of Research:

- Structural Biology.

Focused Areas of Research:

- Structural basis of plasticity and specificity in protein-protein recognition.
- Understanding post-translational modification of proteins with ubiquitin.
- Determination of crystal structure of proteins and their complexes.

Highlights of Research:

The insights obtained through our research are summarized below.

Intramolecular ubiquitination acts as a regulatory mechanism and is a common feature in E2s with extended tails.

Background: We previously reported that Ube2E class of E2s undergo intramolecular auto-ubiquitination at their N-terminal extensions and this self-modification attenuate substrate and E3 ubiquitination activities of Ube2E class of E2s, unlike their close cousins, Ube2Ds. We extended this study to include other E2s with extended tails such as Ube2T and Ube2C.

Achievements: We find that Ube2T also undergoes intramolecular ubiquitination at its C-terminal. However, unlike Ube2E, Ube2T only efficiently mono-/multimono-ubiquitinates itself. Thus, there also exists a fundamental difference between Ube2Ts and Ube2E/Ds that precludes the former from using ubiquitin itself as the acceptor.

ii) Understanding the molecular basis of high-affinity interaction between ZNRF1 and Ube2N Background: RING E3 ligase ZNRF1 contains an unusual H2-type RING domain where two Zn2+ chelating residues are swapped apart from containing a zinc-finger domain. To understand its E2 specificity and affinity we carried out biochemical assays as well as binding studies using isothermal titration calorimetry. Binding studies revealed that ZNRF1 binds Ube2N with a dissociation constant of ~40 nM at 25°C unforeseen for any E3-E2 pairs.

Achievements: We determined the crystal structure of ZNRF1 in complex with Ube2N at 1.47Å. The structure, supplemented with systematic mutational studies, established that (i) ZNRF1 engages Ube2N via its RING domain similar to most RING E3 ligases and (ii) the electrostatic interaction between Arg14 of Ube2N and Glu183 of ZNRF1 is primarily responsible for imparting such an high affinity between this E3 and the E2. We also carried out binding measurements to obtain the change in the heat capacity upon binding. A comparison of the measured heat capacity with that from the theoretical calculation highlighted the importance of the water molecules observed in the protein-protein interface in our crystals.

iii) Importance of the conserved tryptophan residue in imparting ligase activity in monomeric RING E3 ligases

Background: Many of the RING E3s were found to contain a conserved tryptophan that was crucial for their ligase activity while many other E3s lacked that residue yet showed robust activity. We systematically probed into this by using sequence analysis, biochemical data and literature mining.

Achievement: Employing multiple E3s as models along with their mutants we show that the tryptophan is absolutely essential for monomeric E3s while dimeric do not essentially require it. On the other hand, introduction of the tryptophan in dimeric RING E3s results in hyperactivity and makes dimerization redundant for their ligase activity. This data established that the oligomerization mediated control of ligase activity is critically dependent on the absence of the tryptophan justifying the absence of this residue from most of the dimeric E3s.

iv) Elucidation of the structure of the Ufd domain from the non-canonical E1, Uba6 Background: Vertebrates including humans contain two ubiquitin activating enzymes, namely Uba1 and Uba6. Out of these, non-canonical Uba6, is unique as it can activate a second UbL protein, FAT10, apart from the ubiquitin. Uba6 also transfers its ubiquitin to only a subset of E2s and is specific for Ube2Z. Experiments had revealed that the E2 specificity of Uba6 is predominantly dictated by its C-terminal Ufd domain.

Achievements: We have successfully crystallized and determined the structure of Uba6-Ufd domain. The structure depicted differences with the corresponding domain from Uba1. Studies are now underway to understand residue-specific roles of various Ufd domain residues in determining E2 specificity.

v) Molecular determinants of E2 specificity of non-canonical vertebrate E1, Uba6. Background: Ubiquitin itself and all other ubiquitin-like proteins (UbLs) are activated by large mono or multimeric proteins known as UbL activating E1 enzymes. All these E1s, irrespective of their oligomeric organization or UbL specificity, are remarkably similar in terms of their domain organization and structure. For ubiquitin, the E1s are monomeric proteins that activate the ubiquitin in two chemically distinct steps and subsequently transfers the activated ubiquitin to a conjugating E2 enzyme. To begin with, E1 binds the ubiquitin and a molecule of ATP in its adenylation domain resulting in the formation of Ub-AMP intermediate and releases a pyrophosphate moiety. Subsequently, the Ub-AMP intermediate reacts with the catalytic cysteine residue of the E1 present in one of its half-catalytic domains leading to the formation of E1~Ub thioester and release of the AMP moiety. Finally, E1s engage with conjugating E2s via their C- terminal ~100 residue long Ufd domains to release E2~Ub conjugates formed through trans- thioesterification reactions. Uba6, the non-canonical E1 found in vertebrates, is unique amongst all UbL E1s as it can also activate a second Ubiquitin-like (UbL) protein called FAT10. It was also reported that Uba6 not only interacts exclusively with Ube2Z but it can also interact and transfer the activated Ub moiety to a few but not all of the E2s that are also recognized by Uba1.

Achievements: As we could successfully express and purify recombinant human Uba6 last year from using prokaryotic expression systems, this year we concentrated on carrying out biochemical experiments with Uba6 and compare its E2 interaction with that of Uba1. As previously reported, we also found that Uba6 could not transfer the activated the Ub moiety onto any of the wt Ube2Es (Ube2E1, Ube2E2 and Ube2E3) but could efficiently charge Ube2D2, which shares more than 70% similarity with the Ube2Es in their catalytic Ubc core. We therefore prepared three truncated version of the Ube2Es by deleting their N- terminal flexible regions and observed that these truncated constructs are efficiently charged by Uba6 unlike their full-length versions. We also tested a chimeric Ube2D2 that contained the Ube2D2 core with the N-terminal extension of Ube2E1 and observed that the addition of the N-terminal tail reduced the Ub transfer efficiency of Uba6. These results conclusively show that the N-terminal flexible regions present in Ube2Es impart their E1 selectivity. We now plan to look into the Uba6 domains/regions that might be responsible for this E2 differentiation.

Dr. Anupama Ghosh

Associate Professor
Department of Biological Sciences

Name of the Participants:
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Subhasish Mukherjee, SRF, UGC Adhoc
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Anisha Roy, DBT-SRF
Rituparna Mondal, DBT-SRF
Ankita Kar, DBT-SRF
Atreyee Sarkar, UGC Adhoc
Dr. Indraneel Saha (SERB-NPDF)

Research Background and Vision:

The primary focus of our research is to understand the molecular mechanisms of communication between a host and a pathogenic/beneficial microbe within a plant microbe interaction system. As a model biotrophic plant pathogen, we are studying the corn smut fungus Ustilago maydis. From the pathogen's perspective we are investigating the contribution of a number of secreted proteins with different functional domains from Ustilago maydis in the virulence mechanisms of the fungus. In addition, role of small heat shock proteins in the pathogenic development of the fungus is also being studied. While from the host plant's side we are carrying out studies aiming towards identifying defense strategies that the plant employs to control infection. In this part of the study, we are exploring defense mechanisms of Z. mays against U. maydis infection that are active at the interface of the host pathogen interaction which is represented by the apoplast of the infected plants. Our studies also include investigating the molecular responses of maize towards colonization with beneficial microbes isolated from various environments.

Highlights of Research:

- Pathogenic mechanisms of Ustilago maydis
- Involvement of an intrinsically disordered small heat shock protein, Hsp12 from U. maydis in stabilizing lipid vesicles has been demonstrated.
- A small heat shock protein Hsp20 from U. maydis has been shown to regulate a number of cellular processes including endocytosis, determining cell polarity during budding and changes in actin dynamics.
- A phosphatidylserine targeting secreted lipase, Lip1 from Ustilago maydis has been demonstrated to regulate apoplastic pH in infected maize.

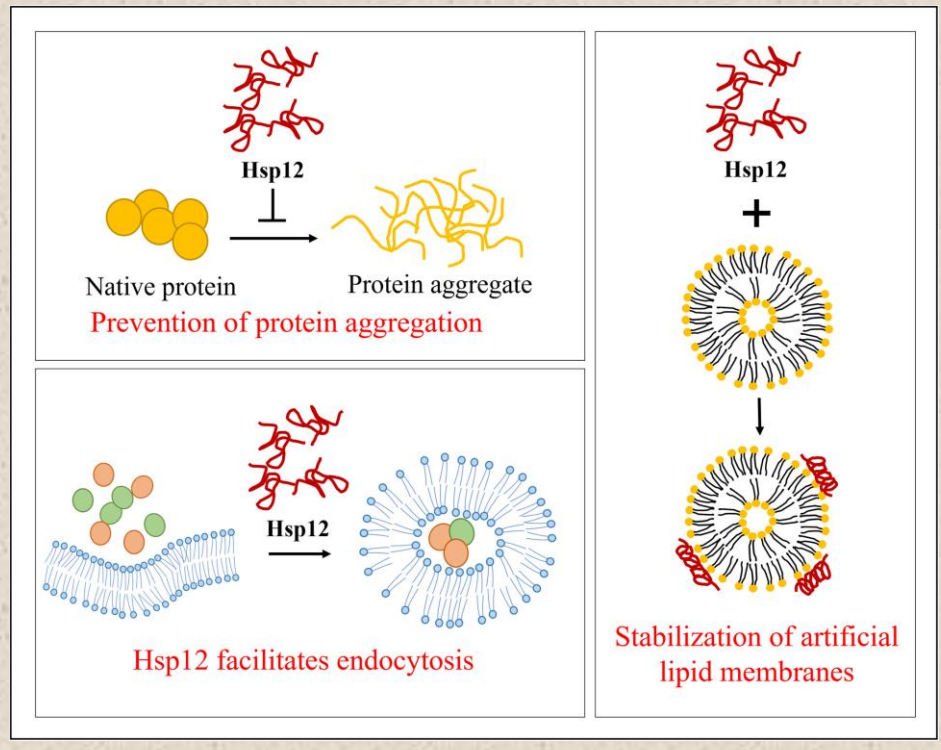

Figure demonstrates the involvement of Hsp12 from Ustilago maydis in the prevention of protein aggregate formation, stabilization of artificial lipid membranes in vitro, and endocytic processes in the pathogen (Mitra et al, Molecular Plant Pathology, July 2023, Vol 24, 1063-1077).

Prof. Atin Kumar Mandal

Professor
Department of Biological Sciences

Name of the Participants:
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Pramit Bhattacharjee, SRF
Somesh Roy, SRF
Madhuparna Chakraborty, SRF
Dhiman Saha, CSIR-SRF
Upama Chowdhury, UGC-SRF
Gourav Some, CSIR-SRF
Alapan Maity, CSIR-JRF

Research Background and Vision:

Proteostasis is finely balanced by the cellular Protein Quality Control (PQC) machinery consisting of molecular chaperones and degradation system. The PQC system is often perturbed by the environmental, cellular or genetic factors, resulted in development of various diseases including cancer, diabetes, hypertrophy and late-onset neurological disorders. The focus of my lab is to understand the molecular collaboration of chaperones and ubiquitin ligases in maintaining cellular protein homeostasis. We have found that Praja1, a highly expressed ubiquitin ligase in brain efficiently clears polyQ proteins, ataxin3 and huntingtin, henceforth, reduces their aggregation and toxicity of polyglutamine proteins. Praja1 level is downregulated in polyQ overexpression condition suggesting its role in manifestation of polyQ diseases when efficiency of PQC machinery is decreased in aging.

Field of Research:

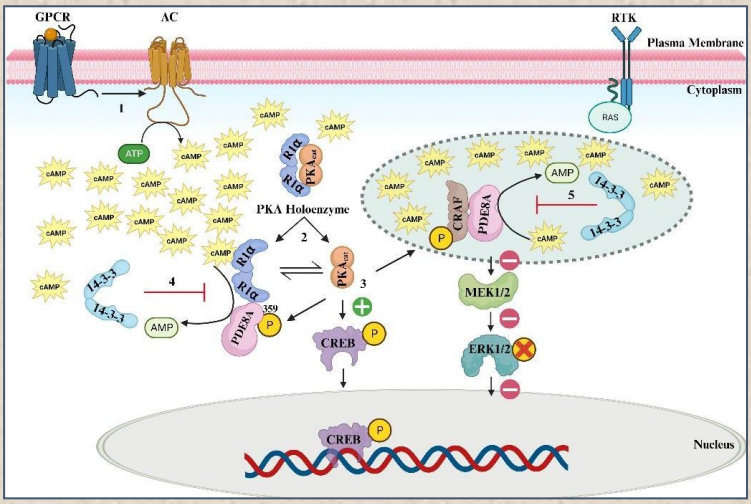
- Mechanism of Cellular Protein Homeostasis.

Focused Areas of Research:

- Understanding the collaboration of molecular chaperones and ubiquitin ligases in maintaining cellular proteostasis.
- Identifying the role of Praja1 ubiquitin ligase in regulating the homeostasis of PolyQ proteins associated with neurodegenerative disorders.
- Quality control of CRAF/Raf1 kinase: Its activation/deactivation by molecular chaperones, scaffold protein 14-3-3 and phosphodiesterase.

Highlights of Research:

Elucidated the role of scaffold protein 14-3-3 in switching the signal between PKA and MAPK pathway by modulating the catalytic activity of Phosphodiesterase 8A (PDE8A). Phosphodiesterase 8A (PDE8A) downregulates PKA signaling by degrading intracellular cAMP pool. PDE8A also activates CRAF kinase by reducing S259 phosphorylation of CRAF, a binding site of 14-3-3ξ protein which keeps CRAF in an inactive conformation at the cytosol, resulting upregulation of MAPK pathway. Interestingly, PKA phosphorylates S259 residue of CRAF kinase to facilitate 14- 3-3ξ binding. Our study shows that 14-3-3ξ directly interacts with PDE8A and reduces the catalytic activity of PDE8A, henceforth, raises intracellular cAMP and sustains PKA signaling. On contrary, 14-3-3 binding to PDE8A downregulates MAPK signaling by enhancing inhibitory phosphorylation (S259) of CRAF kinase. Therefore, 14-3-3ξ plays a critical switch in regulating PKA and MAPK signaling.



Proposed model for the role of 14-3-3ζ in regulation of PDE8A activity and downstream signaling

1. Binding of ligand to the membrane bound G-protein coupled receptor (GPCR) activates Adenylate Cyclase (AC). Activated AC converts ATP to cAMP.
2. cAMP thereby binds to the regulatory subunit (R1α) of PKA and facilitates dissociation of the catalytic subunit (PKAcat).
3. PKAcat in-turn phosphorylates CREB, PDE8A and CRAF at Ser133, Ser359 and Ser259 residues, respectively. Phosphorylated CREB moves to the nucleus and promotes transcription of target genes. On the other hand, activated PDE8A binds to R1α and begins hydrolysing cAMP by substrate channelling thereby turning down the PKA signal. In addition, phosphorylation of CRAF facilitates 14-3-3ζ binding and inactivates MAPK pathway.
4. Binding of 14-3-3ζ to the phosphorylated Ser359 residue of PDE8A, inhibits its phosphodiesterase activity and sustains the cAMP/PKA/CREB cascade.
5. In subcellular microdomains, 14-3-3ζ enhances the cAMP pool by inhibiting PDE8A activity associated with CRAF and promote inhibitory Ser259 phosphorylation of CRAF by PKAcat, thus down regulating of MEK/ERK pathway.

Dr. Basudeb Maji

Assistant Professor
Department of Biological Sciences

Name of the Participants:
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Arpita Hota, SRF
Sreehari Dinesh, Project Assistant
Shreeja Saha, Research Intern
Shadaan Shahid, Research Intern
Soumya Patra, Project Assistant
Amaresh Jana, Research Intern
Koushik Das, Research Intern

Research Background and Vision:

Targeted Protein Degradation to Inhibit EMT in Tripple Negative Breast Cancer

TNBC falls under the category of Basal type as it expresses Cytokeratin 5, 6, or 17, similar to the basal cells lining skin and airways. The lack of functional RB1 and the presence of mutant p53 promote a high proliferation rate in TNBC(Perou 2010). Epidemiological studies suggest that TNBC encompasses 15% of invasive breast cancers and is associated with high mitotic indices, family history of breast cancer, and mutation in the BRCA1 gene(P. Boyle 2012). Hence lack of receptors (ER, PR, and HER2), mutations, and unknown etiology make TNBC a challenging field for developing targeted therapy in medicine and research. Due to the lack of therapeutic targets, standard chemotherapy is the only way to treat TNBC nowadays. In medicine, CMF (cyclophosphamide, Methotrexate and 5-Fluouracil) show higher efficacy than CEF (Cyclophosphamide, epirubicin and 5-fluouracil) in TNBC therapy. While CMF shows good DFS (Disease-free survival) and OS (overall survival) as adjuvant therapy in combination with epirubicin, anthracycline proves to be an effective neoadjuvant therapy for TNBC(Liedtke et al. 2008). Drugs from the Taxane family are also used as chemotherapeutic agents to treat breast cancer. Clinical trials highlight better outcomes from combinatorial administration of Taxane with cyclophosphamide and doxorubicin(Joensuu and Gligorov 2012). GEICAM 9805 study and Breast cancer International Research Group (BCIRG) 001 study show more efficacy of TAC (Docetaxel, doxorubicin and cyclophosphamide) over FAC (Fluouracil, doxorubicin and cyclophosphamide) in treating high-risk node-negative breast cancer and node-positive TNBC(Martín et al. 2010),(Hugh et al. 2009). Although neoadjuvant therapy shows positive outcomes in TNBC, the residual disease after neoadjuvant chemotherapy (NAC) exerts poor overall survival (OS)(André and Zielinski 2012). Certain drugs such as capecitabine, gemcitabine, vinorelbine, or albumin-bound paclitaxel are administered to anthracycline pretreated advanced breast cancer; ixabepilone and capecitabine are used against anthracycline/Taxane resistant breast cancer(Rivera, Lee, and Davies 2008). Another recent drug Platinums demonstrates promising as a neoadjuvant therapy able to promote apoptosis in TNBC bearing BRCA1 mutation. However Platinums is under study at present and is not recommended to patients (Joensuu and Gligorov 2012). Apparently, chemotherapeutics appears

promising therapeutic regimen for cancer intervention, these are cytotoxic that affect normal cells along with cancer cells. In contrast, targeted therapeutics are currently the focus of much anticancer drug development in order to bypass the disadvantages associated with standard chemotherapies. They are a cornerstone of precision medicine, a form of medicine that uses information about a person's genes and proteins to prevent, diagnose, and treat disease (Zhong et al. 2021).

Due to the lack of effective therapeutic methods, we think there is huge scope for developing novel therapeutic strategies by combining biological, chemical, and genome engineering tools.

Field of Research:

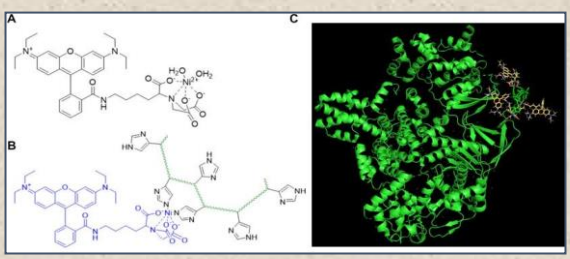
- Chemical Biology.

Focused Areas of Research:

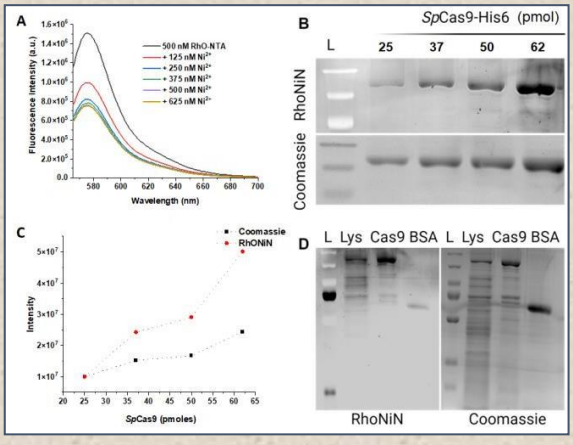
- Chemical controls of CRISPR- based methodologies.
- Precision genome engineering.
- Synthetic Biology-based drug discovery.

Highlights of Research:

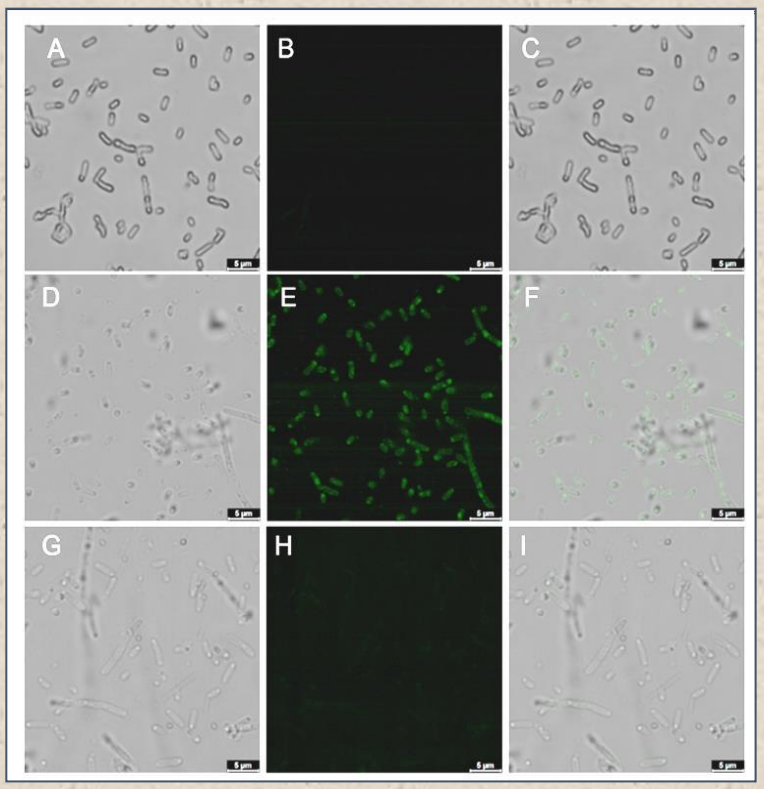
We have developed novel method for CRISPR-enzyme labeling and co-delivery of molecules for genetic and epigenetic applications. Unlike the reported method, our method does not require cysteine residues for bioconjugation and is more generic in nature.



(A) Chemical structure of RhoNiN. (B) Tentative molecular interaction of RhoNiN with His6 peptide. (C) Predicted molecular complex of RhoNiN with SpCas9.



(A) Fluorescence titration of RhoNiN-acid precursor (Rho-NTA) with NiCl2 in 20 mM Tris.HCl, 50 mM NaCl, DTT 1mM, pH 7.5 buffer showing the formation of the metal complex resulting in the decrease in the fluorescence intensity. (B) Top panel shows fluorescence image of 5 µM RhoNiN stained SpCas9-His6 with increasing amount of protein on a denaturing gel. Bottom panel is its corresponding Coomassie staining. (C) Comparative SpCas9 staining signal intensity of RhoNiN and Coomassie. (D) Gel image depicting SpCas9-specific labeling of RhoNiN (5 µM) over BSA and other bacterial proteins present in the crude cell lysate (Lys). L represents the protein ladder.



Fluorescence microscopic imaging of bacterial cells in the presence and absence of RhoNiN. Panel A-C represents bacterial cells alone under the bright field, Rhodamine B channel, and their overlay, respectively. Panel D-F represents bacterial cells expressing SpCas9-His6 with IPTG induction followed by treatment with 5 μM RhoNiN under the bright field, Rhodamine B channel, and their overlay, respectively. Panel G-I represents bacterial cells harboring SpCas9-His6 expression plasmid without IPTG induction in the presence of 5 μM RhoNiN under the bright field, Rhodamine B channel, and their overlay, respectively. The scale bar is 5 μm.

Dr. Debjani Roy

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Department of Biophysics

Name of the Participants:
Dr. Souvik Basak and
Dr. Amit Halder and
their group members,
Dr. B.C. Roy College of
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Sciences, Durgapur

Research Background and Vision:

We are working on the protein fibrillation pathways. We are interested in the development of protein fibrillation inhibitors which have long been recognized as potential therapeutics for ageing diseases. The most part of this work was attributed to big database screening and in vitro validations of these screened efficacious inhibitors. We are trying to develop a unified method for accelerating hit-to-lead strategies. This study emanated from our previously developed methods and subsequently predicted repositioning drug scaffolds. An insight garnered from this network medicine approach integrates multiple types of biological regulators to the genetics of ageing diseases.

Research Highlights/Accomplishments:

- Submitted a grant to the department of Science and Technology and Biotechnology (DSTBT), Government of West Bengal (GOWB) entitled "Use of exosomal microRNAs to diagnose and predict the progression of Parkinson's Disease" on November 30, 2022.
- Identified several new next generation therapeutics for Alzheimer Disease.
- In vitro (Thioflavin T and Congo Red assays) validations of repositioning drugs as protein fibrillation inhibitors.

Aims and Objectives:

1. In vitro Diagnostic device development for human diseases.

- Design of an instrument involving human tissue in a microfluidic platform.
- Biosensor development using microRNA-mRNA-TFs and pathways.

2. Method development for Drug Development

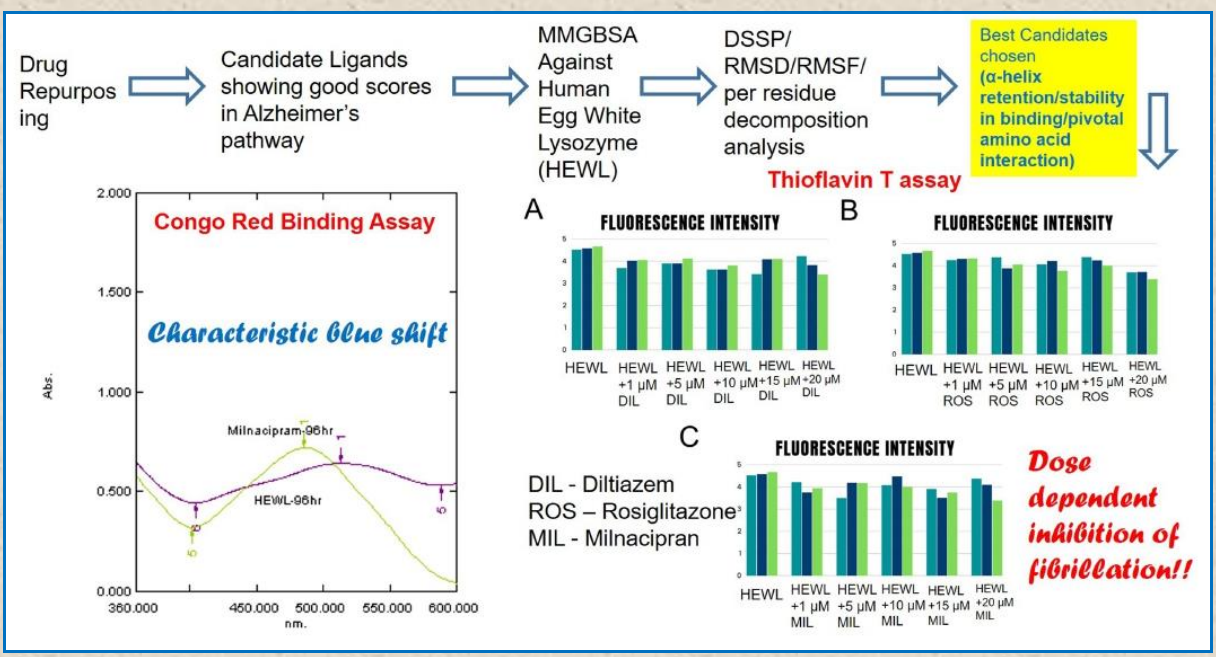
- Identification and characterization of exosomes.

3. Big data analysis

- Bimolecular structure prediction and study their interactions,
- Database and Library design for studying improved interactions.
- Analysis of next-generation sequence data.
- FPGA based device development involving Internet of things for remote control.

Future Plan:

- Use of microRNAs to facilitate the drug action.
- Synthesis and in vivo validations of predicted next generation therapeutics for Alzheimer disease and Breast Cancer.
- Melatonin and circadian rhythm disorders and its implications in ageing.



Prof. Gaurab Gangopadhyay

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Department of Biological Sciences

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Diptasree Kumar - SRF, WBDSTBT Project Fellow
Mushtaq Ahmad Najar - SRF (CSIR, Adhoc Fellow)
Saptadipa Banerjee - SRF (UGC, Adhoc Fellow)
Dr. Bratati Sikdar - Senior Project Associate (Intramural)

Research Background and Vision:

I am a plant biologist working on omics-assisted plant breeding and biotechnology. The main program is on sesame, the emerging oilseed crop. We have developed a few promising recombinants of sesame with high lignan content in oil and tolerance to charcoal rot disease. In the coming years, I'll concentrate on fundamental aspects of flowering. It'll help to combat the deadly Phytoplasma-induced flowering disease causing Phyllody. Besides this project, I have a few other research programs, like the Fusarium-tolerant over-expression line development of Pineapple and deciphering the pathways involved in the somatic embryogenesis of Darjeeling tea integrating metabolomics and transcriptomics analysis.

Field of Research:

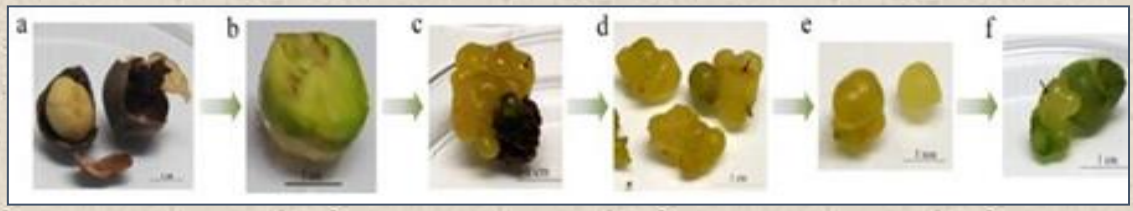
- Plant Genetics, Molecular Biology and Biotechnology.
- Focused Areas of Research:
- Molecular marker-assisted breeding to develop inter-specific hybrid sesame with improved oil profile and fungal tolerance.
- Development of fungal pathogen-tolerant transgenic pineapple.
- Genetic engineering to develop low-phytate rice with enhanced phosphorus and minerals in grains.

Accomplishments:

- First report of a metabolomic study of Phytoplasma-infected Sesame plants.
- First report of identification of essential molecular factors and metabolites behind somatic embryogenesis of Darjeeling Tea.
- New project on microbial quorum sensing.

Highlights of Research:

- LC-MS/MS/MS detected 162 metabolites, of which 82 showed increased accumulation in the Phytoplasma-infected tissue, and 62 exhibited a down-regulating trend.
- The integrated metabolomics and transcriptomics analysis of embryogenic callus (EC), globular embryo (GE), and heart-shaped embryo (HE) showed that various genes and metabolites involved in the phenylpropanoid, auxin biosynthesis, gibberellin, and brassinosteroid pathways enriched in EC, GE, and HE differentially.



- Epigallocatechin gallate (EGCG) from green tea showed microbial quorum sensing inhibitory potential.

Prof. Kaushik Biswas

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Research Background and Vision:

Our Laboratory focusses in understanding how tumor derived glycolipids, specially gangliosides influence the process of tumorigenesis. With that goal in mind, we ask two basic questions – What's the consequence of over-expression of some of these gangliosides in tumor growth, progression and metastasis; and What is the basis of over-expression of these gangliosides in some tumors? In the last few years, we have demonstrated a pro-tumorigenic ability of the ganglioside GM2, which is over-expressed in several cancers, including but not limited to GBM, RCC and Lung Cancer. We have also discovered that GM2-synthase, the gene primarily involved in synthesis of GM2 is epigenetically regulated in RCC at the level of transcription. During the last year, we have progressed in standardizing the protocol for immuno-precipitation of the proteome associated with the TSS of the GM2-synthase gene using a dCas9-guided "enChIP" method. We have also uncovered two distinct signaling axis regulated by GM2 through it imparts EMT and metastasis. Significant progress has also been achieved in our understanding how ganglioside GM2 modulates the tumor micro-environment through its effect on fibroblasts in the process of tumorigenesis. On a different note, we have identified a novel miRNA-mRNA axis and are trying to understand its role in cancer. In an effort to understand how Eriodictyol, a plant derived flavonoid which has been shown from our laboratory to display selective cytotoxicity towards cancer cells, we are now trying to understand its anti-metastatic mechanism in addition to increasing its bio-availability inside cells and its mode of uptake through chemical modifications and nano-formulations.

Field of Research:

- Cancer Biology.

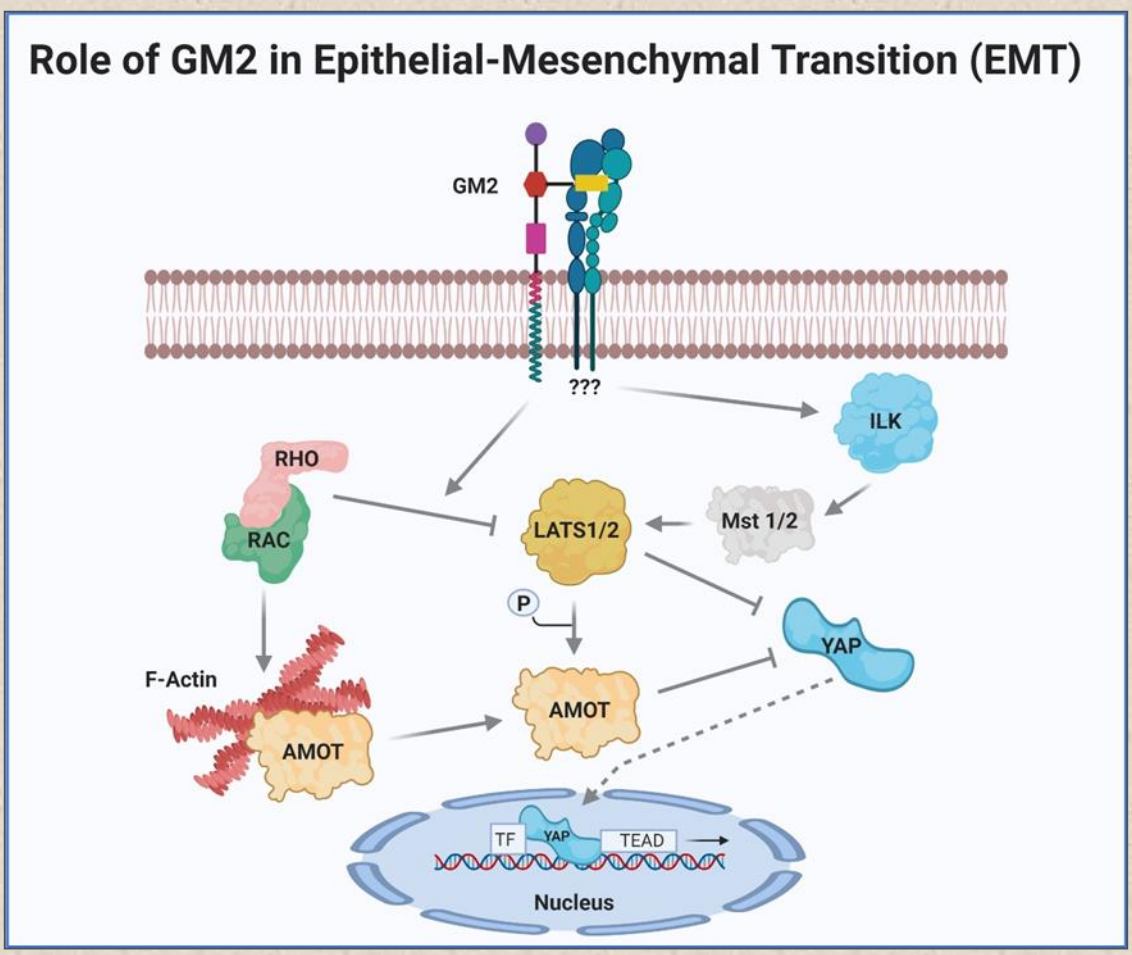
Focused Areas of Research:

Tumor Glycobiology, Role of Cancer Associated Fibroblasts (CAFs) in Carcinogenesis, Transcriptional Regulation of Gene Expression, Epigenetic Regulation of Gene expression, Cell Signaling, Anti-cancer effects and mechanism of compounds from natural sources.

- Understanding the Transcriptional Regulation of GM2- synthase gene in Cancer
- Identification of oncogenic ID1 as a novel target of tumor suppressor miR-615-5p and elucidation of its mechanism in tumorigenesis.
- Screening and Identification of Naturally Occurring Flavones with an aim to obtain High value Anti-Cancer Lead.

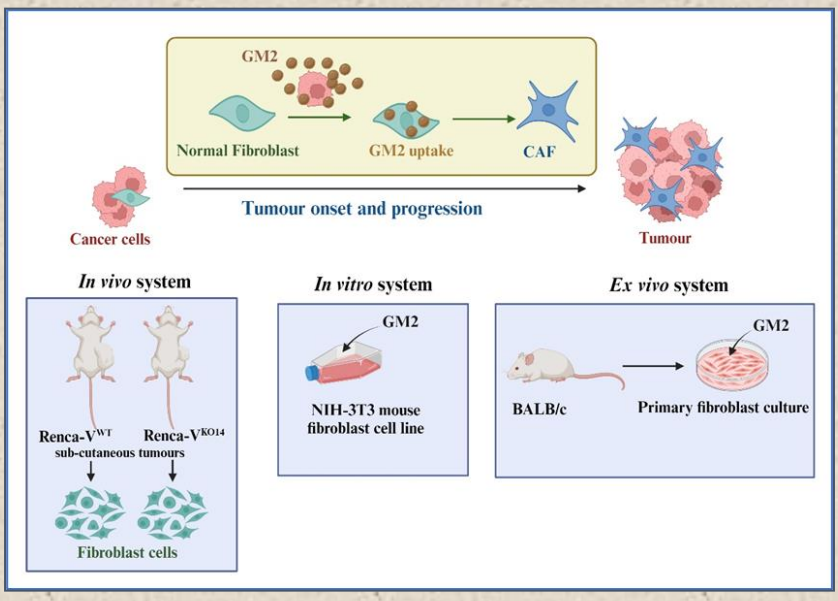
Highlights of Research:

Unravelling the signaling crosstalk employed by ganglioside GM2 in EMT and metastasis : Our laboratory have identified ganglioside GM2 to play a novel role in tumor cell migration and invasion, as well as in inducing epithelial-mesenchymal transition (EMT) and metastasis through distinct mechanisms. We ask "HOW" GM2 over-expression influences the process of carcinogenesis, and "WHY" ganglioside GM2 is at all over-expressed in cancer ? To address the first question, we demonstrated that GM2-mediated tumor cell migration and invasion were found to involve the activation of downstream integrin signaling relaying the signals to converge in modulation of actin cytoskeleton causing increased migration and invasion in tumors. Additionally, GM2-mediated EMT changes were found to involve the HIPPO-YAP/TAZ signaling. Present study aims in defining the role of gangliosides in EMT and metastasis and uncover its mechanism.

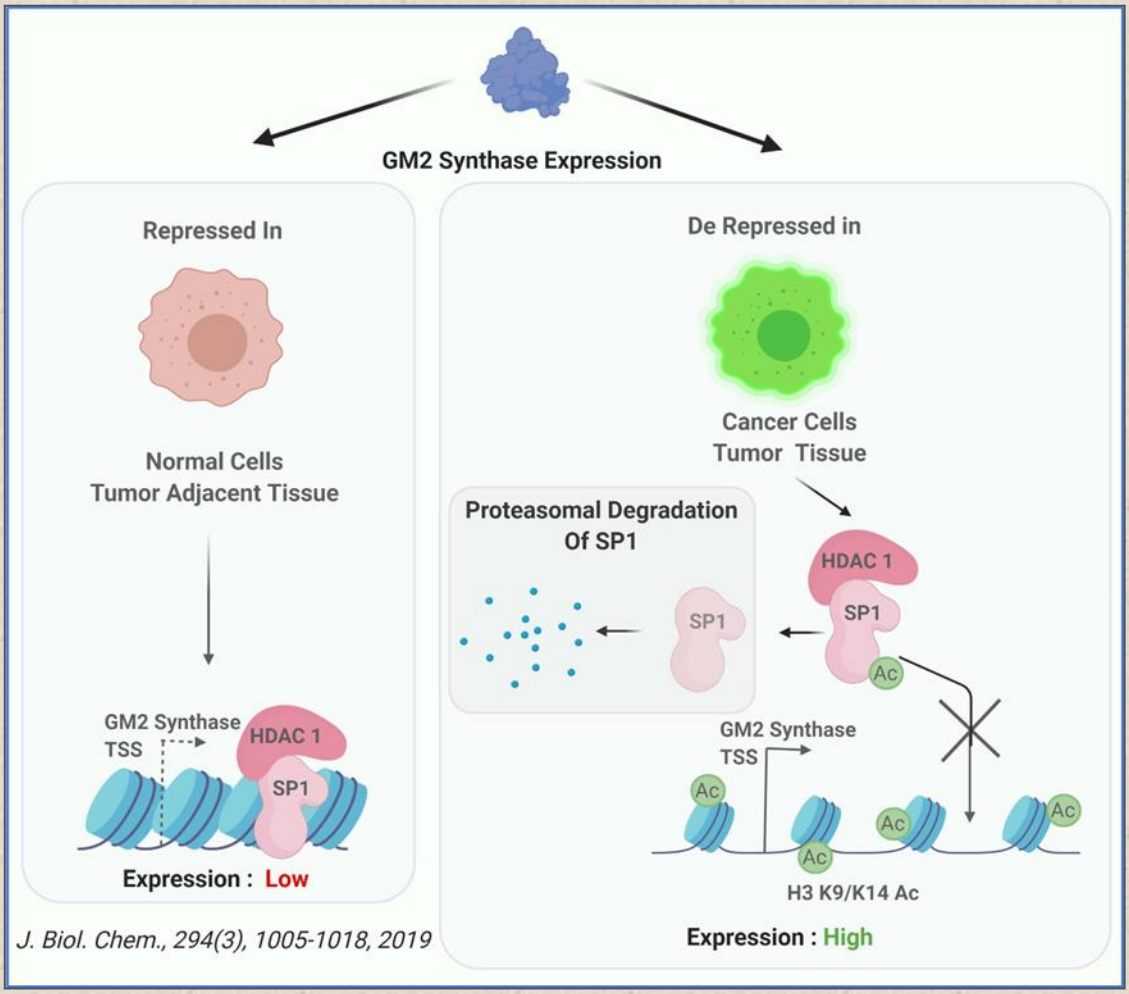


To this end, during the last three years, a global transcriptomic analysis and their validation from cells treated with exogenous GM2 revealed that GM2 modulates Hippo transducer YAP-TAZ dependent gene transcription. Additionally, data shows that, GM2 promotes dephosphorylation, expression and nuclear localization of YAP-TAZ. Addback of exogenous GM2 to GM2-syn KO cells reversed suppression and upregulated YAP/TAZ-target gene expression, confirming that YAP/TAZ-target gene expression is GM2-dependent. We also demonstrated that GM2 caused time-dependent F-actin formation, while F-actin/G-actin ratio decreases in Renca-vGM2-syn KO cells, suggesting a role of F-actin in GM2-mediated HIPPO-YAP/TAZ signaling. Further, Latranculin, an F-actin disruptor blocks GM2-mediated YAP/TAZ target gene expression, confirming the above hypothesis. Additionally, we show that Verteporfin, an inhibitor of YAP/TAZ-TEAD interaction blocks GM2-mediated induction of ctgf and cyr61, confirming that GM2-mediated induction of EMT genes is YAP/TAZ-dependent. In this year, we investigated whether GM2-mediated YAP/TAZ activation translates into a functional outcome. Indeed, siRNA-mediated knockdown of YAP as well as TAZ led to significant reduction in migration of Hela cells, confirming that GM2-mediated induction of migration and possibly EMT is YAP/TAZ-dependent. Further studies are under way to map the signaling events and mediators that leads to GM2-mediated de-activation of the HIPPO signaling and consequent activation of YAP/TAZ. To explore the upstream events, particularly how GM2 leads to HIPPO de-activation which might involve specific receptors, mechano-sensing events, we are exploring both inhibitor as well as siRNA based approaches to either block or down-regulate expression of key receptors, such as TRKs, INTBs and muscarinic receptors. For identification of possible GPCRs, if any, we have initiated pooled CRISPR-Cas based screening system using a ctgf-Reporter HeLa cell line. We have also found that GM2 modulates the ERK-EGR1 axis in modulating tumorigenesis, as Erk1/2 as well as EGR1 KO cells reduced GM2-mediated invasion of tumor cells.

GM2-mediated modulation of the tumor stroma, specifically fibroblasts in promotion of cancer metastasis : For the last few years our laboratory has mostly focused in how ganglioside GM2 influences pro-tumorigenic behavior and how it does that. However, the process of carcinogenesis does not depend only on the tumor themselves, in fact, the dynamic crosstalk between the tumor cells and the stromal cells (consisting primarily of fibroblasts) plays a crucial role. We have just begun to understand how tumor secreted gangliosides, particularly GM2 modulate the process of tumorigenesis. The first step in understanding that is to define signature gene expression profiles that distinguish fibroblasts from cancer associated fibroblasts (CAFs). Our laboratory is presently trying to define CAFs from mouse primary tumors, using gene expression profiling by next generation sequencing. So far, we have been able to successfully isolate and purify with reasonable homogeneity primary mouse fibroblasts.



Unravelling the proteome associated with the TSS of GM2-synthase gene in an effort to understand the transcriptional regulation of GM2-synthase in Cancer : Previously, we demonstrated that increased acetylation of the chromatin environment near the TSS of the GM2-synthase gene in cancer, leads to acetylation of the transcriptional repressor Sp1 resulting in its proteasomal degradation and consequent decreased binding of the repressor HDAC1, leading to overall de-repression of the GM2-synthase transcription in RCC. Since, we already demonstrated a novel epigenetic mechanism in the regulation of GM2-synthase transcription in RCC, we now focused our study towards uncovering the molecular mediators, more specifically the transcriptional modulators, and epigenetic modifiers involved in the process. To this end, we have recently identified two binding sites (upstream of the previously reported Region-P near the TSS of the GM2-synthase gene), for Sp1 as well as Smad. We have shown through luciferase assay using several deletion constructs that, while this second Sp1 site still acts as a repressor, however, the Smad binding element (SBE) acts as an activator of GM2-synthase transcription. We now aim to find out the proteome associated with the TSS of the GM2-synthase gene, which influence GM2-synthase transcription. For this we have adopted two approaches, CLASP and enChIP assay, followed by mass spectrometric identification of the players involved. Are there any HATs involved in GM2-synthase transcription? During this year, we have successfully been able to enrich the desired locus using dCas9-guided pool down of the chromatin, for ether enChIP or CLASP. We have also generated CRISPR-Cas9 mediated knockouts of known HATs such as p300, GCN5 and CBP. We aim to find out whether any of these HATs might play a role and if so, how in regulating GM2-synthase transcriptional activity in cancer.



Identification of a novel axis, miR-615-5p/ID1 in tumorigenesis : Over the last two years, we have identified a novel miR-615-5p/ID1 axis in regulating carcinogenesis, and established ID1 as a novel target for the tumor suppressor miR-615-5p. Although, miR-615-5p was known as a tumour-suppressor miR, and ID1 as an oncogene, that ID1 is a potential target of miR-615-5p is unknown. Overexpression of ID1 is reported in several cancer types including early and late-stage breast cancer, pancreatic ductal adeno carcinoma (PAAD), melanoma, and small cell lung cancer (SCLC). The high expression of ID1 is associated with poor prognosis and survival in glioblastoma, breast as well as in lung cancer patients. Transcriptional regulation of ID1 in tumorigenesis is well studied but only few papers addressed the post transcriptional regulation of ID1 in tumorigenesis. In-silico analysis of the ID1 predicted 3' UTR of ID1 as a putative target for a microRNA miR-615-5p, a well reported tumour suppressor microRNA in PAAD. The microRNAs are small regulatory noncoding RNAs that regulate gene expression post transcriptionally by binding to the 3' UTR of the target genes. The present study focuses on the identification of miR-615-5p as a novel regulator of oncogenic ID1 and to find out the functional implications of such an association in tumorigenesis. The regulatory role of miR-615-5p over ID1 gene expression was assessed by modulating the microRNA expression ex vivo. ID1 expression was assessed in both overexpression as well as microRNA knockdown model. Ectopic overexpression of miR-615-5p using miR mimic resulted in the down regulation of the ID1 gene expression whereas knocking down resulted in its upregulation, which suggested a regulatory role of miR-615-5p over ID1 gene expression. To assess the functional binding of miR-615-5p with the 3' UTR of the ID1, luciferase assay was performed where the wild type UTR region of ID1 gene was cloned at the luciferase 3' region and co-expressed with miR-615-5p mimic. The overexpression resulted in a significant down regulation of luciferase gene expression which is reversed upon mutation of the miR seed sequence in the UTR, which confirms that binding of miR-615-5p with the ID1 3' UTR results in downregulation of its transcript.

Dr. Nirmalya Sen

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Department of Biological Sciences

Name of the Participants:
Souhadri Das
Shuvam Pal
Anjali Singh
Aritra Kundu
Ramandeep Kaur
Sourav Ghosh
Aiindrila Dhara

Research Background and Vision:

We work on regulation of transcription factors in cancer. Currently we are interested in behavior of ETS family oncogenes during various metabolic and genotoxic stress.

- We identified metabolic axis involving PGC1 coactivator and Sirt1 like deacetylases in driving antioxidant function which may result in prostate cancer resistance.
- Since ETV1 and ERG fusion genes act via their DNA binding domains, our laboratory is deploying CRISPR based genome editing technology to study the effects of functional knock-outs in various cancers driven by these genes.
- We are mimicking the acquired drug resistance scenario using TNBC cell line models to understand pathophysiology of TNBC patients and the cause of relapse. Currently, we have identified ETS1 transcription factor driven mechanism in metastatic and drug resistant TNBC.

Field of Research:

Cancer Biology.

Focused Areas of Research:

- Regulation of transcription factors in drug-resistant cancers.
- Mechanism of ETS transcription factors in drug resistance of TNBC (Triple Negative Breast Cancer) and CRPC (Castration resistant prostate cancer).
- Changes in proteomics and transcriptomic landscape during drug resistance development.
- Development of non invasive biomarker for TNBC

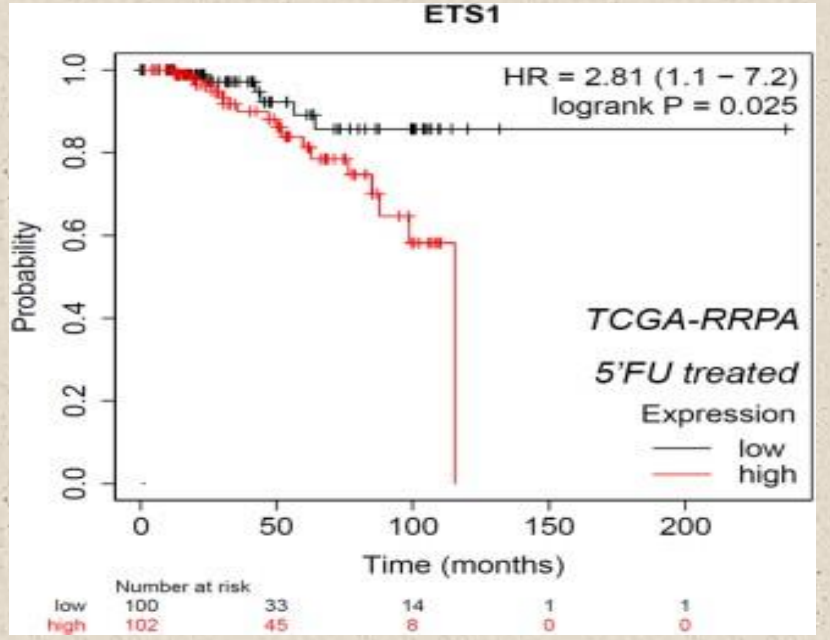
Highlights of Research:

We work on the regulation of transcription factors in cancers, providing the understanding of these important regulators. To date, no drug exists that can directly target transcription factors that are primary drivers of many cancers. Currently our laboratory focuses on ETS (E-Twenty Six) family of transcription factors and their regulation in various cancers. ETS family members are mostly oncogenic transcription factors like ETS1,ETV1, FLI1, ERG, ETV6, etc and often act as primary drivers in various cancers including prostate, breast, liver, GIST, and colorectal tumors4. We have identified certain caveats regarding the regulations of ETS factors in cancers and our projects are based to 'bench to bedside' aspects/solutions of these problems.

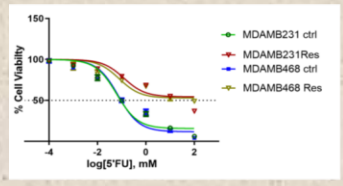
ETS Transcription factors can play various roles in either activating or repressing gene networks. What modulators allow ETS transcription factors to take the decision regarding activation or repression of gene targets, i.e; causes the alteration in axis specificity of transcription factor? Previous work from our laboratory showed various coactivators, cofactors, and stress signals result in alteration of transcriptional landscape and cancer cell fate 5.

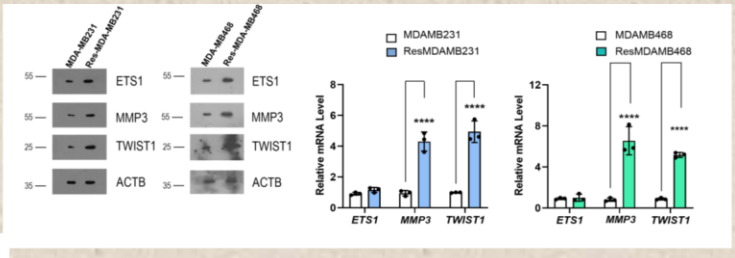
Role of ETS1 in TNBC drug resistance phenotype

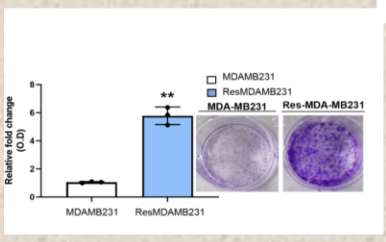
ETS1 protein expression correlates with TNBC resistance phenotype and shows poor survival in patients.

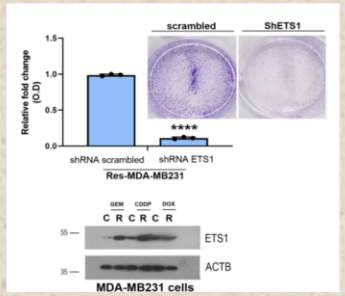


ETS1 expression correlates with acquired drug resistance in TNBC cell types





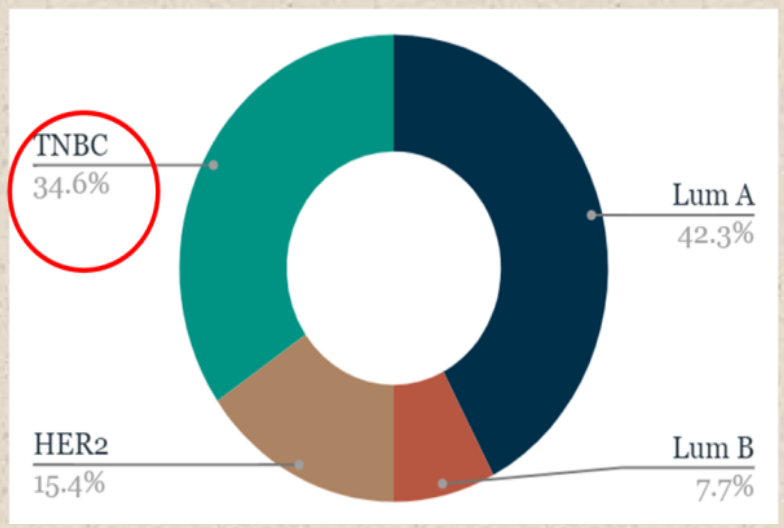




Results: drug resistance cells indicated high ETS1 expression in protein

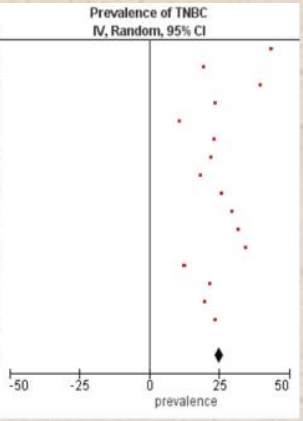
Results: ETS1 is essential for the resistant phenotype

TNBC prevelance in West Bengal, India (in collaboration with AIIMS, Kalyani)



Study or Subgroup	Prevalence of TNBC	SE	Weight	Prevalence of TNBC IV, Random, 95% CI
Aktar 2015	43.7	0.22	6.2%	43.70 [43.27, 44.13]
Chintalapani 2019	19.3	0.005	6.3%	19.30 [19.29, 19.31]
D Sharma 2016	39.94	0.039	6.3%	39.94 [39.86, 40.02]
Doval 2015	23.7	0.001	6.3%	23.70 [23.70, 23.70]
Doval 2016	10.8	0.01	6.3%	10.80 [10.78, 10.82]
G Suryanarayana 2017	23.3	0.006	6.3%	23.30 [23.29, 23.31]
Gogia 2014	21.9	0.004	6.3%	21.90 [21.89, 21.91]
Krishnamurthy 2012	18.5	0.024	6.3%	18.50 [18.45, 18.55]
Lakshmaiah KC 2014	26	0.002	6.3%	26.00 [26.00, 26.00]
Lakshmaiah KC 2017	29.5	0.005	6.3%	29.50 [29.49, 29.51]
M Sharma 2014	31.9	0.007	6.3%	31.90 [31.89, 31.91]
Nabi 2015	34.4	0.052	6.3%	34.40 [34.30, 34.50]
P Suresh 2013	12.5	0.009	6.3%	12.50 [12.48, 12.52]
Suhani 2017	21.8	0.007	6.3%	21.80 [21.79, 21.81]
V Satyanarayana 2016	20	0.025	6.3%	20.00 [19.95, 20.05]
Vandana 2015	23.5	0.015	6.3%	23.50 [23.47, 23.53]
Total (95% CI)			**100.0%**	**25.04 [23.42, 26.67]**

Heterogeneity: Tau² = 10.99; Chi² = 8510433.05, df = 15 (P < 0.00001); I² = 100%
Test for overall effect: Z = 30.21 (P < 0.00001)



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Sweta Mukherjee, JRF

Research Background and Vision:

Plants' response to biotic stress is multifaceted. One of the significant aspects of this regulation is reprogramming the gene regulation cascade, which evolved to create unfavourable conditions for the pathogen. However, pathogen-elicited molecules could circumvent this molecular barrier and create disease. Several environmental factors also influence the pathogenic outcome. Using different pathogens and tomato plants as the model system, we investigate the key molecular players in shaping plant response to disease under ever-changing climatic conditions and the means for manipulating the plant-response pathway to bestow multi-disease tolerance to cultivable tomatoes.

We are using genomics, molecular biological, and plant biotechnological tools, and the following are our current research topics.

- The mechanisms regulating Alternaria stress-responsive microRNA expression and the significance of specific miRNA-mRNA interaction in disease biology.
- The role of mediators of cell death, such as NB-LRRs and metacaspases, in disease development.
- The mechanisms of stress signal perception, regulation of expression, and biological functions of membrane-bound NAC transcription factors in tomatoes.
- Generation of stress-resilient crops of the future by biotechnological approaches.

Field of Research:

- Plant Molecular Biology and Biotechnology.

Focused Areas of Research:

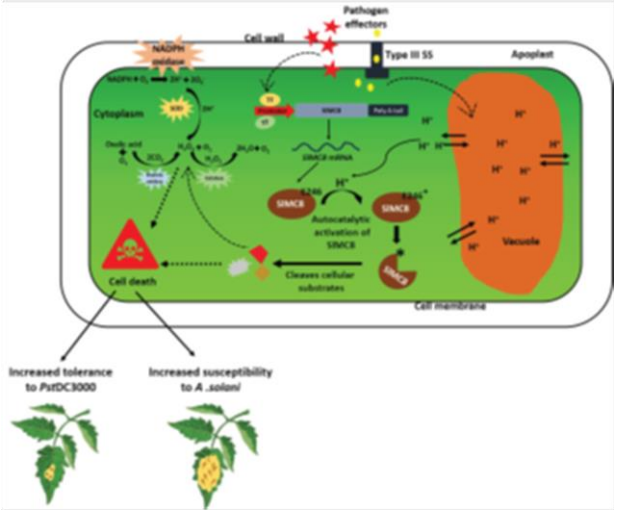
- Enigmatic roles of novel miRNAs in shaping tomato thermal stress-response.

- Coordinated molecular events in stress sensing, activation, and performance of membrane-bound NAC transcription factors in tomato.
- Significance of specific miRNA-mRNA interaction dynamics in early blight disease biology.
- Role of mediators of cell death, such as NB-LRRs and metacaspases, in early blight disease development.
- Generation of stress-resilient crops of the future by biotechnological approaches.

Highlights of Research:

A novel pH-dependent metacaspase governs defense-response against pathogens in tomato.

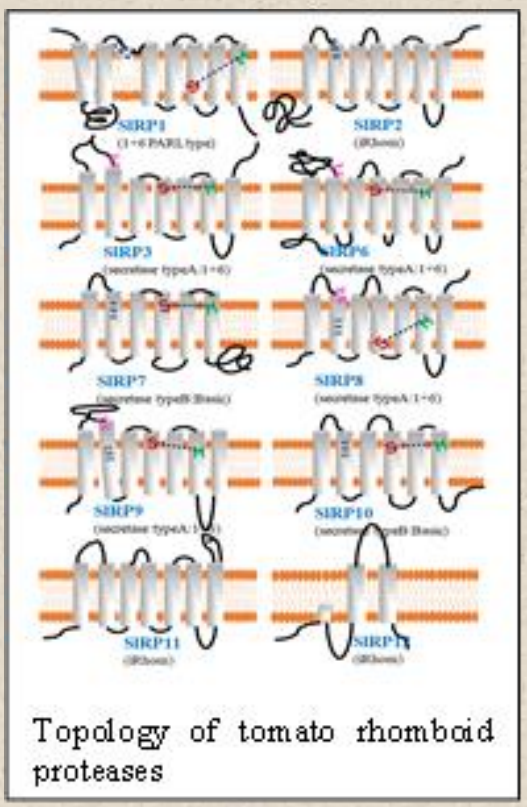
The importance of metacaspases in programmed cell death and tissue differentiation is known, but their significance in disease stress response, particularly in a crop plant, remained enigmatic. We show the tomato metacaspase expression landscape undergoes differential reprogramming during biotrophic and necrotrophic modes of pathogenesis; also, the metacaspase activity dynamics correlate with the disease progression. These stresses have contrasting effects on the expression pattern of SlMC8, a Type II metacaspase, indicating that SlMC8 is crucial for stress response. In accordance, selected biotic stress-related transcription factors repress SlMC8 promoter activity. Interestingly, SlMC8 exhibits maximum proteolysis at an acidic pH range of 5-6. Molecular dynamics simulation identified the low pH-driven protonation event of Glu246 as critical to stabilize the interaction of SlMC8 with its substrate. Mutagenesis of Glu246 to charge-neutral glutamine abolished SlMC8's proteolytic activity, corroborating the importance of the amino acid in SlMC8 activation. The glutamic acid residue is found in an equivalent position in metacaspases having pH dependence. SlMC8 accumulation leads to heightened ROS levels, cell death, and tolerance to PstDC3000, and SlMC8 repression reversed the phenomena. However, SlMC8 overexpression increases tomato susceptibility to necrotrophic A. solani. We propose that SlMC8 activation due to concurrent changes in cellular pH during infection contributes to the basal resistance of the plant by promoting cell death at the site of infection, and the pH dependence acts as a guard against unwarranted cell death. Our study confirms the essentiality of a pH-dependent Type II metacaspase in tomato biotic stress-response regulation.



Pictorial representation of the mechanism of activation of SlMC8 and its effect on pathogenesis. Perception of the pathogen effector molecules (black stars, yellow spheres) ensues a signalling cascade, leading to changes in the ROS equilibrium and redox balance within the cell. This promotes the binding of stress-responsive transcription factors to the promoter of the SlMC8 gene, activating its transcription to produce the SlMC8 mRNA. It is translated into the inactive zymogen within the cell. Pathogen stress causes cytoplasmic acidification by pump-ing hydrogen ions out of the vacuole. This leads to the protonation of the SlMC8 zymogen at E246 (denoted by an asterisk), leading to the activation of its proteolytic function. Activated SlMC8 promotes cell death, either by the direct proteolysis of specific biological substrates (indicated by colored shapes) or by engaging in a feed-forward loop, and modulating the oxidant-antioxidant balance within the cell involving enzymes like Rboh, SOD, Catalase, and oxalate oxidase. Induction of cell death by SlMC8 renders tolerance and hypersusceptibility to PstDC3000 and A. solani infection, respectively, owing to their varying mode of pathogenesis. Rboh, Respiratory burst oxidase homologs, SOD, Superoxide dismutase; SS, Secretion system; TF, Transcription factor.

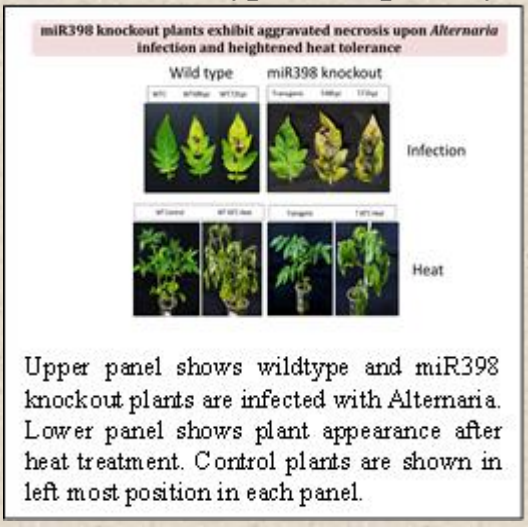
Physico-chemical features and functional relevance of tomato rhomboid proteases

In plants, regulated intramembrane proteolysis (RIP) is crucial for proper growth, development, and stress management. Rhomboid proteases (RPs) residing in the membrane play a vital role in orchestrating RIP. Although RPs can be found in most sequenced genomes, tomato rhomboids (SlRPs) have not yet been studied. Using alternative and comprehensive strategies, we found ten SlRPs encoded in the tomato genome. These SlRPs possess signature motifs and transmembrane domains, showing structural similarity to other members of the RP family. Also, SlRPs are genetically related to other known RPs of the Solanaceae family. Seven of the SlRPs retain serine-histidine catalytic dyads, making them proteolytically active, while three iRhoms lack the dyad and other structural motifs. Although SlRPs could have functional redundancy, their distribution and expression pattern indicate tissue specificity and responsiveness to specific external stimuli. The presence of development and stress-response-related cis-elements in the promoters of SlRPs supports this view. Furthermore, our strategically designed substrate-reporter assay shows that SlRPs have proteolytic activity similar to that of known RPs. This study provides a detailed understanding of all SlRPs and their physico-chemical features, shedding light on their involvement in physiological processes.



Topology of tomato rhomboid proteases

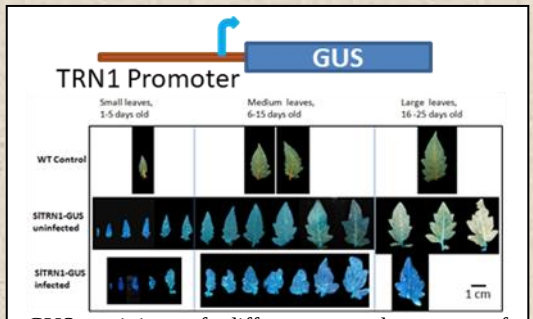
Tomato miR398 knockout disrupts ROS dynamics during stress conferring heat tolerance but hypersusceptibility to necrotroph infection



Upper panel shows wildtype and miR398 knockout plants are infected with Alternaria. Lower panel shows plant appearance after heat treatment. Control plants are shown in left most position in each panel.

An imbalance between ROS production and scavenging during stress results in oxidative bursts, which causes cellular damage. miR398 is a regulator of ROS scavenging since it targets crucial Cu/Zn superoxide dismutases (CSDs). Established functional studies aligned miR398 with plants' heat and heavy metal stress fitness. However, a knowledge gap in the dynamics of miR398-CSD interaction for redox regulation during pathogenic development impeded their use in crop improvement programmes. We use tomato, Solanum lycopersicum, plants, and necrotrophic and biotrophic pathogens to show that a complex transcriptional and post-transcriptional regulatory circuit maintains SlmiR398 and its target SlCSD genes' level. The interaction is indispensable for ROS regulation in either the pathogenic outcome, thermal stress, or a combination of both stresses, as observed in the cultivation field. The miR398 knockout plants display feeble $O_2^{\bullet-}$ accumulation but enhanced levels of H_2O_2, several defense-related genes, metabolites, and vital HSFs and HSPs, which were heightened upon stress. Depletion of miR398, although it renders thermotolerance and resilience to biotrophic pathogens likely due to the augmented hypersensitive response, facilitates necrotrophy. Thus, miR398-mediated ROS regulation seemingly works at the interface of abiotic and biotic stress response for a sustainable reaction of tomato plants.

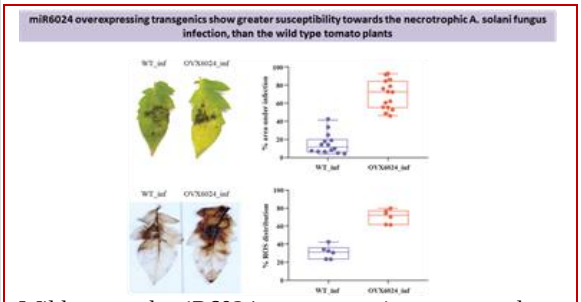
Disruption of tomato TGS machinery by ToLCNDV causes reprogramming of vascular tissue-specific TORNADO1 gene expression



GUS staining of different growth stages of control, transgenic uninfected and transgenic infected tomato leaves showing silencing of promoter activity in mature leaves and regaining during infection

Leaf curl disease of tomato caused by tomato leaf curl New Delhi virus (ToLCNDV) inflicts huge economical loss. Disease symptoms resemble leaf developmental defects including abnormal vein architecture. Leaf vein patterning related TORNADO1 gene's (SlTRN1) transcript level is augmented in virus-infected leaves. To elucidate the molecular mechanism of the upregulation of SlTRN1 in vivo we have deployed SlTRN1 promoter-reporter transgenic tomato plants and investigated the gene's dynamic expression pattern in leaf growth stages and infection. Expression of the gene was delimited in the vascular tissues and suppressed in fully developed leaves.WRKY16 transcription factor readily activated SlTRN1 promoter in varied sized leaves and upon virus infection, while silencing of WRKY16 gene resulted in dampened promoter activity.Methylation-sensitive PCR analyses confirmed the accumulation of CHH methylation at multiple locations in the SlTRN1 promoter in older leaves. However, ToLCNDV infection reverses the methylation status and restores expression level in the leaf vascular bundle. The virus dampens the level of key maintenance and de novo DNA methyltransferases SlDRM5, SlMET1, SlCMT2 with concomitant augmentation of two DNA demethylases, SlDML1 and SlDML2 levels in SlTRN1 promoter-reporter transgenics. Transient overexpression of SlDML2 mimics the virus-induced hypomethylation state of the SlTRN1 promoter in mature leaves while silencing of SlDML2 lessens promoter activity. Further, in line with the previous studies, we confirm the crucial role of viral suppressors of RNA silencing AC2 and AC4 proteins in promoting DNA demethylation and directing it to restore activated transcription of SlTRN1. Unusually elevated expression of SlTRN1 may negatively impact normal growth of leaves.

Heightened miR6024-NLR interactions facilitate necrotrophic pathogenesis in tomato

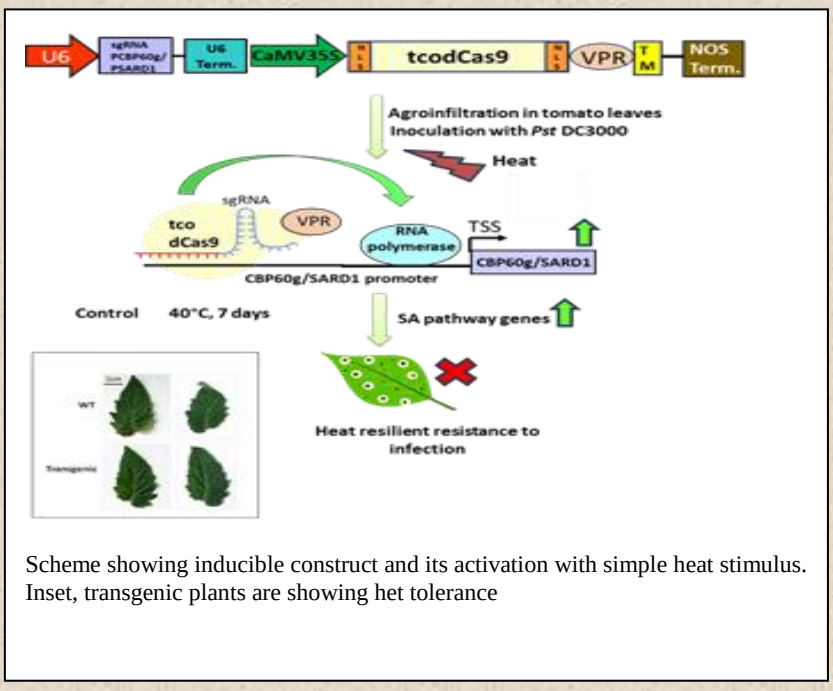


Wildtype and miR6024 overexpressing tomato plants infected with Alternaria. Transgenic plants show hypersusceptibility to disease. Right panel indicates disease area.

Plant resistance genes or NB-LRRs (NLR), integral components of plant disease stress-signaling are targeted by variable groups of miRNAs. However, the significance of miRNA-mediated regulation of NLRs during a pathogenstress response, specifically for necrotrophic fungus, is poorly understood. A thorough examination of Tomato NLRs and miRNAs could map substantial interactions of which half the annotated NLRs were targets of Solanaceae- specific and conserved miRNAs, at the NB subdomain. The Solanaceae-specific miR6024 and its NLR targets analysed in different phytopathogenic stresses revealed differential and mutually antagonistic regulation. Interestingly, miR6024-targeted cleavage of a target NLR also triggered the generation of secondary phased siRNAs which could potentially amplify the defense signal. RNA-seq analysis of leaf tissues from miR6024 overexpressing Tomato plants evidenced a perturbation in the defense transcriptome with the transgenics showing unwarranted immune response-related genes' expression with or without infection with necrotrophic Alternaria solani, though no adverse effect

could be observed in the growth and development of the transgenic plants. Transgenic plants exhibited constitutive downregulation of the target NLRs, aggravated disease phenotype with an enhanced lesion, greater ROS generation and hypersusceptibility to A. solani infection, thus establishing miR6024 negatively impacts plant immune response during necrotrophic pathogenesis. Limited knowledge about the outcome of NLR-miRNA interaction during necrotrophic pathogenesis is a hindrance to the deployment of miRNAs in crop improvement programs. With the elucidation of the necrotrophic disease-synergistic role played by miR6024, it becomes a potent candidate for biotechnological manipulation for the rapid development of pathogen-tolerant solanaceous plants.

A Novel Stress-Inducible dCas9 System for Solanaceous Plants



Scheme showing inducible construct and its activation with simple heat stimulus. Inset, transgenic plants are showing het tolerance

We unveil a groundbreaking advancement in plant gene regulation, introducing a stress-inducible CRISPR/dCas9-based gene regulatory toolkit tailored for precise modulation of gene expression in solanaceous plants, particularly, tomato (Solanum lycopersicum). Through the optimization of CRISPR/dCas9 components, including a tomato codon-optimized dCas9 fused with transcriptional effectors, we achieved remarkable efficacy in fine-tuning endogenous transcription in solanaceous plants. Leveraging a stress-responsive transmembrane domain from a tomato transcription factor (SlNACMTF3), we developed inducible systems for both CRISPR activation (CRISPRa) and interference (CRISPRi), enabling on-demand gene regulation triggered by environmental cues like heat stress. Notably, these systems demonstrated rapid induction and reversibility post-stimulus withdrawal. Furthermore, we demonstrated the practical utility of our stress-inducible toolkit in enhancing tomato immunity against bacterial speck disease under elevated temperatures, by precisely regulating essential salicylic acid signalling components, SlCBP60g and SlSARD1. Additionally, our toolkit was instrumental in engineering heat stress tolerance in tomato plants through multiplex activation of key heat-responsive transcription factors, SlNAC2 and SlHsfA6b. Taken together, our findings demonstrate the unprecedented control offered by our novel stress-inducible toolkit over gene expression dynamics, paving the way for targeted manipulation of complex traits in tomato and other crop species facing environmental challenges.

Mechanistic insights of differential micro RNA processing in Solanum lycopersicum under stress conditions

We have shown the importance of miRNA processing regulation during stress in maintaining miRNA pool in tomato tissues. We have used two functionally well-characterized miRNAs, namely miR167 and miR319, to study their regulation of expression during the processing of these miRNAs' precursors. miR167 is upregulated during cold stress. However, transient overexpression of

precursor does not affect mature miRNA level, confirming regulation during the processing of the precursor. Using strategically designed experiments, we have proven that trans-acting factors and precursor miRNA structural features determine the processing pattern. Further, we have used CRISPR-Csy4-based modern molecular biology tools to identify novel factors interacting with the miR167 precursor. Among the interacting factors, Hsp90 is of particular interest, which is shown to regulate miR167-ARF6/8 interaction and, thus, plant growth during cold stress.

Likewise, miR319, which regulates the expression of the TCP group of transcription factors involved in plant reproductive development and abiotic stress tolerance, is also upregulated during cold stress. Elegantly designed experiments with Phytochrome interacting factor 4 (PIF4)-knockdown lines indicated PIF4 regulates miR319 expression, also at the processing of precursor level. Interestingly, PIF4 knockdown lines are chilling tolerant and show early flowering – indicating the PIF4-miR319-TCP axis likely involved reproductive development during chilling stress.

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Research Background and Vision:

The stress adaptation in plants involves reprogramming of developmental process in response to various environmental cues. A basic requirement of this reprogramming involves alteration in the expression levels of several genes. In eukaryotes, accessibility of DNA sequences to the transcription machinery is critically determined by the degree of packaging of the DNA into chromatin structure. Emerging evidence has shown that epigenetic modifications and/or active chromatin remodelling play a regulatory role in changing the chromatin structure to generate „open" or „closed" chromatin configuration for the transcription. The focus of my research is to study the mechanism of chromatin remodelling in plants to understand the transcription regulation during plant development and stress response. The research is divided into two big projects:

To understand the role of chromatin architectural proteins in modulating chromatin structure in planta.

Investigating the genetic and epigenetic regulation involved in controlling the gene expression during stress response in plant.

Field of Research:

- Plant Molecular Biology.

Focused Areas of Research:

- Plant Developmental Biology and Stress Response.
- Understanding the role of nuclear architectural proteins, ARID/HMG, in Pollen development.
- Characterization of Plant Trithorax factor ULTRAPETALA1 and its role in Plant development.

Highlights of Research:

Focus area I: Understanding the role of nuclear architectural proteins, ARID/HMG, in Pollen development

This project involves characterization of a novel class of HMG-box domain containing protein: ARID/HMG. The unique feature of these plant specific proteins are the presence of two DNA binding domain in their primary structure: AT-rich interaction domain (ARID) and HMG box domain (HMG). ARID domain and HMGB-box domain were known to behave as the architectural proteins in higher eukaryotes. The project involves understanding the role of AtHMGB15 (At1g04880) in pollen development.

Highlights:

1. AtHMGB15 shows highest expression in young and mature flowers.
2. The phenotypic characterization of T-DNA insertion line of AtHMGB15, athmgb15-4, revealed delayed bolting, shorter siliques, and reduced seed set compared to the wildtype Arabidopsis (Colo).
3. Deletion of AtHMGB15 resulted in defective pollen morphology, delayed pollen germination, aberrant pollen tube growth, and a higher percentage of non-viable pollen grains.
4. Molecular analysis indicated the down-regulation of JA biosynthesis and signaling genes in the athmgb15-4 mutant.
5. Furthermore, our study revealed that AtHMGB15 physically interacts with the MYC2 protein to form a transcription activation complexto promote the transcription of MYB21 and MYB24, during stamen, and pollen development.
6. The comparative transcriptome analysis of anther developmental stages (8-11) revealed down-regulation of genes responsible for PCD in athmgb15-4 mutant. Comparison of anthers sections from different stages showed abnormal vacuolization in tapetal cells of athmgb15-4.
7. Analysis of the transcriptome identified the down-regulation of the actin-microfilament cluster in athmgb15-4. Since the actin cytoskeleton partakes in a crucial role in pollen tube growth, we observed highly disorganized actin arrangement in athmgb15-4 pollen tubes with a lesser number of long actin fibers and significantly low f-actin arrangement at the apex.

Conclusion:

Our findings highlight the essential role of AtHMGB15 as a positive regulator of JA signaling, controlling the spatial, and temporal expression of key regulators involved in stamen and pollen development and pollen germination.

Focus area II: Characterization of Plant Trithorax factor ULTRAPETALA1 and its role in Plant development

Co-ordinated interplay between Polycomb group (PcG) and Trithorax group (TrxG) chromatin proteins regulates the spatiotemporal expression of target genes in higher eukaryotes. Rice Trithorax factor ULTRAPETALA 1 (OsULT1) specifically binds to the putative Polycomb response elements “GAGAG” to regulate gene expression. OsULT1 physically interacts with SET domain containing methyltransferase, OsTRX1 that methylates H3K4me3.

Highlights:

1. OsULT1 was found to be upregulated in response to environmental cues suggesting its involvement in the transcriptional regulation of stress responsive genes.
2. A genome-wide chromatin immunoprecipitation analysis revealed OsULT1 enrichment at transcription regulators, oxidative stress signaling, ROS scavengers, and K+ uptake transporters, during salinity stress.
3. Interestingly, loci associated with root development, plant height, inflorescence development, panicles, spikelet numbers, and seed development showed OsULT1 occupancy under control and salt stress. Expression of these genes was regulated by chromatin modifications such as H3K4me3 and H3K27me3.
4. Further, DNA binding analysis showed OsULT1 binding at AP2/ERF core motif A/GCCGAC during salinity stress.
5. OsULT1 overexpression causes developmental changes with enhanced plant height, increase in basal internode length, robust root architecture, and increase in tiller and panicle numbers. 6. OsULT1OE showed salinity tolerance with enhanced seed germination, reduced ROS content, low Na+/K+ ratio in shoot and root tissue, and improved post-stress recovery.

Conclusion:

Our results indicate that ULT1 regulates different plant developmental pathways for better protection and adaptation against environmental stress.

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Research Background and Vision:

The fundamental mechanisms working behind the biochemical or biological processes are associated with the molecular level changes. While experimental methods can identify the shapes of the molecular structures with its all-atom description, the computational methods can facilitate to visualize and witness the dynamic changes occurring at the molecular level to meet the functions. It requires high end computation in substantially large and parallel computing facilities to simulate the molecular events using the fundamental principles of Chemistry, Physics, Mathematics, Statistics, Life sciences. Our group investigates the interactions between biological macromolecules and macromolecule-drugs to elucidate the fundamental molecular mechanisms in biology and to find novel strategies to combat molecular changes that lead to diseases.

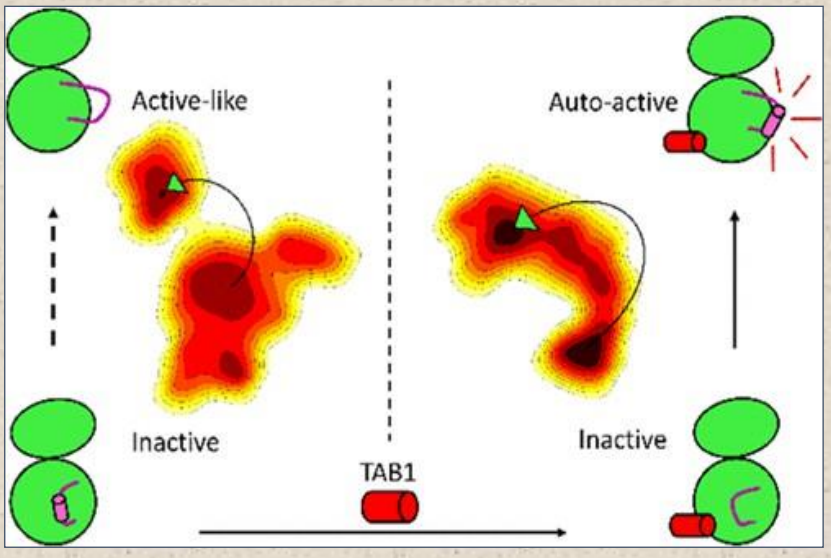
Field of Research:

Computational Biology and Chemistry.

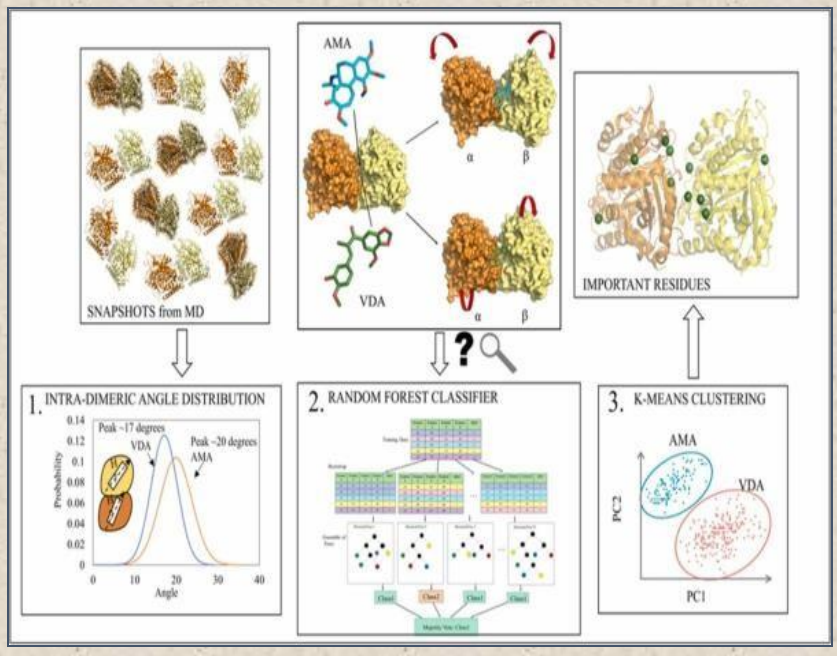
Focused Areas of Research:

- Proteins' structure and dynamics.
- Mechanics insight into kinase allostery.
- Mechanistic insights into the dynamic instability of microtubules in connection to their roles in cell proliferations, to exploit them with therapeutic interest.
- Applications of Machine learning approaches to complement molecular dynamics based sampling of macromolecular conformations to understand structure-function relations.

Highlights of Research:



a) Figure above: Thermodynamic landscape of TAB1 induced allosteric activation of TAB1 was resented giving the molecular mechanism of how the impact of TAB1 can induce conformational change at a remote site that leads to kinase activation (Ref: J. Chem. Inf. Model. 2023, 63, 1, 224–239). This has been further investigated using the machine learning based methods to identify the allosteric hotspots on the TAK1 kinase domain. Primarily two different methods, Random Forest classification and Multi-layered perceptron have been used. New results will be reported in the forthcoming months.



b) The pocket at the interface of the α and β subunits of tubulin dimer can accommodate conchicine and several other ligands and each ligand can have different types of impact which become relevant for curing different types of disease. How this becomes possible? Using MD and machine learning we have shown how the shornger vs. milder impact of ligands works in this system (Ref: Comput Biol Chem. 2024 Feb;108:108004).

Dr. Smarajit Polley

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Samrat Mitra
Afreen Haque

Research Background and Vision:

Multicellularity is the most complex form of life. Well-being of multicellular organisms depend upon delicate balance and fine-tuned regulation of inter- and intra-cellular signaling pathways. Eukaryotic Protein kinases (EPKs) and transcription factors are at the centre of attention in the laboratory. EPKs provide the regulatory framework for most, if not all, signaling pathways ineukaryotic cells.They bestowde novo physico-chemical properties and functionality to protein substrates by adding phosphate group(s). We work primarily on two modelkinase systems: a) Inhibitor of kappa B Kinases (IKK), gateway to NF-κB activation and b) Dual Leucine Zipper Kinase 1 (DLK1), crucial for axonal regeneration.We primarily use biochemical, chemical and structural biology (mainly CryoEM, and X-ray crystallography) tools to understand the mechanistic details of these kinases, and their scaffolding partners (like NEMO, JIP) and substrates (like p53, IκBα).

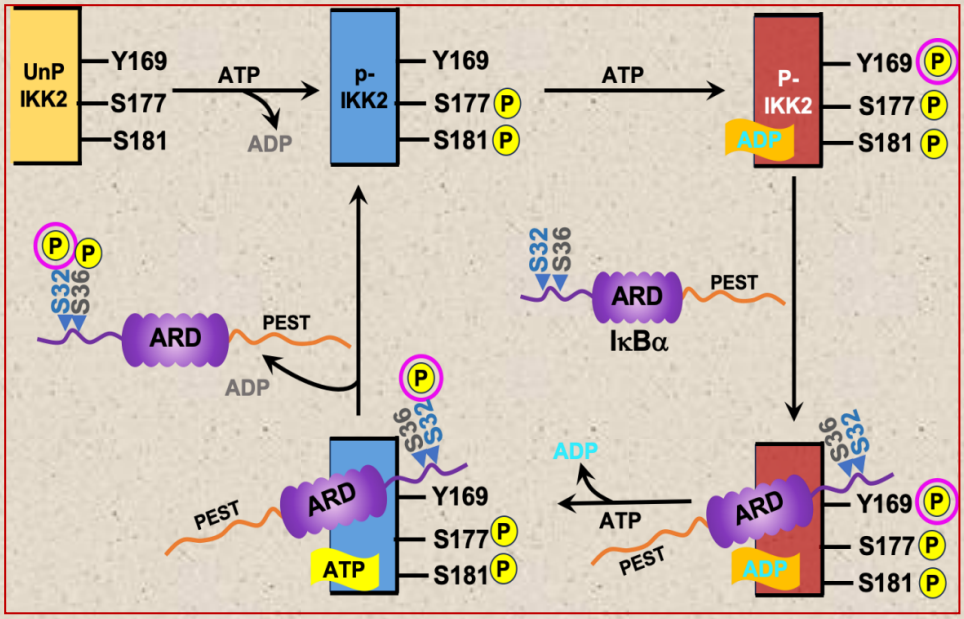
Field of Research:

- Structure function relationship of biologically relevant macromolecular complexes.
- Focused Areas of Research:
- Understanding the Biochemical and Structural Basis of Signaling Modularity of Kinases in Their Biological Context.
- Understanding the Structural basis of cancer promoting function of p53 GoF (Gain of Function) mutants.
- Enzymatic remediation of environmental pollutants.

Highlights of Research:

Dual-specific autophosphorylation of kinase IKK2 enables phosphorylation of substrate IκBα through a phosphoenzyme intermediate.

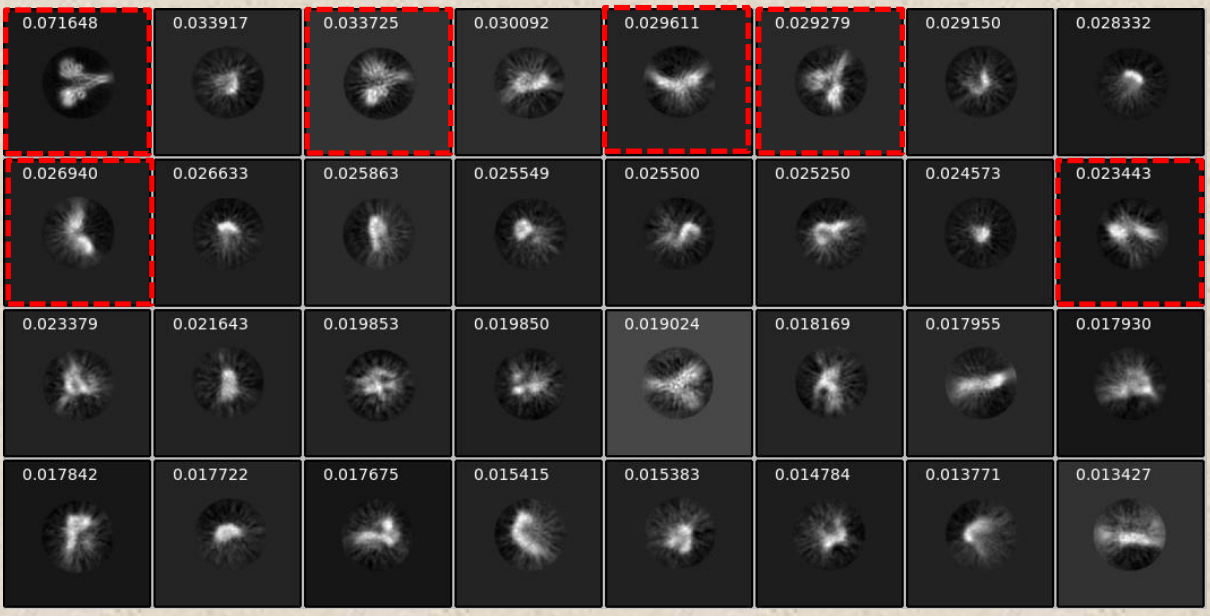
Inhibitor of κB Kinase 2/β (IKK2/β) is an essential Ser/Thr kinase in metazoans. It is a pleiotropic kinase phosphorylating multiple substrates in a context dependent manner. However, in the scenario of pathogenic insults and inflammatory insults its primary job is to phosphorylate two specific serines on NF-κB inhibitor IκBα at positions 32 and 36. This kinase is so specific for those two serines that it fails to phosphorylate the protein when those serines are replaced with threonines. Furthermore, this phosphorylation is very robust and happens within minutes of proinflammatory insults experienced by the cells. This is phosphorylation event is essential for the activation of otherwise dormant NF-κB dimers through the canonical pathway. It was however not clear how IKK2 specifically recognizes IκBα in a pool of thousands of proteins. It was previously described that the scaffolding protein NEMO (NF-κB Essential Modulator) directs the kinase activity of IKK2 specifically to IκBα. Yet it remained elusive how those two specific serines on IκBα were phosphorylated. We discovered that IKK2 is a dual specificity kinase that autophosphorylates itself on Tyrosine residues along with serines on itself as well as on substrates. We also found that this tyrosine autophosphorylation was essential for confirming the specificity of phosphorylation of Ser 32/36 on IκBα. We also found that, IKK2 engages this autophosphorylated state as an intermediate to transfer the phosphate group directly from one of its phosphorylated residues to the substrate unlike the usual way of transferring the γ- phosphate directly from ATP to the substrate.

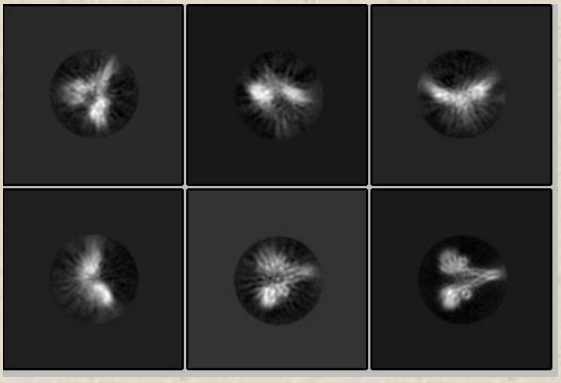


CryoEM analyses of full length IKK2:

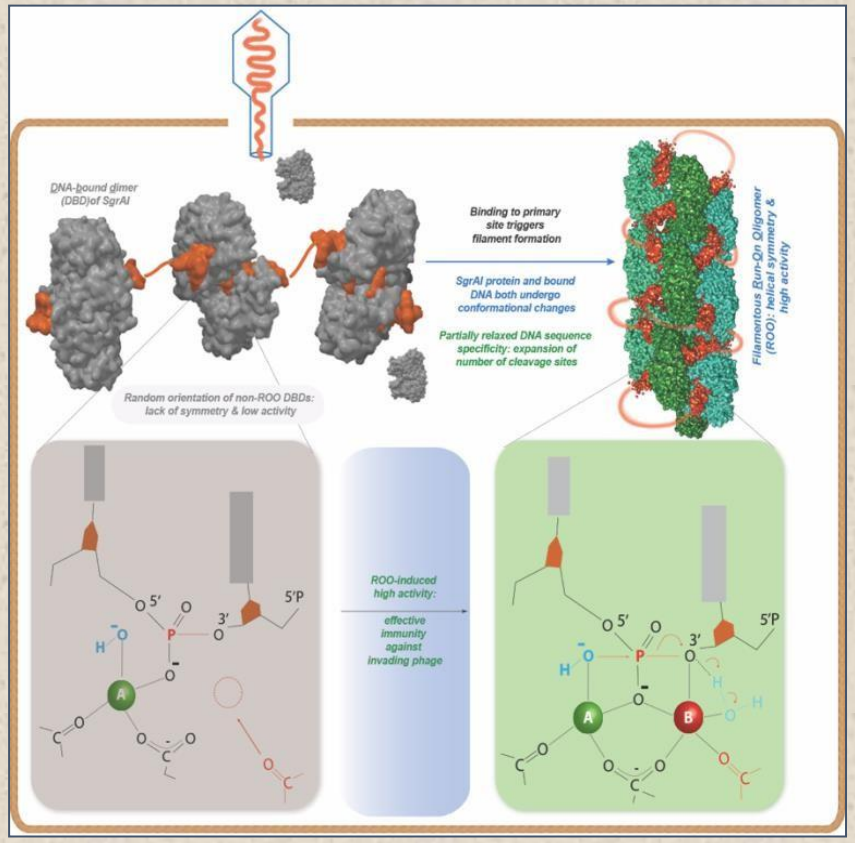
Crystal structures of IKK2 are known from human and Xenopus. However, all these structures lacked the C-terminal NEMO Binding Domain. It may again be noted that NEMO-binding is essential for IKK2 to exert its function to activate NF-☐B. To bridge this gap in understanding IKK2 from a structural perspective, we took to CryoEM for determining the full-length structure of IKK2.

After rigorous optimization with limited scope of using high end CryoEM (as none is available here in the city), we were able to obtain a data set from the National CryoEM facility in IISc in a 200kV microscope. The data was processed and we obtained the following 2D classes. However, we could not obtain a high-resolution 3D structure because of lack of enough orientation and enough particles. We realized that we need more data for better resolution and to further improve the resolution we shall have to collect a significant data set on a 300kV microscope.





Filamentous Run-On Oligomer (ROO) formation in a SgrAI type II restriction endonuclease provides effective immunity against invading phages:

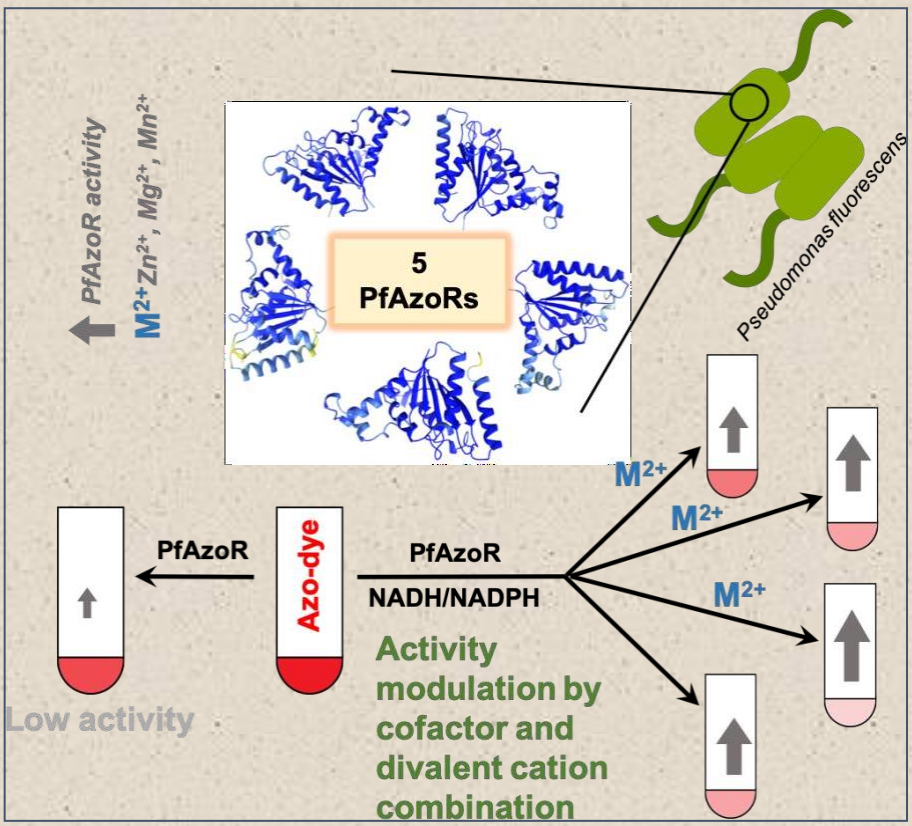


Filament formation by enzymes is increasingly recognized as an important phenomenon with potentially unique regulatory properties and biological roles. SgrAI is an allosterically regulated type II restriction endonuclease that forms filaments with enhanced DNA cleavage activity and altered sequence specificity. Here, we present the cryoelectron microscopy (cryo- EM) structure of the filament of SgrAI in its activated configuration. The structural data illuminate the mechanistic origin of hyperaccelerated DNA cleavage activity and suggests how indirect DNA sequence readout within filamentous SgrAI may enable recognition of substantially more nucleotide sequences than its low-activity form, thereby altering and partially relaxing its DNA sequence specificity. Together, substrate DNA binding, indirect readout, and filamentation simultaneously enhance SgrAI's catalytic activity and modulate substrate preference. This unusual enzyme mechanism may have evolved to perform the specialized functions of bacterial innate immunity in rapid defense against invading phage DNA without causing damage to the host DNA.

Divalent metal ions and cofactor combination modulate activities of Azoreductases, that are not known metalloenzymes

Uncontrolled urbanization and industrialization pose great threats to the environment. Azo dyes are one of the major polluting dyes emanating mainly from the fashion industries. Cloth- coloring dyes, that include azo-dyes, pollute the water resources and put the aquatic flora and fauna in great danger. Remediation of these dyes by chemical means are often energy intensive and non-economical. Bioremediation using natural enzymes could help mitigating this problem. Azoreductases (AzoRs) can efficiently reduce the highly recalcitrant azo-bond in these dyes. We performed structural and biochemical characterization of previously uncharacterized AzoRs from Pseudomonas fluorescens. We found that these enzymes harbour all the structural features already reported in AzoRs from other organisms and are FMN-dependent. They can utilize both NADH and

NADPH as electron sources in a substrate - specific manner. In addition, binding to divalent metal ions further influence substrate specificity and activity of these enzymes despite the lack of any canonical metal ion binding site. A specific metal ion does not inhibit or activate an AzoR's activity in a generalized manner. Inhibition or activation of an AzoR's activity is substrate and nicotinamide specific. In summary, we found that cofactor and divalent cation combination helps in altering substrate specificity and activity of AzoRs in a context dependent manner. These findings broaden the scope of realizing their application in bioremediation of a broader subset of azo-dyes with fewer enzymes.



The following manuscript describing these results has been communicated:

Samrat Mitra, Trina Dutta*, Pranita Ray, Prateeka Borar & Smarajit Polley. Impact of divalent cations on the substrate specificity and activity of a non-metalloenzyme azoreductase in a context dependent manner.*

Prof. Srimonti Sarkar

Professor & Chairperson
Department of Biological Sciences

Name of the Participants:
Ankita Das, INSPIRE Fellow-SRF
Nabanita Patra, CSIR Fellow-SRF
Avishikta Chatterjee, INSPIRE Fellow-SRF
Pritha Mandal, CSIR Fellow-SRF
Trisha Ghosh, UGC Fellow-SRF
Anurupa Sett, UGC Fellow- SRF
Babai Hazra, UGC Fellow-JRF

Research Background and Vision:

Diarrheal disease is a major health burden for India. One of the major contributors to this burden is Giardia lamblia (also known as Giardia intestinalis and Giardia duodenalis), an intestinal parasite with a prevalence of >20% in the Indian population. Children are particularly susceptible to giardiasis, which not only causes malnutrition but also impairs their cognitive development. There are increasing incidences of drug-resistant giardiasis. To address this emerging issue, we focus on identifying key parasite-specific pathways, whose inhibition will not only cure the disease but also limit the parasite's transmission in the community.

Our research is also directed towards engineering yeast strains that can produce bioethanol more efficiently. Towards this, we are studying the cellular pathways used by Saccharomyces cerevisiae to counter ethanol toxicity.

Field of Research:

- Protein Degradation in G. lamblia and stress response in S. cerevisiae.

Focused Areas of Research:

- Stress-induced changes in the protein degradation machinery.
- Functional characterization of the proteasomal subunits of Giardia lamblia.

- Identification and characterization of the components driving protein trafficking in Giardia lamblia.
- Role of yeast vacuole morphology in ethanol stress response.

Highlights of Research:

Diarrheal diseases, such as giardiasis, pose a persistent challenge to the health and economic welfare of the Indian population. The human gut pathogen Giardia lamblia has two morphological forms: the trophozoite and the cyst. The transition between these two states is necessary for host-to-host parasite transmission. Since vesicular transport and protein degradation are vital for this morphological transition, we are investigating the molecular underpinnings of these two types of cellular machinery to identify unique parasite-specific features. Functionally, characterization of Giardia proteins is challenging for several reasons. Unlike most eukaryotic model organisms, trophozoites are tetraploid, which eliminates the adoption of gene knockout approaches. Furthermore, the proteins of this evolutionarily diverged organism are very different from those of most model eukaryotes, which renders commercially available antibodies useless. GFP-tagging of Giardia proteins also poses a challenge as this organism is a microaerophile, and hence, the high oxygen concentration needed for GFP's folding will induce stress. Given these constraints, we have had to raise antibodies against several Giardia proteins, which is time-consuming. Also, we have adopted molecular-genetic approaches to characterize giardial proteins in yeast by using functional complementation and yeast two-hybrid. We have raised antibodies against multiple giardial proteins and used them for immunolocalization. This approach is better than the widely-used HA-tagging employed by a majority of researchers to immunolocalize proteins of Giardia as it allows the colocalization of multiple proteins. Using this approach, we have shown that many giardial proteins localize to multiple locations within the cell. While some of these subcellular locations are consistent with the distribution of the corresponding homologues in other eukaryotes, other locations are unique to Giardia (overlap zone of the ventral disc and the disc periphery, bare zone around the median body, paraflagellar dense rods associated with flagella, marginal plates, flagellar pores, median body etc.). This indicates that many of Giardia's proteins are most likely to discharge multiple functions.

Such moonlighting functions of proteins enable this unique unicellular eukaryote to engineer its complex cellular architecture and multiple morphological states with a small genome (~12.5 Mb). Another strategy employed by Giardia to circumvent the challenge posed by minimal genome space is to minimize the number of components of multiple cellular machinery. We find this to be true for the proteasomal lid subunit, the ESCRT machinery for membrane sculpting and the TRAPP tethering complex that allows docking of vesicles to target membranes. We have used yeast two-hybrid assay to interrogate the change in binary interaction profile within the components of these molecular machines. We found unique features of giardial proteins that enable the assembly of functional complexes even in the absence of components essential in higher eukaryotes.

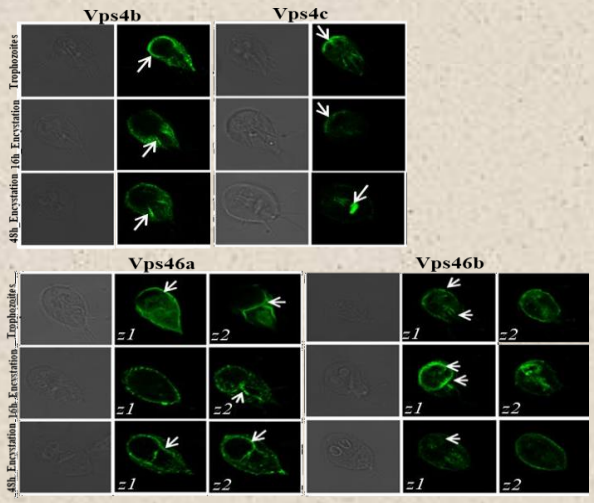


Fig. 1: ESCRT proteins are enriched on the vacuole/lysosome membranes of higher eukaryotes. Giardial ESCRT orthologues localize at not only the peripheral vesicles (equivalent to the lysosome) but also parasite-specific locations, such as the ventral disc margin and its overlap zone, the flagellar axonemes, the paraflagellar dense rods and the median body.

Besides Giardia, my laboratory is also interested in the morphological changes of the yeast vacuole in response to stress. Besides its degradative functions, this organelle plays an active role in stress response. The vacuole is highly dynamic and several recent reports have documented complex morphological changes of the vacuole during various stress conditions. Currently, we are analysing the function of the vacuole in mitigating ethanol stress. We aim to bioengineer yeast strains with increased ethanol tolerance. We have observed that exposure to ethanol causes yeast vacuole to lose its lobbed structure, and phosphoinositide dynamics contributes to this shape change. Given the functional similarity between the yeast vacuole and the mammalian lysosomes, we are also using Saccharomyces cerevisiae to understand the negative effects of cigarette smoke extract on vacuolar function.

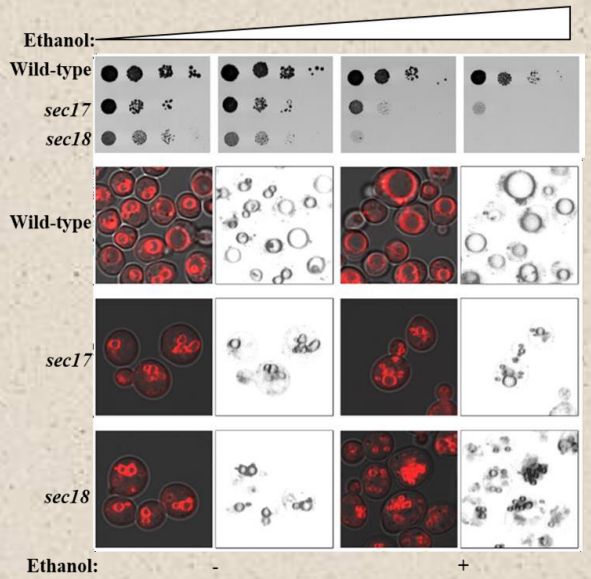


Fig. 2: Mutants with deficiency in vacuole fusion are more sensitive to ethanol.

Dr. Subhash Haldar

Assistant Professor
Department of Biological Sciences

Name of the Participants:

Shuvronil Chakraborty

Research Background and Vision:

Epigenetic alterations are very common in different cancers, which influence cancer cell's metabolic energy yielding pathways, and play a crucial role in cancer progression and metastasis. However, very limited studies available regarding epigenetic alteration mediated metabolic factors involved in different chemotherapy resistant cancers. To maintain aggressiveness, cancer cells always support certain cells in tumor microenvironment (TME) to be self-sustainable and therapy resistant, called cancer stem cells. The dynamic crosstalk between different cells in TME always favors and supply factors required for the maintenance of stemness, which are epigenetically modulated depending on metabolic changes in TME.

Field of Research:

- Carcer Biology.

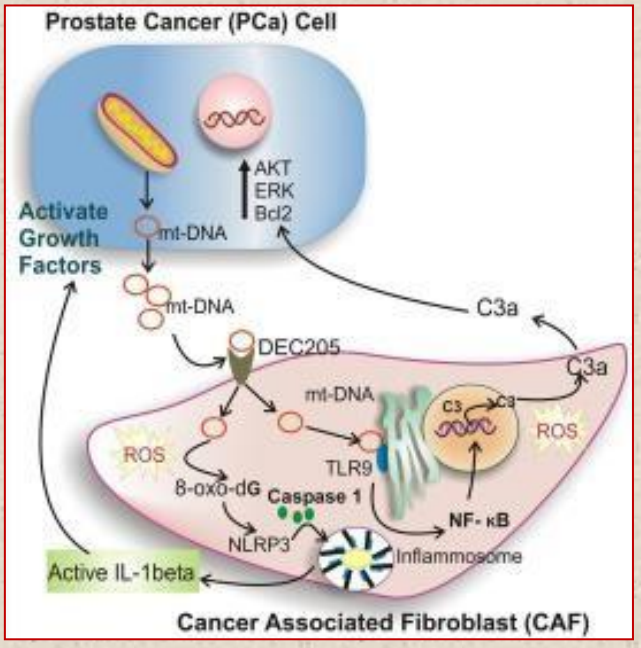
Focused Areas of Research:

Understand the role of the tumor microenvironment in cancer progression and different mediators involved in metastatic progression.

- Prognostic value of circulating mitochondrial DNA in cancer.
- Role of NLRP3 inflammasome in chemotherapy resistant metastatic cancer.
- RAS-GAP and chemo-resistant cancer progression in Breast and Prostate cancer.

Highlights of Research:

Cell-free mitochondrial DNA as potential prognostic biomarkers in prostate cancers and targetable prostate cancer therapeutic candidates impacting stromal-epithelial interactions essential for chemotherapy response.



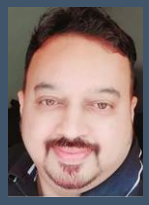
Studies on epigenetic changes and metabolic alterations in chemotherapy resistant breast cancer

Breast cancer (BCa) is the most frequently diagnosed cancer and the leading cause of cancer death in female worldwide, with an estimated 2.3 million new cancer cases (1 in 4 new cancer cases) and 685,000 cancer deaths (1 in 6 deaths) in 2020. Globally, 2,964,197 new cases of female breast cancer are expected to be reported in 2040, representing a 31% rise from the equivalent 2,260,127 cases in 2020. It is very common practice of using chemotherapeutic agents to handle wide variety of malignant cancers. While effective, some chemotherapeutic agents pose significant toxicity and patients gradually develop resistance against the drug(s) during the treatment period, as a result tumor relapse takes place. Chemotherapy drugs may induce aberrant epigenetic alterations after treatment. Epigenetic alterations are very common in different cancers, which influence cancer cell's metabolic energy yielding pathways, and play a crucial role in cancer progression and metastasis. To maintain aggressiveness, cancer cells always support certain cells in tumor microenvironment (TME) to be self-sustainable and therapy resistant, called cancer stem cells. The dynamic crosstalk between different cells in TME always favors and supply factors required for the maintenance of stemness, which are epigenetically modulated depending on metabolic changes in TME. One of the important factors Ras-GAPs, the GTPase-activating structurally related proteins that play a critical role in regulating Ras activity in both healthy and malignant cells. Silencing or loss of function of Ras- GAPs may promote abnormal activation of Ras mediated metabolic alterations leads to cancer

progression through the maintenance of stemness in chemoresistance cancer. Our previous study showed that silencing of RASGAP in castrate resistance prostate cancer promotes glutamine mediated energy yielding pathways, which nourishes cancer cells. However, very limited studies available regarding epigenetic alteration of RASGAP mediated metabolic alterations in maintenance of stemness involved in chemotherapy resistant breast cancer. Understanding the factors involved in epigenetic changes in both cell culture and mouse xenografts model will provide a therapeutic strategy against chemotherapy-resistant cancer.

Objectives:

- To find out the epigenetically silenced/activated RASGAPs and associated genes involved in cancer progression in chemotherapy resistant breast cancer.
- To check the methylation pattern and identify CpG islands on the promoter or ORF regions of identified genes.
- To determine the role of epigenetic changes induced by chemotherapy and the genes involved in subsequent metabolic pathways leading to maintenance of stemness.
- To find out the factors (DNMTs/others) and their role in promoter methylation of the identified genes and addressing/targeting the factors involved.



Prof. Subhrangsu Chatterjee

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Department of Biological Sciences

Name of the Participants:
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Ananya Roy
Laboni Roy
Debopriya Bose
Dr. Trina Sengupta
Suman Panda

Research Background and Vision:

My group is involved in the understanding of Calcium Tunneling in cancer cells using G-quadruplex structures in the Promoter Region of ORAI1 gene. Our lab is also engrossed in understanding the inference of SWI/SNF protein ALT mediated pathway to develop cancer malignancy. We have seen that G4 mediated down regulation of SMARCAL1 exalts the expression of PML bodies which are the marker of cellular stress, thus fueling replication stress in ALT positive osteosarcoma. We also cultivated that promoter G quadruplex MAPK12 protein in triple negative breast cancer tunes its transcriptional fate to dictate the proliferation and the stemness of the cancer cells.

Highlights of Research:

- Inference of SWI/SNF protein, i.e. SMARCAL1 ALT mediated pathway to develop cancer malignancy.
- Regulation of transcriptional fate of MAPK12 protein in triple negative breast by targeting its promoter G4.
- Sequence driven interaction of amino acids in de-novo designed peptides determines c-Myc G4 unfolding inducing apoptosis in cancer cells.

Future Plan:

- Involvement of LINC00273 in cancer metastasis and stemness via miRNA sponging in Triple Negative Breast Cancer.
- Understanding of Calcium Tunneling in cancer cells targeting G4 structures in the promoter of ORAI1.
- Unraveling a specific switchable tetraplex elements in the heterogeneous nuclear ribonucleoprotein K promoter.

Prof. Subrata Sau

Professor
Department of Biological Sciences

Name of the Participants:
Tushar Chakraborty, SRF
Debasmita Sinha, SRF

Research Background and Vision:

To identify innovative growth inhibitors of bacteria, several virulence factors and virulence regulators of *Staphylococcus aureus* and *Escherichia coli* have been investigated using various computational and experimental probes. Of the factors, capsule-producing enzyme CapF, alternative sigma factor σ^B, anti-σ^B factor RsbW, and anti-RsbW factor RsbV are expressed by *S. aureus*, whereas FKBP22, a Mip-like virulence factor carrying peptidyl-prolyl *cis-trans* isomerase activity, is synthesized by *E. coli*.

Field of Research:

- Virulence factors/regulators of pathogenic bacteria.

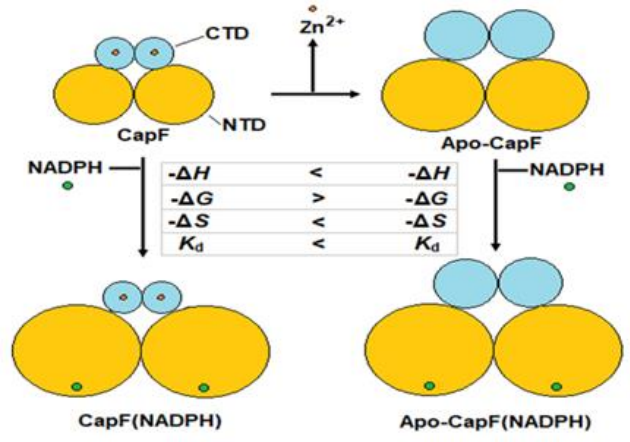
Focused Areas of Research:

Studies on the structure, function, and stability of the virulence factors/regulators of *Staphylococcus aureus* and *Escherichia coli*.

- Studies on an anti-sigma factor of *Staphylococcus aureus*.
- Studies on a capsule-producing enzyme of *Staphylococcus aureus*.
- Studies on a Mip-like virulence factor of *Escherichia coli*.

Highlights of Research:

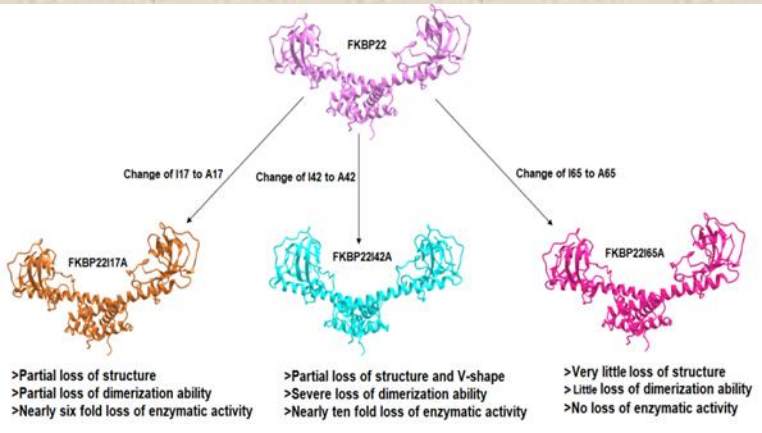
S. aureus CapF is a dimeric protein, and its each monomer carries a C-terminal domain (CTD) and an N-terminal domain (NTD). CTD and NTD bind Zn2+ ion and NADPH, respectively. We have found out that the equilibrium unfolding of a recombinant CapF (rCapF) in the presence of urea or guanidine hydrochloride (GdnCl) occurs via the generation of a different numbers of dimeric intermediates. While two intermediates were formed at 0.5 M and 1.5 M GdnCl, three intermediates were produced at 1 M, 2 M, and 3 urea. The intermediate made at higher GdnCl concentration showed significantly less NADPH binding activity, whereas other intermediates retained full NADPH binding activity. The shape of all intermediates (except the intermediate formed at 3 M urea) was smaller than that of rCapF. The tertiary structure and



hydrophobic surface area of the intermediates differed not only from each other but also from those of rCapF. Additional investigations revealed that Zn2+ is essential for preserving the structure, shape, and surface hydrophobicity of rCapF and its rCTD, a chimeric CTD. The Zn2+-free rCapF (Apo-rCapF), like rCapF, existed as the dimers, whereas the rCTD and the Zn2+-free rCTD (Apo-rCTD) existed as the dimers and tetramers in the aqueous solution. Furthermore, the NADPH binding activity and Cys accessibility of a recombinant NTD (rNTD), rCapF, and Apo-rCapF are considerably different from each other. NADPH exhibited spontaneous binding to the above three proteins and its binding released heat at 25^{0}C, and increased their shapes. The structure, stability, shape, and oligomerization ability of rNTD, rCTD, and rCapF also did not match each other.

σB, RsbW, and RsbV, produced by S. aureus and related bacteria, usually help them to encounter stress environments. S. aureus also uses σB to cause diseases. RsbW not only inhibits σB but also has serine kinase activity and phosphorylates RsbV using ATP. Our modeling data revealed that domain 3 of σB (σB3) binds at the dimerization region of RsbW, whereas RsbV binds at most regions of this anti-sigma factor. In addition, Arg 23, Arg 32, and Lys 44 of RsbW predominantly contribute to bind σB3. Arg 23, and Lys 44 of RsbW also participate in the binding of RsbV. On the other hand, Arg 32 and Arg 11 are involved in the dimerization of RsbW. All of the above Arg/Lys residues are either conserved or semi-conserved residues. The roles of one of the above basic amino acid residues (i.e., Arg 23) have so far been thoroughly investigated using a RsbW mutant harboring an Ala residue at position 23. The data indicate that that RsbW employs Arg 23 to preserve its structure, kinase activity, and stability of RsbW. Interestingly, it shows little interaction with rσB.

E. coli FKBP22, a dimeric enzyme, forms a V-like shape using its two monomers. Each FKBP22 monomer is composed of a C-terminal domain (CTD) and an N-terminal domain (NTD). While CTD possesses enzymatic activity and binds inhibitors, NTD is employed for its dimerization. Analysis of a structural model of FKBP22 reveals that its dimerization requires 40 amino acid residues including Ile 9, Ile 17, Ile 42, and Ile 65. Except Ile 9, other Ile residues are partly conserved in the FKBP22 orthologs. To find out the roles of Ile 17, Ile 42, and Ile 65, three point mutants of FKBP22 were constructed by replacing them with an Ala residue. Studies



on the above mutants indicate that Ile 65 is little required for dimerization or enzymatic activity of FKBP22. Conversely, both Ile 17 and Ile 42 are essential for preserving the structure, enzymatic activity, and dimerization of FKBP22. Interestingly, Ile 17 and Ile 42 showed no inhibitor-binding activity under the conditions of study. The molecular dynamic simulation study also showed the change of V-shape of FKBP22 due to the presence of Ala at position 42.

Dr. Sudipto Saha

Associate Professor
Department of Biological Sciences

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Saran N, SRF-extended
Abhirupa Ghosh, DBT BINC SRF
ShaziaFirdous, SRF, UGC
Jagnnath Das, JRF, DBT
Paramita Roy, JRF, DST, Inspire fellow
Dibakar Roy, JRF, UGC
Stuti Ghosh, JRF, UGC

Research Background and Vision:

Lung microbiome dysbiosis can cause chronic asthma, COPD, and lung cancer. We study the interaction between the lung microbiome, and its metabolites with the host innate immune cells (epithelial cells and macrophages) in obstructive pulmonary diseases using bioinformatics and multi-omics based approaches. Our study shall illuminate a new direction in obstructive pulmonary diseases pathogenesis and management.

Field of Research:

Bioinformatics and Systems Biology

Focused Areas of Research:

- Pulmonary diseases.
- Allergy and Asthma Biomarkers.
- Survey of drug resistance-associated genes in Mycobacterium Tuberculosis (MTB) and ESKAPE.
- Studying lung microbiome of pulmonary diseases.

Highlights of Research:

- Study of lung microbiome dysbiosis and lung mitochondrial dysfunction in pathogenesis of chronic respiratory diseases.

Objectives:

1. To develop two databases on i) the human gut-lung microbiome of respiratory diseases and ii) mitochondrial proteins associated with diseases.
2. To develop AI-based models to predict the severity of asthmatics and COPD patients using respiratory microbiome and metabolome data.
3. To validate the role of predicted microbial metabolites in in-vitro lung epithelial and macrophage cell lines.
4. To perform an in-vivo study on asthmatic mice models to understand the role of the specific lung microbes and mitochondrion proteins using a multi-OMICS-based study.

Chronic Respiratory Diseases (CRDs) are considered the most common non-communicable diseases globally and are a leading cause of morbidity and mortality. CRDs include Asthma, Bronchiectasis, Chronic Obstructive Pulmonary Disease (COPD), and Cystic Fibrosis (CF). There are reports of the role of the lung microbiome and its metabolites in the disease pathogenesis of chronic respiratory diseases. Until now, the role of lung microbial metabolites and their interaction with host immune receptor cells has not been fully understood. Thus, collecting, compiling, and developing databases of lung microbiomes and their metabolites and performing meta-analysis to identify specific microbial markers of these diseases is necessary. The gut-lung and lung-brain axes in chronic respiratory diseases still need to be fully explored. Still, there is a vast gap in knowledge of how lung microbiome dysbiosis in respiratory diseases contributes to disease pathogenesis.

Similarly, reports of mitochondrion dysfunction are associated with several diseases, including chronic respiratory diseases. However, the question of how the mitochondrial proteins are involved in mitochondrial dysfunction and are related to chronic respiratory diseases like asthma is open. Identifying specific mitochondrial targets that can be used to restore its activity is essential in these diseases. Keeping these in mind, we are interested in dissecting the mitochondrial proteins and their networks/pathways in the asthmatic mice models and identifying the critical targets for therapeutics.

Dr. Wriddhiman Ghosh

Professor
Department of Biological Sciences

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Mahamadul Mondal, JRF
Nibendu Mondal, SRF.
Jagannath Sarkar, SRF
Sumit Chatterjee, SRF
Subhajit Dutta, SRF

Collaborators:
Dr. Aninda Mazumdar,
Geological Oceanography
CSIR- National Institute of Oceanography, India
Prof. Ranadhir Chakraborty
Department of Biotechnology
University of North Bengal, India

Research background and Vision:

My laboratory, traditionally, explores the ancient metabolism called sulfur chemolithotrophy (which is thought to have originated in the hot and reducing environments of the early Earth) in the quest for novel biochemical pathways and mechanisms. Concurrently, we also explore the geochemical, biochemical and biophysical windows of opportunity that sustain life at the entropic and bioenergetic extremities of the Earth's biosphere. Our researches are currently engaged in revealing the in situ metabolisms, ecosystem constraints and opportunities, and geochemical manifestations of microorganisms in general and those of the Carbon-Sulfur cycle in particular, within microbiomes having major interfaces with the Earth's geological processes. We also envisage the implications that our findings hold for the extant biogeochemical cycles, geobiological evolution of the Earth, and habitability on a planetary scale.

Methodologically, our investigations at the cross-roads of biology and geochemistry are conducted at various organizational levels of life - from biomacromolecules, genes/proteins, metabolic pathways, genomes and cell systems, to populations, metagenomes, communities and ecosystems. Outcomes of our studies have implications for understanding early metabolism, ancient ecosystems, origin of life, overall planetary health, and habitability of biophysically-extreme biomes on Earth, as well as potential extraterrestrial locations. Furthermore, our latest undertakings in relation to Carbon-Sulfur cycling in the cold are aimed at opening new vistas in biodigestion technology for composite organic waste degradation at zero to sub-zero degree Celsius temperature.

Field of Research:

- Geomicrobiology

Focused Areas of Research:

- Extreme ecosystems explored by us include the following.

The geochemically-peculiar hot spring systems of the Trans-Himalayan region (eastern Ladakh, India), namely,

- the pH-neutral, and sodium-, boron-, sulfide-, sulfate- and thiosulfate-rich hot springs of Puga geothermal area (altitude: ~4436 m above the mean sea level) that are remarkably poor in silica and total dissolved solids (TDS), compared with most of the other well-studied hydrothermal systems of the world; these hot springs are situated to the south of the Indus-Tasngpo Suture Zone, the tectonically-active collision boundary between the Asian and Indian continental plates involved in Himalayan orogeny;
- the relatively alkaline hot springs of Chumathang geothermal area that have high salinity, TDS, lithium, and sulfate, but no sulfide; these hot springs are situated to the north of the Indus-Tasngpo Suture Zone at an altitude of ~3950 m above the mean sea level.

Carbon-sulfur cycling/sequestration in the sulfidic (anoxic) sediments of the perennial and seasonal oxygen minimum zones (OMZs) of the Arabian Sea.

Besides trying to elucidate the ecosystem constraints and opportunities, and geochemical manifestations, of the microbes of the Carbon-Sulfur cycle (at the entropic and bioenergetic extremities of the Earth's biosphere), we also try to discover novel biochemical pathways and mechanisms of chemolithotrophic sulfur oxidation.

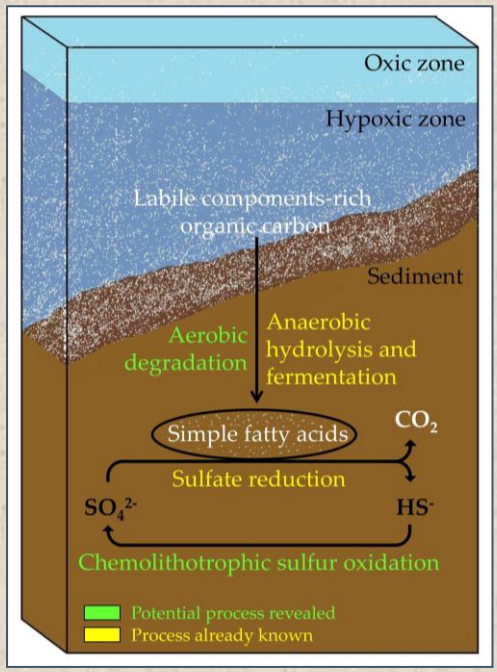
Highlights of Research:

Carbon-sulfur cycling in the sediments of the Arabian Sea OMZ

Aerobic microbial life in extremely-oxygen-scarce marine sediments (Bhattacharya et al., 2020; Sarkar et al., 2024)

The potential presence and activity of aerobic microorganisms are never explored in marine oxygen minimum zone (OMZ) sediments even though they can significantly impact the carbon-sulfur cycle of these highly-sulfidic (anoxic) sinks of complex organic matter. Our group first discovered metabolically active communities of aerobic chemolithoautotrophs and chemoorganoheterotrophs in a three-meter sediment horizon of the eastern Arabian Sea OMZ using metagenomics and metatranscriptomics. Genetic signatures of diverse aerobic metabolisms were found to be abundant within either category of meta-omic data obtained along the ~3-m sediment-cores retrieved from 530 mbsl (meters beneath the sea-level) and 580 mbsl, off the west coast of India. Subsequently, several such obligately aerobic bacteria were isolated from across the sediment-cores which died upon anaerobic incubation despite being provided all possible alternative electron acceptors. High levels of sequence correspondence between the isolates' genomes and the habitat's metagenomes and metatranscriptomes illustrated that the strains were widespread and active in situ. The sulfur-chemolithoautotrophs isolated could oxidize, and grow on, reduced sulfur compounds only in the presence of O2. Likewise, the chemoorganoheterotrophic isolates could catabolize simple or complex organic compounds at high or low, but not zero, O2. Some of them, however, could grow anaerobically on yeast extract or acetate by reducing nitrate and/or nitrite. Fermentation did not support growth in any of the strains, but enabled some of them to maintain a fraction of the cell population amidst prolonged anoxia. Under extreme oligotrophy, limited growth followed by protracted stationary phase was observed for the chemoorganotrophic isolates at low cell density, amid high or low, but not zero, O2 concentration. While metabolic deceleration could be particularly

useful for the strains' survival in the critically carbon-depleted layers below the explored sediment-depths (core- bottom organic carbon content was 0.5-1.0 % w/w), metagenomic data suggested that in situ anoxia could be surmounted via potential supplies of cryptic O2 from native, chlorite or nitric oxide dismutating, microorganisms. The present findings not only hold critical implications for the remineralization/sequestration of buried organic matter within anoxic marine sediments, but also illustrate the possibilities of sulfide back-flux (reconversion to sulfate) causing pyrite dissolution and metal mobilization in situ.



The hitherto-unknown aerobic microbial ecology of marine oxygen minimum zone (OMZ) sediments was revealed in two ~3- m-long sediment-cores from the eastern Arabian Sea OMZ using metagenomics, pure-culture-isolation, genomics and metatranscriptomics.

Prof. Zhumur Ghosh

Professor
Department of Biological Sciences

Name of the Participants:
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Byapti Ghosh, DST Inspire Fellow
Gourab Das, ICMR SRF
Pritha Sengupta, UGC SRF
Satakshi Bagchi, UGC SRF
Soumya Mal, ICMR SRF

Research Background and Vision:

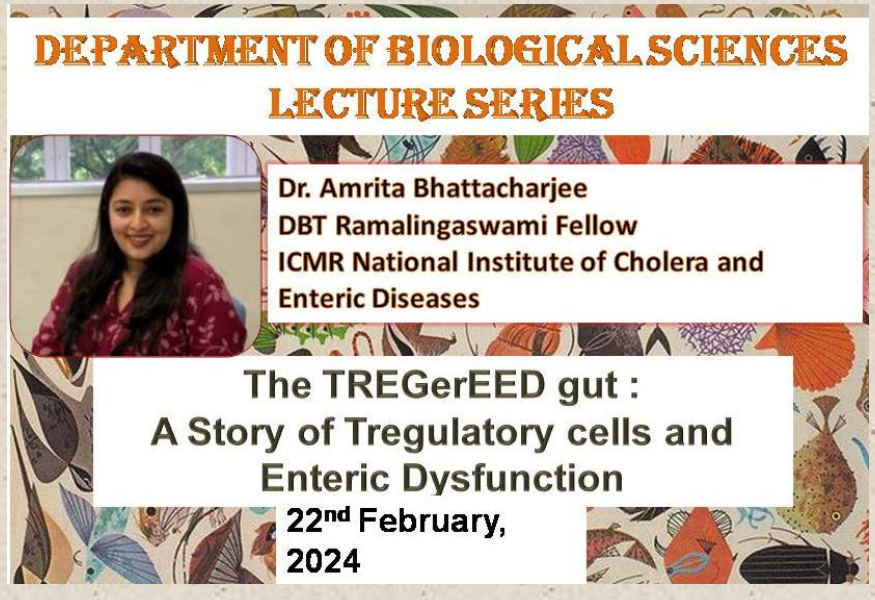
- Our lab has the main focus to understand the role of regulatory noncoding RNAs in cancer and early embryonic development where stem cell plays a crucial role. We are also looking into the role of noncoding RNAs in neurodegeneration.
- Our lab's vision is to develop relevant tools and databases (aligned to our lab's research focus) which will boost nation-wide implementation of omics facilities in clinical settings by efficient big data management so as to promote personalized therapy in India.

Field of Research:

- Bioinformatics and Molecular Biology.

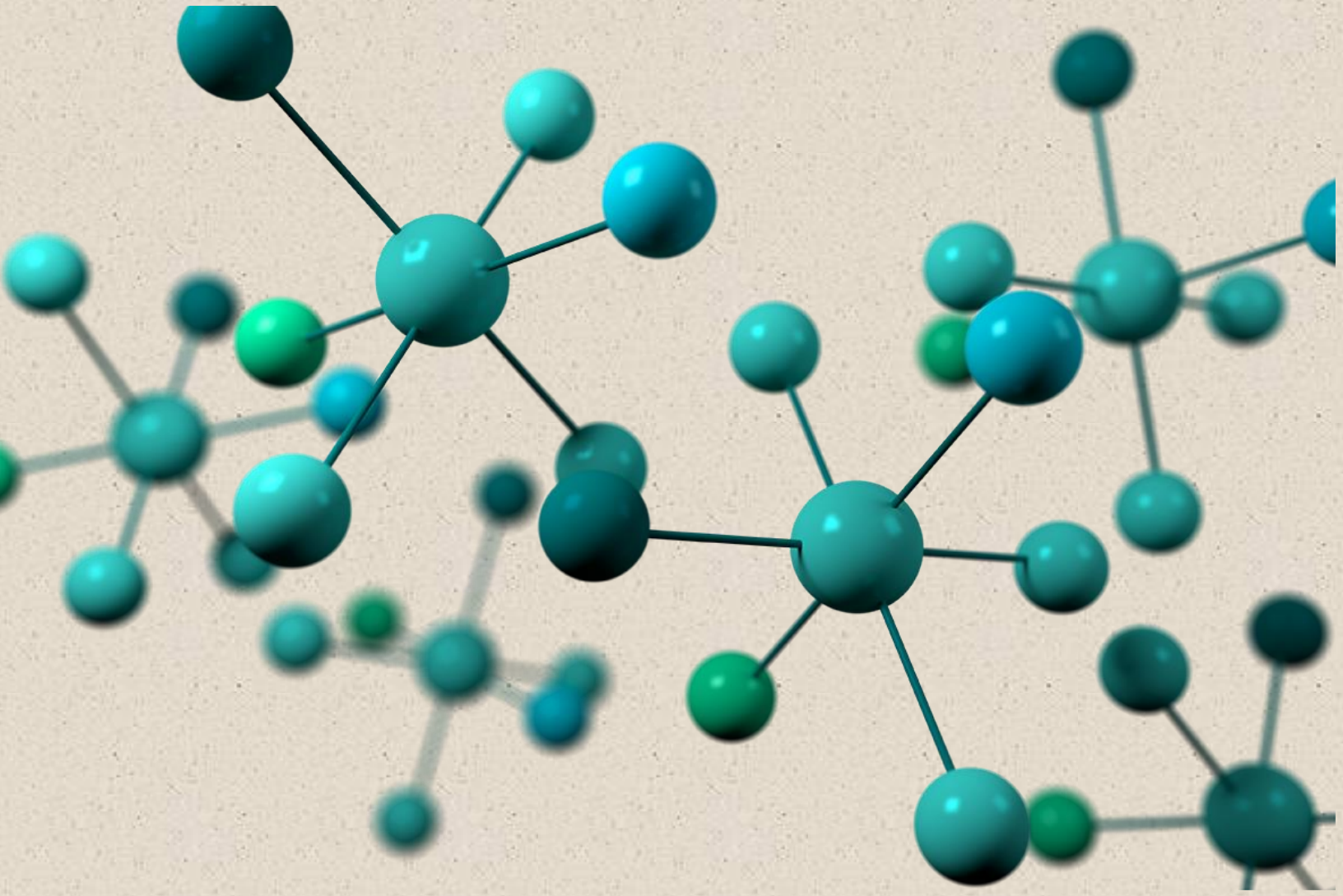
Highlights/Accomplishment of Research:

- Elucidated the role of parental miRNAs and long noncoding RNAs as regulators during fertilization and early stages of murine development and identifying potential noncodingRNA-mRNA interaction which is having significant role in determining fertility.
- Elucidating the role of miRNAs towards inducing oncogenicity in stem cell derivatives.
- Deciphering the role of SNPs present with the lncRNA loci towards cancer risk prediction in case of patients having abnormal breast or ovary conditions that increases the risk of getting breast or ovarian cancer.



Short term training at Bose Institute:

Short term summer training was offered during June to August 2023 at Bose Institute. Outstanding students in Physical Sciences (5), Chemical Sciences (1) Biological Sciences (13) from all over India successfully carried out projects at Bose Institute. (Coordinator: Prof. Dhruba Gupta, Department of Physical Sciences).



DEPARTMENT OF CHEMICAL SCIENCES

National Science Day Celebration

Observation of National Science Day 2024 in
Unified Academic Campus, Bose Institute on 28.02.2024

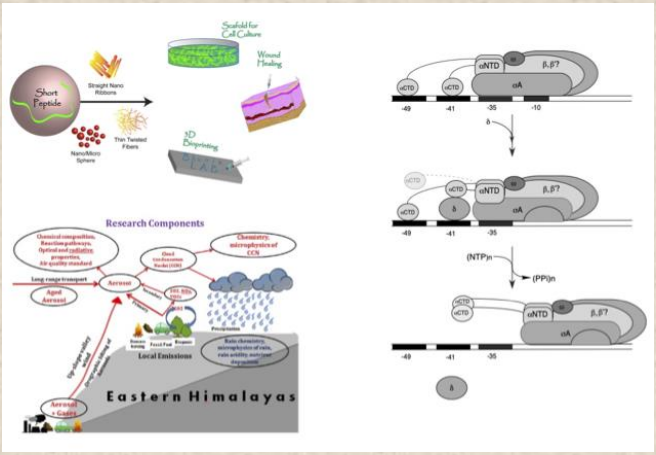
DEPARTMENT OF CHEMICAL SCIENCES

Overview

The Department of Chemical Sciences, erstwhile Chemistry, was established in 1917, at the time of the inception of the Institute. A major part of Shambhu Nath Dey's seminal work on discoveringcholera toxin was performed in this department, for which he was nominated for the Nobel Prize. Over time, the department has adopted different aspects of chemical principles to explore carbohydrate and nucleoside chemistry, medicinal chemistry, structure and functions of anti-microbial peptides, principles of prokaryotic gene regulation, theoretical and quantum chemistry, natural product-based drug development, ultrafast spectroscopy, and environmental and atmospheric chemistry.

Presently, the department focuses on:

- Design and characterization of antimicrobial peptides for agriculture and healthcare applications
- Natural product-driven drug discovery and development
- Understanding the mechanism of gene regulation in prokaryotes
- Study of biomass burning and vehicular emissions, the major sources of particulate matter pollutionover the eastern Himalayas.



List of Personnel:

Research Scientist: Dr. Aritreyee Datta, Post-Doctoral Associate

Students : JRF/SRF : Mr. Abhijit Rana, CSIR-SRF, Mr. SamimSahaji, UGC-MANF, Ms. Puja Bag, UGC-JRF, Mr. Saikat Dogra, UGC-JRF, Mr. Aniket Majhi, UGC-JRF, Mr. Satyajit Haldar, UGC-SRF, Mr. Sumon Mukherjee, CSIR-Adhoc, Mr. TuhinSubhra Roy, CSIR-Adhoc, Md. Sorique Aziz Momin, Inspire-SRF, Ms. Noyel Ghosh, UGC-SRF, Mr. SourajitSaha, SRF, Mr. Aniruddha Tewary, SRF, Ms. Ritu Jaiswal, SRF, Ms. NilanjanaHazra, SRF, Ms. Madhurima Chatterjee, SRF, Ms. Suravi Nandi, UGC-JRF, Dr. Arun Kumar Sharma, RA, Ms. Swarnali Kar, ICMR-Adhoc, Ms. Rinita Dhar, SRF, Mr. RanitPariary, SRF, Mr. Dibakar Sarkar, SRF, Ms. Dipanwita Roy, SRF, Ms. Karishma Biswas, SRF, Mr. Sourabh Kundu, Project Fellow, Mr. Rahul Haldar, JRF, Sk. Bappa, JRF, Ms. Sanchari Kundu, PA-I, Ms. Monami Dutta, SRF, Mr. Sauryadeep Mukherjee, SRF, Mr. Soumen Raul, JRF.

Prof. Abhijit Chatterjee

Professor
Department of Chemical Sciences

Name of the Participants:
Monami Dutta
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Soumen Raul

Highlights of Research:

1. ***PM2.5 pollution across India: Results from national network "National Carbonaceous Aerosols Program"***

   The Carbonaceous Aerosol Emissions, Source Apportionment and Climate Impacts (COALESCE) is a multi-institutional Indian network project to better understand carbonaceous aerosol induced air quality and climate effects.

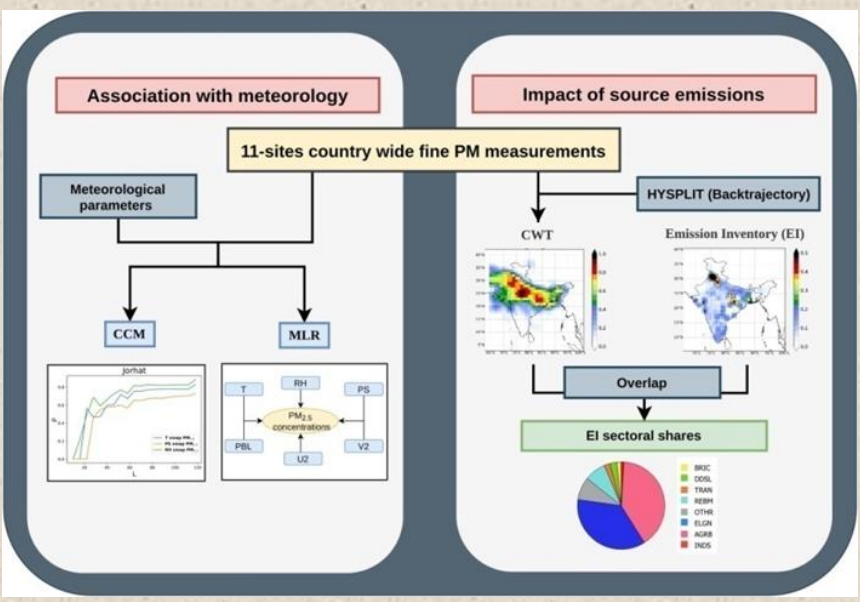

Fig 1: Factors involved in PM2.5 loading over different stations in India

Our study presents time-synchronized measurements of surface PM2.5 concentrations made during 2019 at 11 COALESCE sites across India. The influence of six meteorological parameters on PM2.5 was evaluated. Causality analysis suggested that temperature, surface pressure, and relative humidity were the most important factors influencing fine PM mass on an annual and seasonal scale. Further, a multivariable linear regression model showed that meteorology could explain 16%–41% of PM2.5 variability across the network annually. Concentration Weighted Trajectories (CWT) and the results of causality analysis revealed common regional sources affecting PM2.5 concentrations at multiple regional sites.Further, CWT source locations for all sites across the network correlated with the SMoG-India emissions inventory at the 95th percentile confidence. Finally, CWT maps in conjunction with emissions inventory were used to obtain quantitative estimates of anthropogenic primary PM2.5 sectoral shares from a mass-meteorology-emissions reconciliation for all 11 pan-India network sites. These estimates can help guide immediate source reduction and mitigation actions at the national level.

2. *Acidity and oxidative potential of aerosols over Sundarban mangrove ecosystem: Impact of transported biomass burning plume*

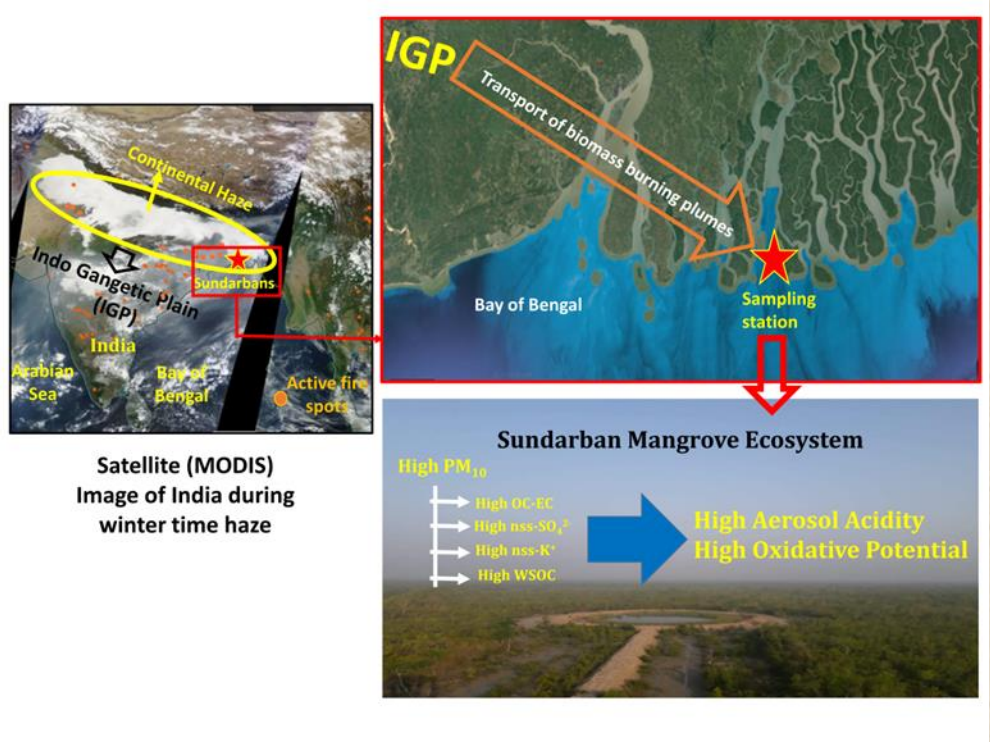

Fig 2: Acidity and oxidative stress over Sundarban mangrove ecosystem increases during transport of haze and biomass burning plume from central IGP

To investigate the acidity and the water-soluble oxidative potential of PM10, during the continental biomass-burning plume transport, a three-year (2018-2020) winter-time campaign was conducted over a pristine island (21.35°N, 88.32°E) of Sundarban mangrove ecosystem situated at the shore of Bay of Bengal. The average PM10 concentration over Sundarban was found to be 98.3 ± 22.2 μg m-3 for the entire study period, with a high fraction of non-sea-salt- SO42- and water-soluble organic carbons (WSOC) that originated from the regional solid fuel burning. The thermodynamic E-AIM(IV) model had estimated that the winter-time aerosols over Sundarban were acidic (pH:2.4± 0.6) and mainly governed by non-sea-SO42-. The volume and mass normalized oxidative potential of PM10 were found to be 1.81 ± 0.40 nmol DTT min−1 m−3 and 18.4 ± 6.1 pmol DTT min−1μg−1,

respectively, which are surprisingly higher than several urban atmospheres across the world including IGP. The acid-digested water-soluble transition metals (Cu, Mn) show stronger influences in the oxidative potential (under high aerosol acidity) than the WSOC. The study revealed that the advection of regional solid fuel burning plume and associated sea SO42- is enhancing aerosol acidity and oxidative stress that, in turn, could be extremely hazardous for such marine ecosystems rich in ecology and bio-geochemistry.

3. *Particulate matter (PM10) pollution over eastern Himalaya, its root causes, future prediction and control*

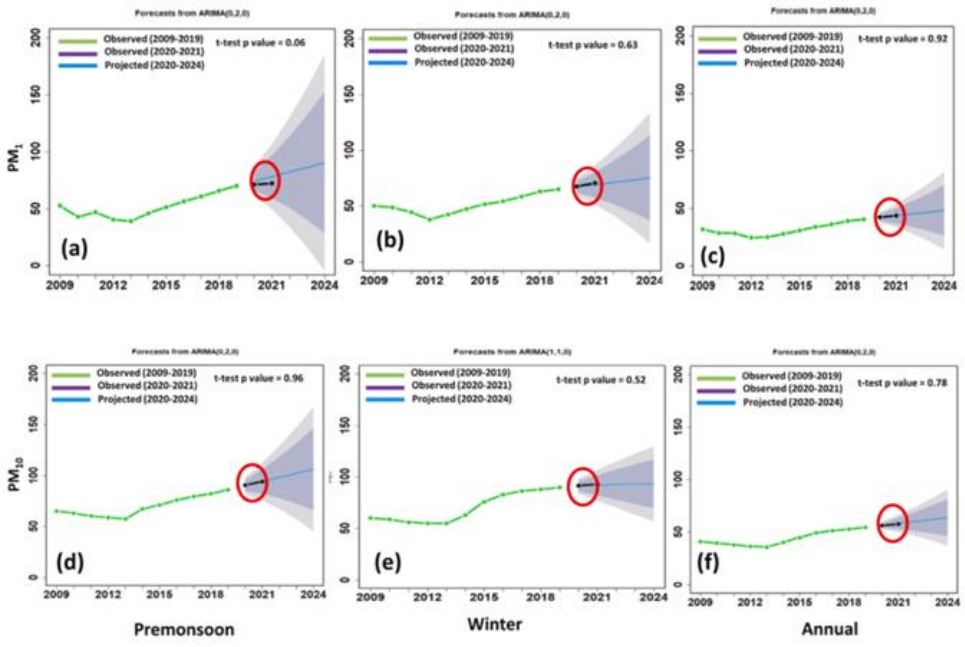

Fig 3: Future projections of PM10 and PM1 pollution over eastern Himalaya under "business-as-usual" scenario

A thirteen years-long (2009–2021) study was conducted on PM10 pollution over a high-altitude station, Darjeeling in the eastern Himalayas in India. PM10 was found to remain within its Indian standard (60 μg m−3) in every year of the study period (long-term average PM10: 46 ± 8 μg m−3). Most of the anthropogenic water-soluble ionic components as well as carbonaceous aerosols exhibited maximum intensity at PM1 too. PM10 exhibited a steady decrease from 2009 to 2013 but since 2014, a sharp rise was observed. Further, we have observed that premonsoon and winter-time PM1 pollution was the key factor for a such high rise in PM10. Auto regressive integrated moving average (ARIMA) model for future prediction revealed that PM10 would cross its Indian standard and PM1 alone would cross the PM2.5 standard in 2024 if the current scenario remains the same and the city would be enlisted among the "non-attainment" cities of the country under "National Clean Air Program (NCAP)" of Government of India. The Positive matrix factorization (PMF) model was run to apportion the sources of PM1 and PM10. It was observed that the vehicular emissions in premonsoon (33% in PM1; 28% in PM10; contribution of vehicular emission in PM1 to PM10 > 90%) and biomass burning in winter (27% in PM1; 23% in PM10; contribution of PM1 to PM10 > 80%) are the most influencing sources that need to be curbed to mitigate PM1 and hence PM10 pollution over Darjeeling.

4. Himalayan biosphere acts as the source of organic aerosols and cloud condensation nuclei

A study was conducted to investigate the potential of water soluble organic carbon (WSOC) in CCN activation (formation of cloud droplets) under restricted anthropogenic emissions over eastern parts of Himalaya in India. Here we observed that under restricted fossil fuel emissions during lockdown (57% decline in NOx), surface ozone was increased by 31%, that in turn favored the photochemical oxidation of biogenic VOCs emitted only from coniferous forest cover to produce huge amount of organic carbon. The ultrafine "biogenic-only" WSOC (under restricted anthropogenic WSOC during lockdown) participated in CCN activation actively and with higher proficiency compared to the normal period. The study bears immense importance of the role of biogenic emissions in cloud droplet formation over this part of the Himalaya under restricted anthropogenic emissions. The present hypothesis could open a new route of aerosol formation and their CCN activation under high deficiency of anthropogenic emissions.

5. High exceedance of PM2.5 pollution over semi-urban atmosphere in eastern Indo-Gangetic Plain over Indian standard

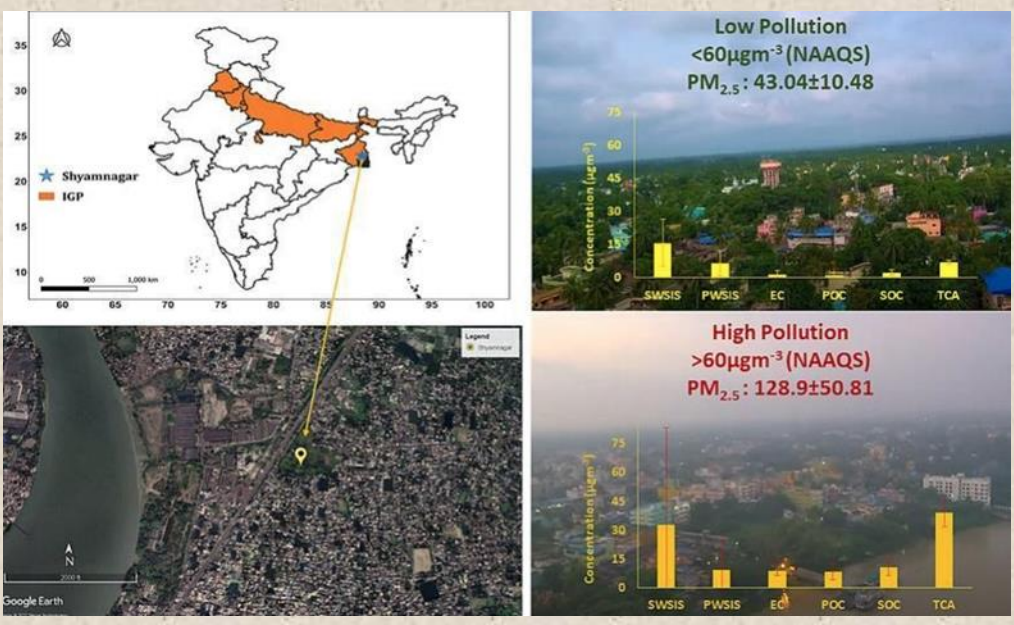

Fig 4: Chemistry of atmospheric aerosols over semi-urban atmosphere of eastern IGP during low and high pollution episodes

A study on the chemical characterization and meteorological impact on PM2.5 was conducted over a semi-urban atmosphere in the easternmost part of the Indo-Gangetic Plains (IGP). We observed that under the least favorable conditions (low ventilation coefficient), high PM2.5 pollution (exceeding Indian standard) was associated with a high increase in secondary components of PM2.5. Eastern, central and western parts of IGP, as well as Nepal, were the major long-distant source regions whereas the northern part of West Bengal and parts of Bangladesh were the major regional source region for high PM2.5 pollution. The ratios like char-EC/soot-EC, non-sea-K+/EC and non-sea-SO42−/EC strongly indicated the dominance of fossil fuel burning over biomass burning. Compared with other studies, we observed that the PM2.5 pollution over this semi-urban region was comparable (and even higher in some cases) with other parts of IGP. The high exceedance of PM2.5 over the Indian standard strongly demands an immediate initiation of systematic and regular based air pollution monitoring over semi-urban/non-urban regions in India, especially IGP, in addition to the polluted cities.

Prof. Anirban Bhunia

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Department of Chemical Sciences

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Sourabh Kundu
Subhamoy Chakraborty
Suvajit Das
Suprity Majumder

Research Background and Vision:

Biological membranes are an important functional interface for many physiological reactions taking place within the cell. Thus, all biological membranes are an indispensable platform for several surface proteins, membrane-integrated proteins/peptides, and other ions and signaling molecules. The determination of molecular structure and dynamics of biomembranes and the associated functional peptides and proteins is, in fact, one of the most significant challenges in contemporary science. In this connection, vesicles and liposomes mimicking the lipid bilayer structure have been used to study membrane-protein/peptide interaction. Recently, nanodiscs comprising lipid bilayer and membrane scaffold proteins (MSP) represent a more native environment than liposomes/ bicelles or detergent micelles. Recent developments in NMR spectroscopy have facilitated in-depth characterization of the dynamics of interactions at the atomic resolution. This precise structural knowledge is crucial to correlate with their membrane-directed functioning. Dr Bhunia's laboratory involves several biophysical techniques, including cutting-edge solid- and solution-state NMR spectroscopic techniques to characterize the membrane-associated functioning of several biologically active peptides and proteins.

Field of Research:

- Medicinal Chemistry, Structural Biology.

Highlights of Research:

- Understanding the structure-function correlation of rationally designed antimicrobial peptide against Pseudomonas-associated corneal keratitis.

- Membrane-induced amyloid pathogenicity.
- Molecular mechanism of amyloidosis in the presence of metals and sequence context.
- Introducing SARS CoV E protein peptide derivatives for materials science applications. The viral origin provides inherent bioactivity and self-assembly propensity that could enable smart biomaterials.
- The water extract of Lasunadya Ghrita (LG), an Indian traditional medicine, has been repurposed to treat Alzheimer's disease.

Prof. Anup Kumar Misra

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Mr. Aniket Majhi, UGC-JRF
Ms. Rittika Chakraborty, Project trainee
Mr. Debashis Mazumder, SLA

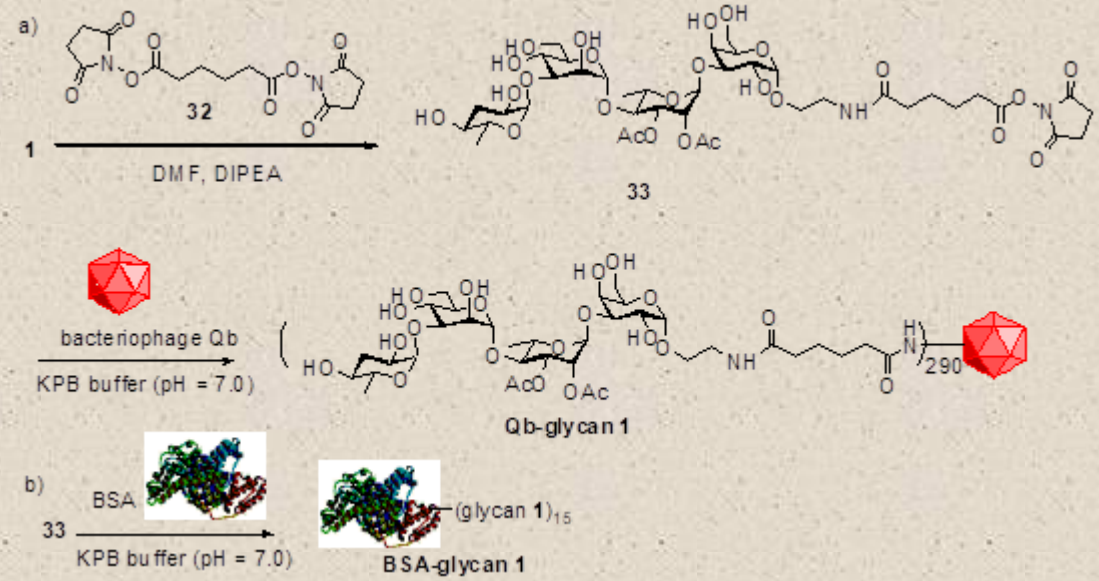
Research Background and Vision:

Development in the glycobiology research amplified the demands for well-defined oligosaccharide motifs for various biological studies. Naturally derived bacterial capsular polysaccharides have been the basis for effective anti-bacterial vaccines, but little is known about the protective glycotopes for many serotypes. Since natural sources cannot provide a large quantity of oligosaccharides with homogeneity and adequate purity, it is essential to develop chemical synthetic approaches to access the complex oligosaccharides. The stereoselective glycosylation reaction is the key to assembling monosaccharides to synthesize complex oligosaccharides. Cell wall oligosaccharides corresponding to the repeating units and sub-units of polysaccharides, differing in chain length and monosaccharide composition, help identify antigenic determinants for creating semi-synthetic glycoconjugate vaccine candidates.

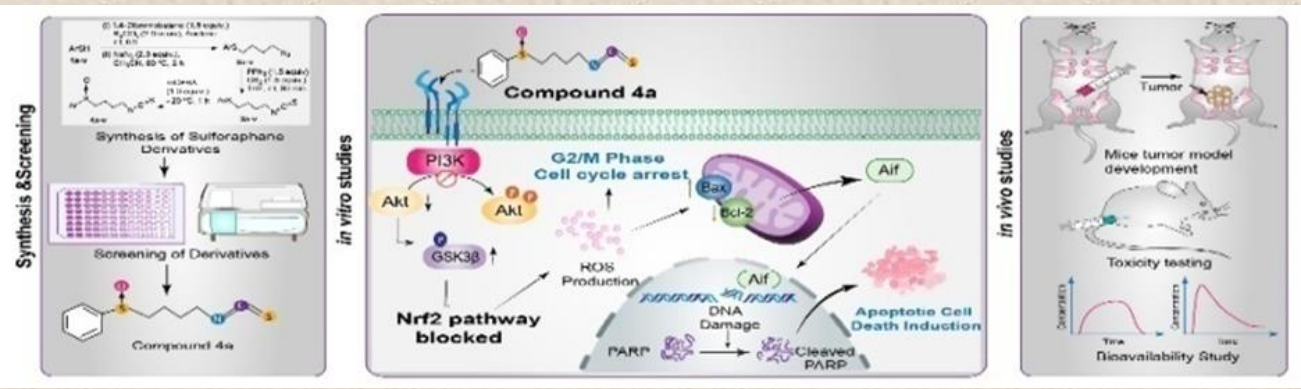
Field of Research: Our laboratory focuses on (a) developing novel synthetic methods for biologically relevant oligosaccharides and carbohydrate-derived small molecules with promising therapeutic potential.

Focused Areas of Research:

- Organic synthesis of complex oligosaccharides and development of novel reaction methodologies.



- Medicinal Chemistry.



Highlights of Research:

- A series of complex oligosaccharides corresponding to the cell wall of pathogenic bacteria such as E. coli, Salmonella, Acinetobacter, Klebsiellaetc have been successfully synthesized using chemical synthetic strategies.

- A series of novel synthetic methodologies for the synthesis of glycomimetics have been developed.

Prof. Debaraj Mukherjee

Professor
Department of Chemical Sciences

Name of the Participants:
Irshad Ahmad Zargar
Norein Sakandar
Bisma Rasool
Rahul Haldar
Sk. Bappa
Sanchari Kundu

Research Background and Vision:

Our lab aims to engaged in the development of novel methods for O-/C-/N-glycosylation, nucleoside synthesis, synthesis of oligosaccharide mimetics, and carbohydrate-fused bicyclic systems containing medium-ring to macrocyclic of promising therapeutic potential, non-infringing routes for the synthesis of carbohydrate-based active pharmaceutical ingredients (APIs). Also focusing on the generation of natural product-inspired small molecule-based leads in the area of cancer, neurodegenerative disease, antiviral, and antimicrobial chemotherapeutics.

Highlights of Research:

- Non-infringing route for API synthesis.
- Development of novel methods in carbohydrates
- Isolation and DOS of Small Molecules from Microbes as Kinase Inhibitors and Their Medicinal Chemistry

C-30 analogues of betulinic acid as potent cytotoxic agents: design, synthesis, biological evaluation and in-silico studies: In an endeavour to improve the anti-cancer activity of betulinic acid (BA), a series of C-30 derivatives were envisaged and synthesized with a novel synthetic approach. All the derivatives were evaluated for cytotoxic activity by MTT assay against six different human cancer cell lines: prostate (PC3), lung (A549), human hepatocellular carcinoma (HepG2), human leukemia (Molt-4), pancreatic (Panc-1) and breast (MCF-7). The data revealed that compound 16 was observed most promising cytotoxic agent with IC50 values of 7.43 μM, 9.1 μM, and 9.64 μM against A549, MCF-7, and PC3 cancer cell lines respectively. A further

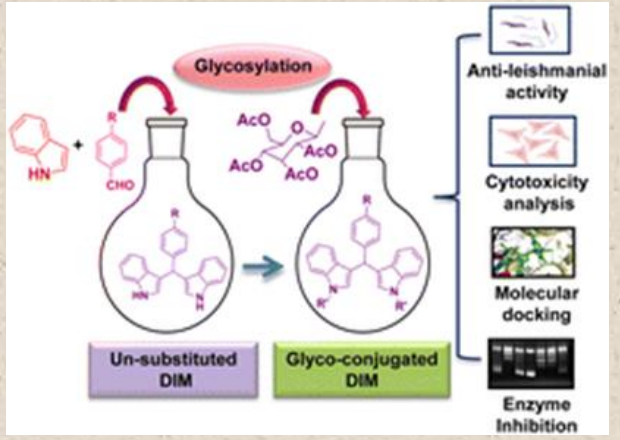
mechanistic study confirmed compound 16 showed significant cell death by arresting the cell cycle in the G1 phase and inducing apoptosis in A549 cells.

A path from synthesis to emergency use authorization of Molnupiravir (EIDD-2801) asCOVID-19 therapy: Coronaviruses are a group of enveloped viruses with non-segmented, single-stranded, and positive-sense RNA genomes. It belongs to the 'Coronaviridae family', responsible for various diseases, including the common cold, SARS, and MERS. The COVID-19 pandemic, which began in March 2020, has affected 209 countries, infected over a million people, and claimed over 50,000 lives. Significant efforts have been made by repurposing several approved drugs including antiviral, to combat the COVID-19 pandemic. Molnupiravir is found to be the first orally acting efficacious drug to treat COVID-19 cases. It was approved for medical use in the UK in November 2021 and other countries, including USFDA, which granted approval an emergency use authorization (EUA) for treating adults with mild to moderate COVID-19 patients. Considering the importance of molnupiravir, the present review deals with its various synthetic strategies, pharmacokinetics, bio-efficacy, toxicity, and safety profiles. The comprehensive information along with critical analysis will be very handy for a wide range of audience including medicinal chemists in the arena of antiviral drug discovery especially anti-viral drugs against any variant of COVID-19

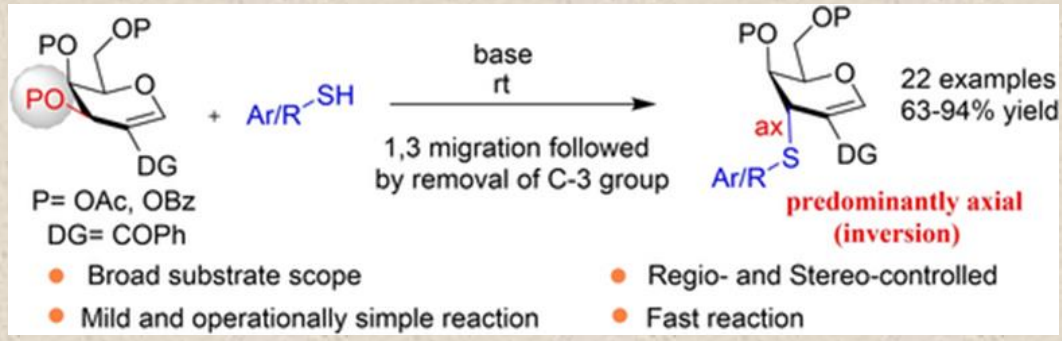
Discovery of colchicine aryne cycloadduct as a potent molecule for the abrogation of epithelial to mesenchymal transition via modulating cell cycle regulatory CDK-2 and CDK-4kinases in breast cancer cells: In this study, we synthesized a new-generation library of colchicine derivatives via cycloaddition of colchicine utilizing position C-8 and C-12 diene system regioselectivity with aryne precursor to generate a small, focused library of derivatives. We assessed their anticancer activity against various cancer cell lines like MCF-7, MDA-MB-231, MDA-MB-453, and PC-3. Normal human embryonic kidney cell line HEK-293 was used to determine the toxicity. Among these derivatives, silicon-tethered compound B-4a demonstrated the highest potency against breast cancer cells. Subsequent mechanistic studies revealed that B-4a effectively modulates cell cycle regulatory kinases (CDK-2 and CDK-4) and their associated cyclins (cyclin-B1, cyclin-D1), inducing apoptosis. Additionally, B-4a displayed a noteworthy impact on tubulin polymerization, compared to positive control flavopiridol hydrochloride in a dose-dependent manner, and significantly disrupted the vimentin cytoskeleton, contributing to G1 arrest in breast cancer cells. Moreover, B-4a exhibited substantial anti-metastatic properties by inhibiting breast cancer cell migration and invasion. These effects are attributed to the down-regulation of major epithelial to mesenchymal transition (EMT) factors, including vimentin and Twist-1, and the upregulation of the epithelial marker E-cadherin in an apoptosis-dependent manner.

Design, synthesis, and biological evaluation of 3,3′-diindolylmethane N-linked glycoconjugate as a leishmanial topoisomerase IB inhibitor with reduced cytotoxicity: Leishmaniasis, one of the neglected diseases, ranks second to malaria in the cause of parasitic mortality and morbidity. The present chemotherapeutic regimen faces the limitations of drug resistance and toxicity concerns, raising a great need to develop new chemotherapeutic leads that are orally administrable, potent, non-toxic, and cost-effective. Several research groups came forward to fill this therapeutic gap with new classes of active compounds against leishmaniasis, one such being 3,3′-diindolylmethane (DIM) derivatives. We tried to link this concept with another promising approach of glycoconjugation to study how glycosylated groups work differently from non-glycosylated ones. In the present study, a series of 3,3′-DIM derivatives have been synthesized and screened for their anti-leishmanial potency on Leishmania donovani promastigotes. Next, we synthesized the β-N,N′ glycoside of potent compound using indole–indoline conversion, Fischer-type glycosylation, 2,3-dichloro-5,6-dicyano-1,4-benzoquionone (DDQ) oxidation, and molecular iodine catalyzed coupling with a suitable aldehyde in reasonable overall yield. The biological evaluation revealed that glycosides had reduced cytotoxic effects on the J774A.1 macrophage cell line. The enzyme inhibition study confirms that the glycoside derivatives have significant inhibitory

activity against the leishmanial topoisomerase IB enzyme. Molecular docking further displayed the better binding efficiency of glycoside with the target enzyme, suggesting the involvement of more H-bond interactions in the case of glycosides as compared to free drugs. Therefore, this work helps in proposing the fact that the addition of sugar moieties adds some favorable characteristics to free inhibitors, making it a promising approach for future clinical diagnostic and therapeutic applications, which can prove to be a valuable arsenal in combating such neglected diseases. Pictorial representation is given below.

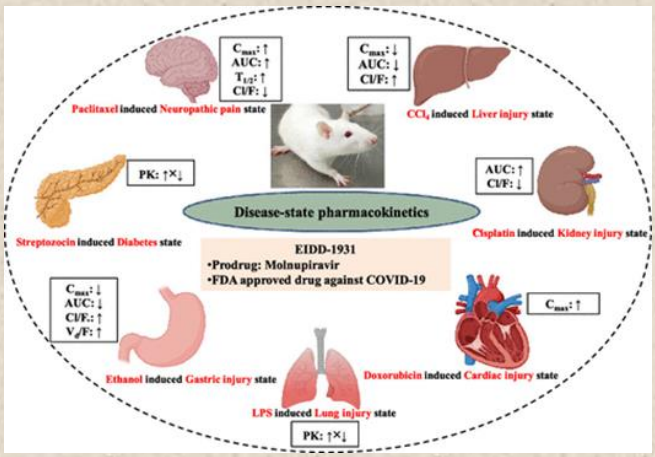


2-Ketophenyl Assisted Biomimetic Synthesis of 3-Thio Substituted Glycals at Room Temperature: We designed a strategy for the synthesis of regioselective and stereoselective displacement of C-3 acetate group in the presence of other C-4 and C-6 acetate of 2-ketophenyl-glycal by different aromatic and cyclic aliphatic thiol nucleophiles taking inspiration from cytosolic esterase mediated thiolation of glucosamine sugars into cellular glycan. Under a mild base condition at room temperature, the protocol generated a library of 3-arylthiosugars with excellent yields and high axial selectivity. This stereoselective approach tolerated well with different ester-protected glycals and thiophenols, aliphatic cyclic thiols, and mercaptans. A variety of control experiments were conducted to establish the mechanism and reason behind the stereoselectivity. In this work, we have described a synthesis of 3-thiosugars stereoselectively from 2-ketoglycals via regioselective displacement of C3 ester group with inversion of configuration. This strategy tolerates well with a variety of substituted thiophenols, aliphatic cyclic thiols, and mercaptans.

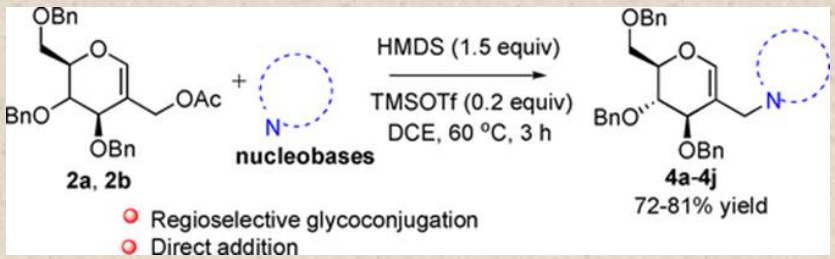


Switchable reactivity of 2-benzoyl glycals towards stereoselective access of 1-3 and 1-1 S/O linked disaccharides: We have developed a synthesis of 1-3 and 1-1 disaccharides from 2-benzoyl glycal and anomeric thiol and/or hydroxy sugar acceptors under mild conditions at room temperature. The regio and stereo-selectivity of the newly formed inter-glycosidic linkages are dependent on the nature of the glycal donor (D or L) and anomeric acceptor.

Impact of Disease States on the Oral Pharmacokinetics of EIDD-1931 (an Active Form of Molnupiravir) in Rats for Implication in the Dose Adjustment: The pharmacokinetic alteration of an antimicrobial medication leading to sub-therapeutic plasma level can aid in the emergence of resistance, a global threat nowadays. In this context, molnupiravir (prodrug of EIDD-1931) is the most efficacious orally against corona virus disease (COVID-19). In addition to drug–drug interaction, the pharmacokinetics of a drug can significantly vary during any disease state, leading to disease–drug interaction. However, no information is available for such a recently approved drug. Therefore, we aimed to explore the oral pharmacokinetics of EIDD-1931 in seven chemically induced disease states individually compared to the normal state using various rat models. Induction of any disease situation was confirmed by the disease specific study(s) prior to pharmacokinetic investigations. Compared to the normal state, substantially lowered plasma exposure (0.47- and 0.63-fold) with notably enhanced clearance (2.00- and 1.56-fold) of EIDD-1931 was observed in rats of ethanol-induced gastric injury and carbon tetrachloride-induced liver injury states. Conversely, paclitaxel-induced neuropathic pain and cisplatin-induced kidney injury states exhibited opposite outcomes on oral exposure (1.43- and 1.50-fold) and clearance (0.69- and 0.65-fold) of EIDD-1931. Although the highest plasma concentration (2.26-fold) markedly augmented in the doxorubicin-induced cardiac injury state, streptozocin-induced diabetes and lipopolysaccharide-induced lung injury state did not substantially influence the pharmacokinetics of EIDD-1931. Exploring the possible phenomenon behind the reduced or boosted plasma exposure of EIDD-1931, results suggest the need for dose adjustment in respective diseased conditions in order to achieve desired efficacy during oral therapy of EIDD-1931.

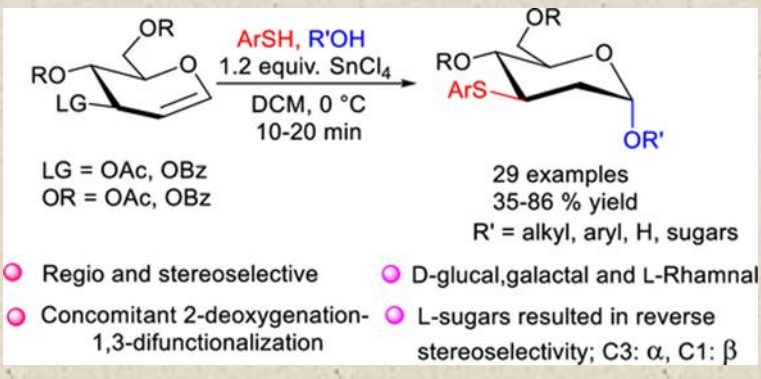


Lewis Acid Catalysed Regioselective Access of Novel C-2 Homo-Pyranose Nucleosides From 2-Acetoxy Methyl Glycals: Novel C-2 homo-pyranose nucleosides can be synthesized by regioselective glycoconjugation of C-2 acetoxymethyl glycals with nucleobases in the presence of a catalytic amount of a Lewis acid. The reaction proceeded via the formation of exo-Ferrier allylic

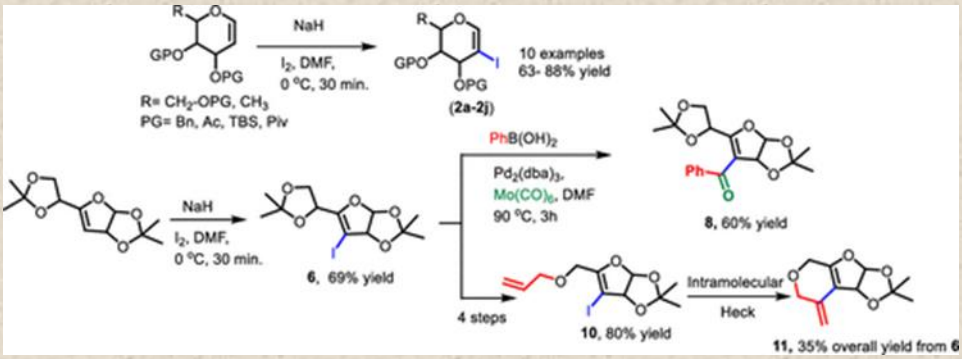


cation as an intermediate and the site selectivity is controlled on the basis of HSAB principle.

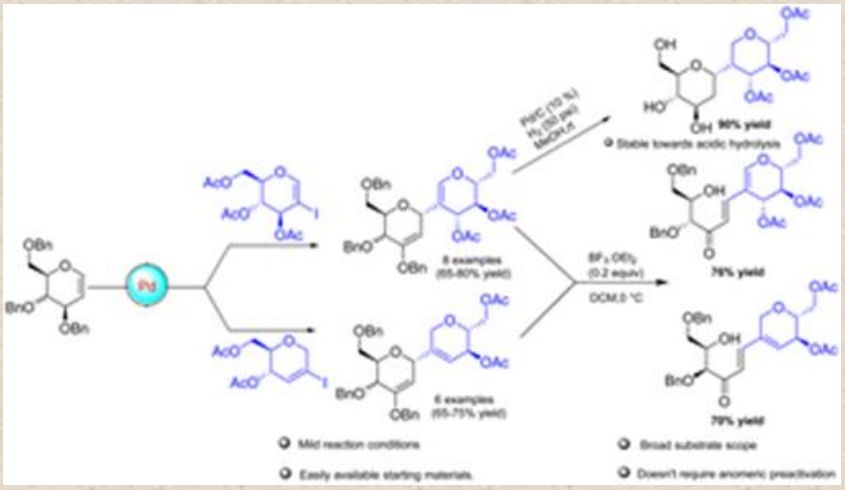
Regio and Stereoselective One-Pot Synthesis of 2-Deoxy-3-thio Pyranoses and Their O-Glycosides from Glycals: A reaction of glycals with two different types of nucleophiles in the presence of $SnCl_4$ enabled one-pot rapid access to 2-deoxy-3-thio pyranoses and their O-glycosides. The process involves thioaryl substitution at C-3 with stereoretention and α-selective O-glycosylation at C-1 from d-glycals, thus combining two reactions with three interventions. The present methodology features an attractive three-component coupling (1:1.2:1.5 ratio) with operational simplicity at 0 °C in 10–20 min. This stereoselective one-pot 1,3-difunctionalization approach of glycals is compatible with wide range of primary and secondary alcohols affording products in good to excellent yields. This methodology was successfully extended toward disaccharide synthesis. Several control experiments suggested a plausible reaction mechanism and rationale behind regio and stereoselectivity. The reaction strategy possesses an intrinsic ability for the synthesis of various natural products and drug molecules.



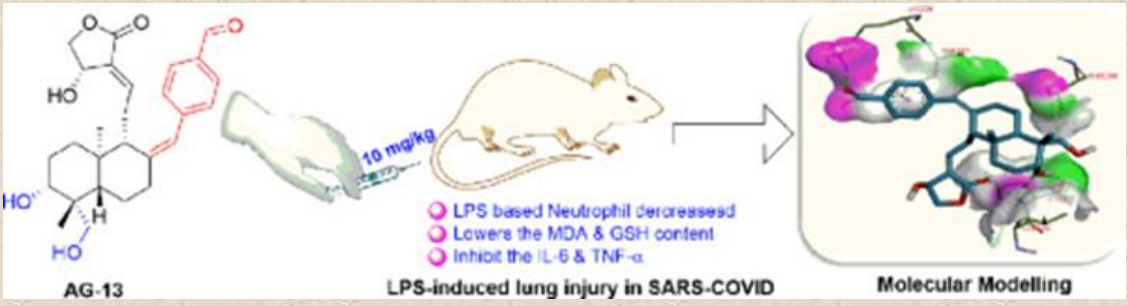
Base-Mediated Transformation of Glycals to Their Corresponding Vinyl Iodides and Their Application in the Synthesis of C-3 Enofuranose and Bicyclic 3, 4-Pyran-Fused Furanose: A simple method for the iodination of unsaturated sugars to form sugar vinyl iodides was developed under oxidant-free conditions using NaH/DMF/iodine as a reagent system at ambient temperature. 2-Iodoglycals bearing ester, ether, silicon, and acetonide protection were synthesized in good to excellent yield. 3-Vinyl iodides derived from 1,2:5,6-diacetonide glucofuranose were transformed to C-3 enofuranose and bicyclic 3,4-pyran-fused furanose via Pd-catalyzed C-3 carbonylation and intramolecular Heck reaction, respectively, as the key step.



Pd-catalyzed synthesis of hetero 1,2-interlinked C-disaccharides by coupling of iodo glycals with glycals: A facile synthesis of C1–C2 interlinked disaccharides is achieved from readily available iodo-glycals and unsubstituted glycals. Ester-protected donors reacted with ether-protected acceptors under Pd-Ag catalysis to access C-disaccharides bearing C-3 vinyl ether, which upon ring opening by Lewis acid furnished pi-extended conjugated orthogonally protected chiral ketones. Benzyl deprotection and reduction of the double bonds resulted in a fully saturated disaccharide stable toward acid hydrolysis.



Stereoselective and regioselective Heck arylation at C-17 exocyclic double bond of andrographolide to generate labdane-based lead molecule against acute lung injury: Andrographolide (AG-1) is identified as an attractive scaffold based on in silico/in vitro/in vivo (preclinical and clinical) studies against COVID-19 infection, for which hardly any effective drug is available to date. Due to complexity of its chemical structure, stereoselective and regioselective Heck arylation reactions at C-17 exocyclic double bond of AG-1 is a major challenge and we stepped forward to generate a small focused library of compounds. Among all the molecules, AG-12 and AG-13 were predicted to have better pharmacokinetic profiles than AG-1. Upon evaluation of in vivo efficacy of AG-12 and AG-13 in comparison to AG-1 using an LPS-induced acute lung injury model, AG-13 showed promising action towards reduction of the neutrophil count, minimization of oxidative stress, and inhibition of inflammatory cytokines. Further, lead optimization should be carried out towards developing potential natural product-driven therapeutics to combat acute respiratory distress syndrome (ARDS) situations during COVID-19.



Prof. Jayanta Mukhopadhyay

Professor
Department of Chemical Sciences

Research Background and Vision:

Our lab aims to understand the fundamental mechanism of transcription and gene regulation in bacteria by characterizing the interactions among RNAP, sigma factors, and regulators required for various gene expressions in prokaryotes. We have shown that the binding of RNAP at the promoter stabilizes the transcriptional regulator, δ in B. subtilis at the -41 site of the promoter DNA through an interaction with its αCTD and successively facilitates the open complex formation. In another project, we have shown that RFA-1 inhibits RNA polymerase similar way as rifampin by binding to a site different than rifampin.

Highlights of Research:

- Mechanism of δ mediated transcription activation in Bacillus subtilis: interaction with αCTD of RNA polymerase stabilizes δ and successively facilitates the open complex formation.
- Show that RFA-1 inhibits rifampicin-resistant RNA polymerase by binding to a site different than rifampin.
- Identify promoters of Sigma A of M. tuberculosis by SELEX.
- List of International and national collaborations
- Prof Graham Stuart, University of Surrey, UK, Project: ADP-ribosylation of DNA in Mycobacterium tuberculosis.

Prof. Suman Banik

Professor
Department of Chemical Sciences

Name of the Participants:
Tuhin Subhra Roy, SRF
Md. Sorique Aziz Momin, SRF
Dr. Mintu Nandi, IIEST, NPDF
Prof. Sudip Chattopadhyay, IIEST
Prof. Pinaki Chaudhury, CU

Research Background and Vision:

A living system survives in a continuously changing environment. To respond to the changes in the surroundings, each living species has developed specialized gene regulatory networks (GRNs). One of the major functions of a GRN is to transduce the incoming signal efficiently. The inherent noisy interactions in the biochemical system make signal transmission stochastic and can be understood using the formalism of non-equilibrium processes. Our lab aims to develop theoretical frameworks to study signal transduction in GRNs using information theory tools. The broad focus of our research group is to understand the basis of signal transduction in biochemical networks within the purview of fluctuations in a single cell.

Field of Research:

Theoretical and Computational Biology.

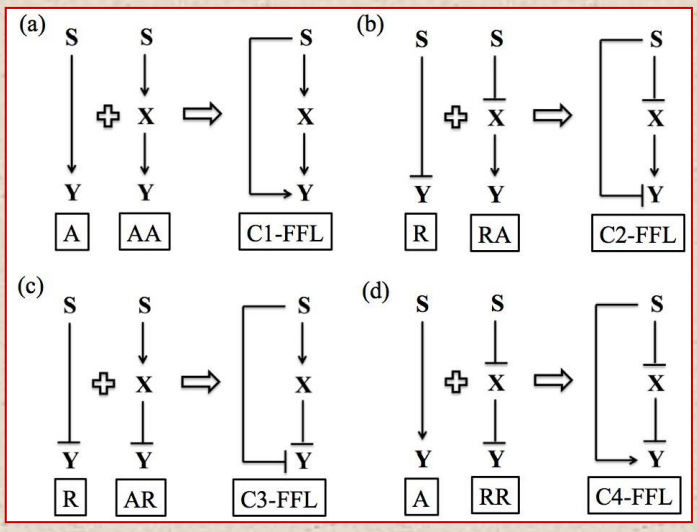
Focused Areas of Research:

- Noise decomposition in coherent feed-forward loop motifs.

Highlights of Research:

We developed a stochastic framework to decipher fluctuation propagation in classes of coherent feed-forward loops (CFFLs). The systematic contribution of the direct (one-step) and indirect (two-

step) pathways is considered to quantify fluctuations of the output node. We also considered bothadditive and multiplicative integration mechanisms of the two parallel pathways (one-step and two-step). Analytical expression of the output node's coefficient of variation shows contributions ofintrinsic, one-step, two-step, and cross-interaction in closed form. We observe a diverse range of degeneracy and non-degeneracy in each decomposed fluctuation term and their contribution to the overall output fluctuations of each CFFL motif. The analysis of output fluctuations revealed amaximal fluctuation of the CFFL motif of type 1.



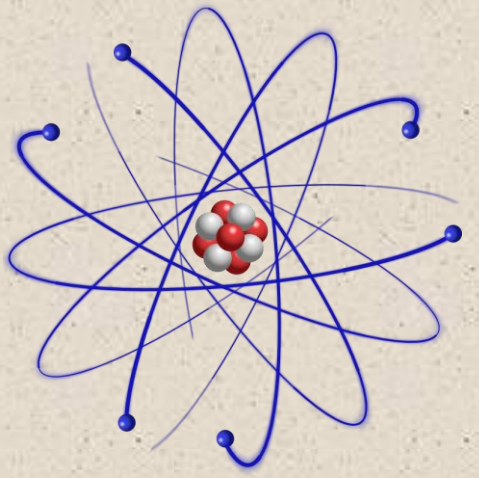
Schematic diagram of inbuilt components of coherent feed-forward loop (CFFL) motifs.

Participating 1st Winter Arctic Expedition from 17 Jan to 12 Feb 2024 for investigation of pristine bioaerosols over North Pole, collecting atmospheric samples under dark harsh polar nights as shown in the left image.

Participating Indian Summer Arctic Expedition during 17 May to 20 June 2024 for investigation of airborne microorganisms over North Pole, collecting atmospheric samples under polar daylight conditions as shown in the right image.

Campaign from 6 to 9 Mar 2024 for collecting Airborne Microorganisms over Sundarban Mangrove Reserve Forest under the extramural project (CRG/2021/000619) funded by SERB, Govt. of India

Deliver a popular lecture to school students belonging to rural areas in West Bengal



DEPARTMENT OF PHYSICAL SCIENCES

The “FAIR Industry Meet” was held at Bose Institute, Kolkata during April 12-13, 2023. The goal of this meeting was to appraise the Indian industries regarding the opportunities as well as challenges in the various upcoming International scientific facilities, especially the Mega Science projects where India is playing a crucial part in building the facilities and encourage them to participate in these ventures.

The event was inaugurated by Prof. (Dr.) Uday Bandyopadhyay, Director, Bose Institute. Mr. Manfred Auster, the Hon’ble Consulate General of the Federal Republic of Germany, Kolkata was present as the Chief Guest. Among others present were Dr. Sumit Som, Director, VECC and chief patron for Indo-FAIR Project, Dr. David Urner, Head, In-Kind Office & Procurement, FAIR GmbH and Mr. Gaurav Aggarwal, Scientist from International Cooperation Division of the Department of Science and Technology, Government of India.

DEPARTMENT OF PHYSICAL SCIENCES

Overview:

The Department of Physical Sciences at Bose Institute has been an active center for high quality research in the frontier areas of Physics for more than a century. Inspired by the dream of its founder - Acharya J. C. Bose, the research activities in the department cover diverse areas in experimental and theoretical Physics, Environmental Sciences as well as areas at the interface of Biological and Chemical Sciences.

The specific research areas perused are Quantum Information, Statistical Physics, Biophysics, Complex Systems, Condensed Matter Physics, Materials Science, Cosmic Rays, Nuclear Astrophysics, High Energy Physics, String Theory and Environmental Sciences. We have active international collaborations with ALICE at LHC, CERN and ISOLDE radioactive beam facility at CERN. We are the nodal centre in India to facilitate Indian activities at the Facility for Antiproton and Ion Research (FAIR) at GSI, Germany.

List of Personnel:

Senior Scientists: Prof. Dipankar Home, NASI Senior Scientist

Students: RA/SRF/JRF/Project Associate: Dr. Rupa Sarkar (Women Scientist, DST-SERB/ Guest Worker, Bose Institute); Dr. Prabir Banik (NPDF); Dr. Debarsee Chowdhury (NPDF); Dr. Somen Gope (R.A.-I FAIR Project); Dr. Anjali Sharma (R.A.-I FAIR Project); Dr. Sumit K. Saha (R.A. ALICE-III); Dr. Sanchari Thakur (R.A. ALICE-III);

Ms. Kabita Kundalia; Ms. Trishna Bhattacharyya ; Mr. Deep Nath; Mr. Prottoy Das; Mr. Abhi Modak; Ms. Debjani Banerjee; Md. Asif Bhat; Ms. Chumki Nayak; Mr. Suvadip Masanta; Mr. Arindam Sen; Mr. Ritankar Mitra; Ms. Rudrapriya Das; Ms. Swati Sharma; Mr. Debanjan Roy; Mr. Arijit Roy; Mr. Niloy Ghosh; Mr. Subhankar Maity; Shahina Raushan Saikh; Mr. Ramnarayan Bera; Mr. Mintu Haldar; Mr. Pritam Sinha; Mr. Akash Gupta; Mr. Sayan Samanta; Mr. Subir Mandal; Md. Abu Mushtaque; Ms. Antara Pramanik; Mr. Jashvant K. Prasad; Ms. Riya Adhikary.

Departmental Activities:

A. The Department of Physical Sciences has organized the following seminars during the period of April-2023 to March-2024:

1. "Attosecond Vision and Control of Electron Dynamics in Quantum Systems" by Dr. Shubhadeep Biswas, SLAC, Stanford University, December 22, 2023.
2. "Formation and Evolution of the very FIRST STARS (primordial stars) in the Universe" by Dr. Jayanta Dutta, HRI, Prayagraj (Allahabad), December 15, 2023.
3. "Precise measurement of the weak mixing angle by the MOLLER experiment at Jefferson Lab" by Dr. Sayak Chatterjee, University of Massachusetts, Amherst, November 14, 2023.
4. "Is kinetic constraint sufficient to generate quantum many-body scars?" by Dr. Bhaskar Mukherjee, University College London, October 03, 2023.
5. "A de Sitter anecdote: Can sub-leading corrections be consistently ignored?" by Dr. Dibya Chakraborty, Ashoka University, August 21, 2023.
6. "Quantum Walking: A paradigm for quantum simulation and computation" by Mr. Prateek Chawla, SRF, IMSc Chennai, June 21, 2023.
7. "Correlations & Fluctuations: A Tool For Unlocking The Properties of Quark-Gluon Plasma Through ALICE Experiment at CERN" by Dr. Sumit Basu, Lund University, Sweden, May 19, 2023.
8. "A sharp future of medium-size telescopes in the era of automated adaptive optics" by Dr. Jyotirmay Paul, University of Liege, Belgium, April 05, 2023.

B. Lab visit of students on national Science Day (Feb 28, 2024).

Prof. Achintya Singha

Professor

D

of Physical Sciences

Name of the Participants:
Dr. Debasree Chowdhury, NPDF
Shib Shankar Singha, Guest Researcher
Tara Shankar Bhattacharya, Guest Researcher
Himadri Sekhar Tripathi, SRF
Chumki Nayak, SRF
Suvadip Masanta, SRF
Pritam Sinha, JRF
Avijit Paul, M.Sc. Physics student at IIT Kharagpur, Summer Project Student
Shyam Sundar Mallik, BI

Research Background and Vision:

Over the past decade, quantum materials based on transition metal dichalcogenides (TMDCs) and transition metal oxides (TMOs) have attracted considerable research interest due to their distinctive physical and chemical properties. These materials have shown immense potential in a wide range of applications. Recently, advances in crystal engineering have paved the way for discovering novel physical phenomena and unlocking new possibilities for emerging technologies. In our work, we focus on material engineering within TMDCs and TMOs using techniques such as alloying, doping, functionalization, and heterostructure formation. Through these strategies, we explore exciting phenomena like spin-valley physics and exciton-plasmon coupled optical properties. Additionally, we investigate the potential of these engineered materials in applications related to optoelectronics and energy storage, offering promising avenues for next-generation quantum technologies.

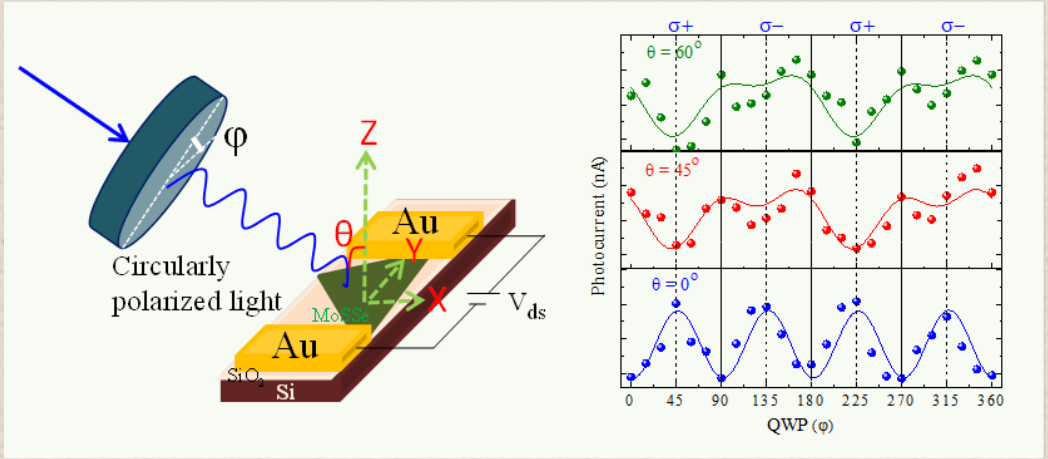
Research Areas:

- Quantum materials and devices

Highlights of Research:

Generation of Helicity-Dependent Valley Photocurrent in TMDC Alloy MoS2xSe2(1-x)

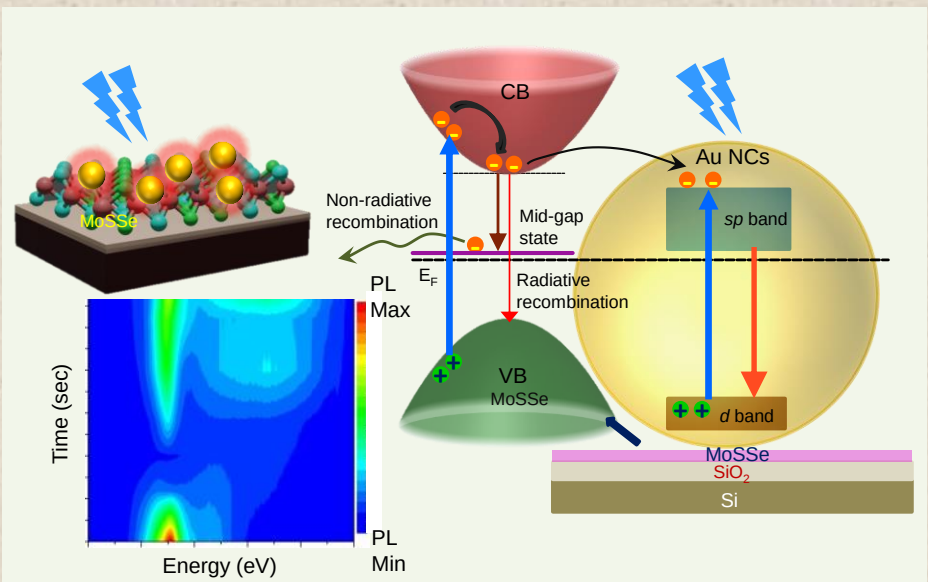
Controlling spin-valley coupling in monolayer transition metal dichalcogenide (TMDC) materials has profound implications for fundamental physics and offers improved functionalities in the field of valleytronics device applications. In recent years, while the spin-valley physics of pristine TMDCs and their heterostructures has been well-studied, but less attention given to TMDC alloys. This study investigates the spin-valley physics of monolayer and bilayer TMDC alloys, specifically MoS2xSe2(1-x), focusing on the generation of photocurrent via the circular photogalvanic effect. Piezoelectric force microscopy reveals an internal electric field perpendicular to the alloy layer, breaking out-of-plane mirror symmetry in both mono and bilayer samples. The dynamic control of the magnitude of the photocurrent is explored via optical and electrical tuning. These experimental findings are



corroborated by first-principles calculations using density functional theory. We anticipate that our study will pave the way for profound implications in fundamental physics and enhanced functionality in the realms of valleytronics and quantum information [C. Nayak et al., Physical Review B, 109, 115304 (2024)].

Tailoring Light-Matter Interaction in MoS2xSe2(1-x) Alloys through Gold Nanostructure Coupling and Exploring Underlying Mechanisms

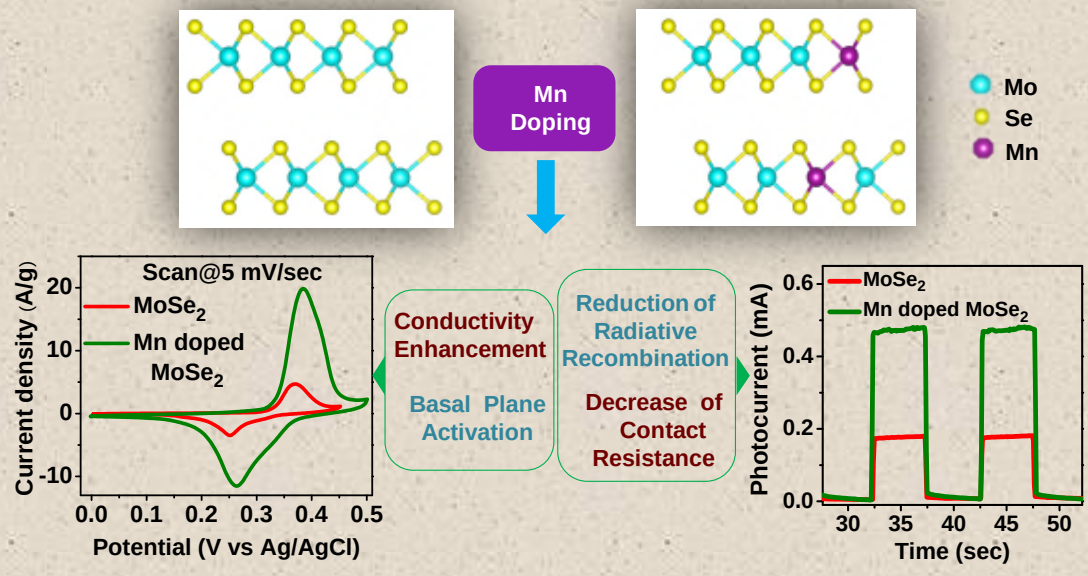
Tailoring exciton-plasmon interaction in transition metal dichalcogenides coupled with noble metal nanostructures has significant implications in cavity quantum electrodynamics, spintronics and valleytronics. Here, we report a simple strategy to modulate recombination pathways in transition metal dichalcogenide alloy MoS2xSe2(1-x) coupled with Au nanoclusters through engineering the geometrical parameters of Au nanoclusters. Experimental investigations using PL and Raman studies demonstrated successful tuning of the optical and vibrational properties of alloy TMDC through the incorporation of Au NCs. First principles calculations further provided microscopic understanding about Au/ MoS2xSe2(1-x) hybrid samples, after incorporation of Au NCs. The observed quenching in PL emission was attributed to the formation of mid-gap states during the initial phases of Au growth over the MoS2xSe2(1-x) layer, leading to non-radiative charge recombination. Subsequent band realignment in the hybrid structure facilitated charge transfer from MoS2xSe2(1-x) to Au NCs.



By systematically modifying the shape and size of Au NCs, the localized electric field resulting from surface-plasmon resonance played a pivotal role in increasing the PL intensity. This work provides both experimental and theoretical groundwork for the development of next-generation optoelectronic devices, such as photodetectors, solar cells, and light emitting devices, based on plasmonic nanostructures coupled with alloy TMDC materials [C. Nayak, et al., Physical Review B, 109, 125306 (2024)].

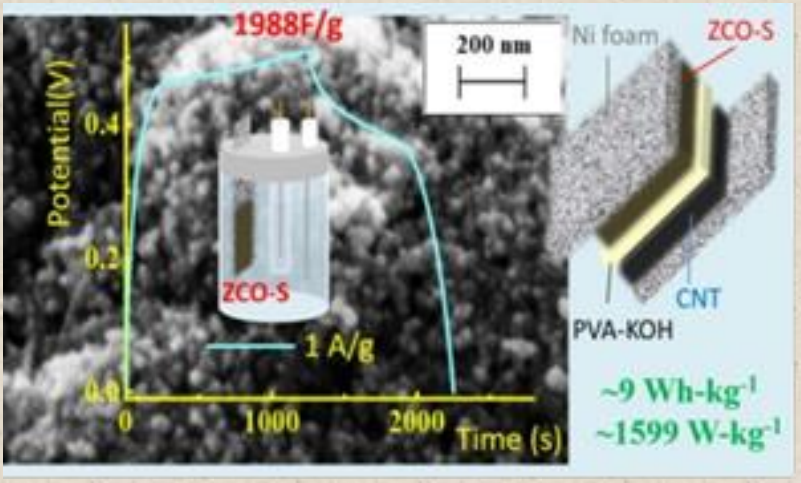
Advancing MoSe2 for Enhanced Electrochemical Energy Storage and Photosensing via Mn Doping

To achieve advanced functionalities in nanostructured MoSe2, an important member of TMDC family with impressive physical and chemical properties, we propose an effective strategy: the substitutional doping of Mn heteroatoms, for enhanced electrochemical charge storage and improved photosensing. This study demonstrates a significant increase in specific capacitance for 6.2% of Mn doping compared to pristine MoSe2 in three-electrode configuration. Moreover, superior charge-storage performance is observed in a two-electrode arrangement. The enhanced electrode performance is attributed to increase electrical conductivity resulting from the higher electron density associated with the n-type nature of Mn doping, corroborated by X-ray photoelectron spectroscopy and density functional theory calculations. These analyses reveal that Mn doping introduces catalytically active sites by disrupting the homogeneous charge distribution over the topology of the MoSe2 basal plane, contributing to improved charge-storage performance. Additionally, Mn doping induces a shift in the Fermi level of MoSe2 towards the conduction band, minimizing the contact barrier height and enhancing its capabilities as a photosensor device. Furthermore, Mn doping alleviates the charge recombination process, leading to increased photocarrier separation. Consequently, a 187% enhancement in photocurrent, along with significantly higher responsivity and detectivity, is observed for 6.2% Mn-doped MoSe2 compared to its pristine counterpart. This proposed doping strategy demonstrates promising potential for MoSe2 and other two dimensional transition metal dichalcogenides in the development of next-generation energy-storage and optoelectronic devices [S. Masanta et al., ACS Applied Nano Materials, 6, 7, 5479-5492 (2023)].



Surface-Engineered $ZnCo_2O_4$ Nanoparticles for Binder-Free Electrode in All-Solid-State Asymmetric Supercapacitor

In the field of supercapacitors, surface chemical treatment of electrode materials is an exciting area of research. In this study, we examine how four different surface modifiers (three surfactants and one mineralizer) affect ZCO electrodes directly grown on Ni foam. We compare the impact of these modifications on the performance of the electrodes. The analysis revealed that the modified ZCO electrodes formed a cubic spinel structure with an average particle size of approximately 30 nm. Among the modified electrodes, those treated with sodium dodecyl sulfate (ZCO–S) exhibited the



best electrochemical performance, achieving a specific capacitance of 1988 F/g at 1 A/g and maintaining 87% capacity retention after 7000 cycles at 10 A/g. Additionally, an all-solid-state asymmetric supercapacitor (ASC) was fabricated using the ZCO–S electrode on Ni foam, paired with carbon nanotubes. This device demonstrated a specific capacitance of 102 F/g at 1 A/g and a power density of approximately 1599 W/kg, underscoring ZCO–S as a promising material for supercapacitor electrodes.

Prof. Dhruba Gupta

Professor & Chairman
Department of Physical Sciences

Name of the Participants:
Dr. Rupa Sarkar, DST Women Scientist
Sk. Mustak Ali, SRF
Kabita Kundalia, SRF
Subhankar Maity, SRF
Ritankar Mitra, SRF
Sayan Samanta, JRF
Nilay Ghosh, JRF
Manas Datta

Research Background and Vision:

In nuclear astrophysics, the cosmological lithium problem is a well-known unresolved problem, where there is a serious anomaly between big-bang nucleosynthesis (BBN) calculations and the observed abundance of ^{7}Li. Since ^{7}Be is the main source of primordial ^{7}Li, we are studying the breakup and transfer reactions of ^{7}Be to look for a nuclear physics solution to the problem. We are also studying the radiative capture reaction that affects the C/O ratio. This is crucial for stellar nucleosynthesis of elements heavier than carbon and the evolution of life in the universe. We also plan to study nuclear reactions relevant to inhomogeneous nucleosynthesis.

Field of Research:

- Nuclear Astrophysics.

Highlights of Research:

Measurement of the ^{7}Be(d,^{3}He)^{6}Li* reaction and the ^{6,7}Li anomalies

Study of the ^{7}Be(d,^{3}He)^{6}Li* transfer reaction has been carried out. The population of the 2.186 MeV excited state of ^{6}Li in this reaction channel is observed for the first time. The effect of this reaction on ^{6,7}Li abundances are investigated at the relevant BBN energies. The S factor of the (d, ^{3}He) channel from the present work is about 50% lower than the existing data at nearby energies. At big-bang energies, the S factor is about three orders of magnitude smaller than that of the (d, p) channel. The (d, ^{3}He) reaction rate is found to have a less than 0.1% effect on the ^{6,7}Li abundances.

Study of transfer reaction of ^{7}Be + ^{12}C at 5 MeV/u

We measured the angular distributions for the transfer reaction ^{12}C(^{7}Be,^{3}He)^{16}O* at E = 5 MeV/u. We obtained the Sα and ANCs for the ground state and subthreshold states of ^{16}O. The angular

distribution for ground state of ^{16}O has been measured for the first time. The present study is related to the α-capture reaction ^{12}C(α,γ)^{16}O, a key reaction in the helium-burning phase of stars. This reaction along with the preceding triple-α fusion reaction forming ^{12}C, determines the C/O abundance ratio in stars.

Breakup reactions from ^{7}Be + ^{12}C at 5 MeV/u

The measurement of the breakup of the radioactive nucleus ^{7}Be on ^{12}C at 5 MeV/u is reported for the first time. Significant coincidence events of α and ^{3}He from the direct and sequential breakup of ^{7}Be have been identified. Further work is in progress to obtain the angular distribution and comparison with CDCC calculations.

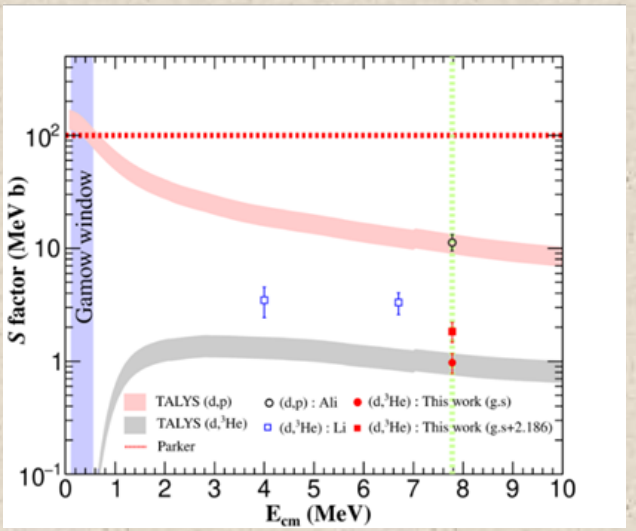


Figure 1: Astrophysical S factor for the ^{7}Be(d,^{3}He)^{6}Li reaction. The red solid circle and square correspond to the present work. The red and gray bands are TALYS calculations for (d,p) and (d,^{3}He) channels respectively, normalized to the present data at 7.8 MeV (green vertical line). The red dotted line is the (d,p) estimate used till date.

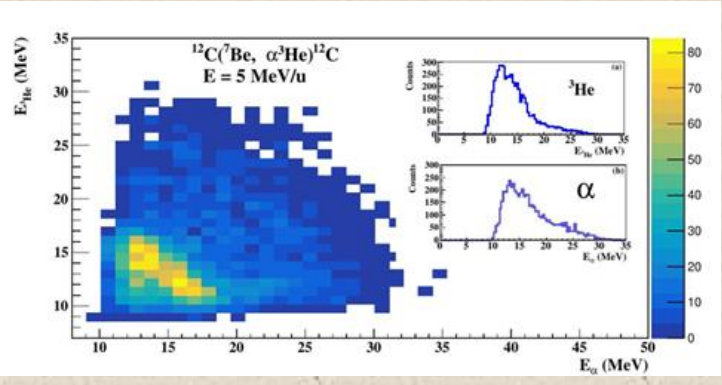


Figure 2: Energy correlations of coincident ^{3}He and α from the breakup of ^{7}Be on ^{12}C at 5 MeV/u. The inset shows the coincident energy spectrum for (a)^{3}He and (b) α.

Dr. Pramod Kumar Shukla

Assistant Professor
Department of Physical Sciences

Name of the Participants:
Collaborator:
Michele Cicoli, (INFN Bologna & University of Bologna, Italy)
George K. Leontaris (University of Ioannina, Greece)
Matteo Licheri (INFN Bologna & University of Bologna, Italy)
Pellegrino Piantadosi (INFN Bologna & University of Bologna, Italy)
Fernando Quevedo (DAMTP-Cambridge, The United Kingdom & Perimeter Institute for Theoretical Physics, Canada)

Research Background and Vision:

From the cosmo-phenomenological studies in the context of models developed in string theory framework, it has been experienced that satisfying the requirements for moduli stabilization along with the local constructions of chiral visible sector remains a challenging issue. In the standard approach of string model building, global issues (such as moduli stabilization, realizing inflationary aspects) and local issues (such as embedding MSSM-like spectrum) are studied quite independently. Although this helps in understanding both sectors significantly, the same appears to be too simplistic for realistic model building purposes, and an interplay of local and global effects needs to be considered at the same time within a single framework.

Addressing along the way some mathematical/phenomenological challenges, we have been working on a systematic study of type IIB string compactifications in LARGE volume scenarios (LVS) with the main objective of combining moduli stabilization along with realizing inflationary. This ongoing task has been targeted with a two-fold goal: the first one being more mathematical in which we have been interested in the construction of 'suitable' CalabiYau (CY) orientifolds using the toric-geometry-based package/tools, like Package for Analyzing Lattice Polytopes (PALP), System for Algebra and Geometry Experimentation (SAGE), Cohomology Computation of Algebraic Varieties (cohomCalg) and CalabiYau Tools Package (CYTools). And in the second part we construct explicit models addressing issues like moduli stabilization, flat vacua with (post-)inflationary aspects.

Field of Research:

- Theoretical High Energy Physics.

Focused Areas of Research:

String Theory.

- String Phenomenology.
- Exploring the Calabi-Yau Geometries.
- Global Model Building in String Cosmology

Highlights of Research:

The main objective of the research work in our group has been focused on making attempts to construct realistic models in string phenomenology. We have several ongoing long-term programs in continuation to our previous series of works in this area, which are constituent parts of our broader goal. These can be described along the following lines:

- To understand moduli stabilization schemes in explicit global setups via constructing the orientifold of Calabi-Yau threefolds, particularly focused on type IIB superstring compactifications.

- Study of (generalized) flux compactifications, including the insights of non-geometric scalar potentials induced from U-dual completion of the flux superpotentital in type II supergravities.

- Construction of model with the possibility to realize de- Sitter vacua and subsequently embedding of inflationary aspects and the stability of inflationary models against (un-) known corrections.

- Classifying the Calabi-Yau geometries suitable for string phenomenology and scanning the landscape of flux vacua in the lights of swampland conjectures.

While working on these goals we have developed an important scanning tool for exploring the “suitable” Calabi-Yau geometries needed for string model building. This database can be of huge interest to not only the string theorists but also mathematicians who are working on the algebraic geometry and topology.

Prof. Rajarshi Ray

Professor
Department of Physical Sciences

Name of the Participants:
Pratik Ghoshal
Pracheta Singha

Other Collaborators:
Chowdhury Aminul Islam
Munshi Golam Mustafa

Research Background and Vision:

Our work has been mainly to develop a consistent model framework for understanding the thermodynamic properties of strongly interacting matter. Our objective has been to study the limitations of existing models by contrasting them with certain available first principle calculations as well as by contrasting them with the experimental data. Thereby we developed an extremely well suited quasi-particle model of gluon thermodynamics for the exploration of the phases of strongly interacting matter.

We have further initiated some studies in understanding the field theoretic properties in gravitational backgrounds to study thermodynamic properties during the evolution of the early universe as well as the properties of super-massive stars.

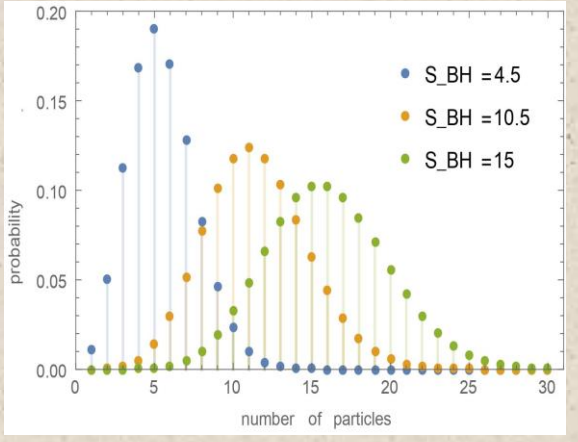


Figure illustrating the essence of our research work

The figure illustrates the probability distribution of decay of a Black Hole having entropy S_BH via the emission of various number of particles. It resembles a Planckian distribution except that instead of the Wein's displacement law where the location of the maxima of the distribution is inversely proportional to temperature, here the maxima is proportional to inverse of the square of the temperature.

Major Achievements:

- Developed the most consistent model for gluon thermodynamics.
- Obtained the probability distribution for the number of decay modes of a stationary Black Hole.

Future Plan:

- Develop a consistent description of phases of strong interaction for a wide range of temperature and chemical potentials.
- Explore strongly interacting matter in gravitational backgrounds.

Dr. Saikat Biswas

Associate Professor
Department of Physical Sciences

Name of the Participants:
Arindam Sen, SRF, INSPIRE Fellow
Subir Mandal, JRF, UGC
Pranjal Barik, Summer Trainee, Savitribai Phule Pune University
Dr. Somen Gope (Research Associate-I, FAIR project)
Dr. Anjali Sharma (Research Associate-I, FAIR project)
Mayukh Chatterjee (St. Xavier's College, Kolkata)
Aheesh Chandrakant Hegde (NISER)
Monika Aggarwal (Central University of Haryana)
Subrata Das (BI)

Research Background and Vision:

I am working on the Physics of particle detectors, specifically on the research of gaseous detectors and the scintillation detector for heavy ion and cosmic ray experiments.

The main goal is to study the physics of Quark-Gluon Plasma (QGP) at low baryonic density and high temperature in the ALICE experiment, and also at low temperature and moderate to high baryon densities in the CBM experiment at FAIR. As both these experiments will use fast gaseous detectors, we are working on the R&D of these detectors. This R&D program includes research on Resistive Plate Chamber (RPC), Gas Electron Multiplier (GEM), Straw tube detector and Scintillation detector (for cosmic ray study). We are also working on the study of cosmic ray at high altitude.

Field of Research:

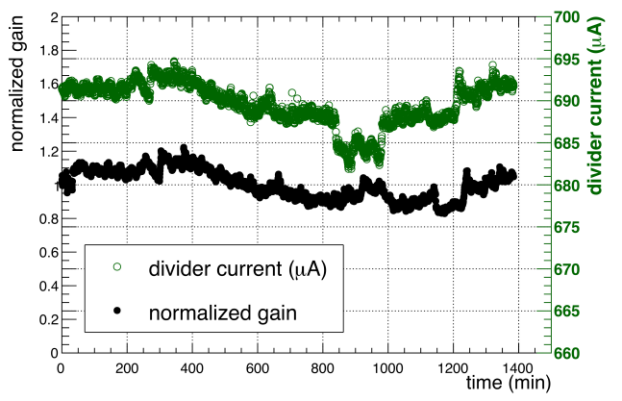
- Experimental High Energy Physics.

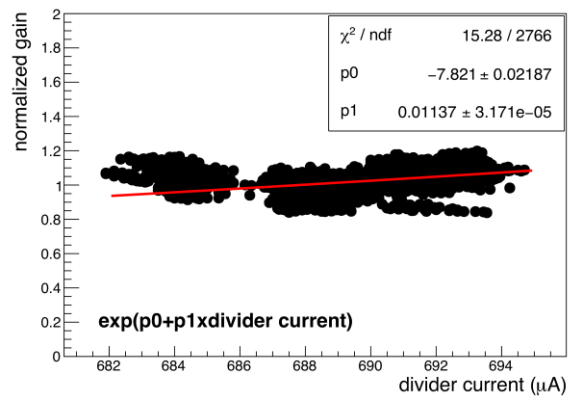
Highlights of Research:

Observation on the bias current variation of a single mask triple GEM chamber. (With S. Chatterjee, A. Sen, S. Das, R Paul, S. Sahai)

The Gas Electron Multiplier (GEM) detector is one of the advanced members of the Micro Pattern Gas Detector (MPGD) family, used in High Energy Physics (HEP) experiments as a tracking device due to its high-rate handling capability and good spatial resolution. Investigation of the long-term stability is an essential criterion for any tracking device used in HEP experiments. To investigate the long-term stability of a Single Mask (SM) triple GEM detector prototype, it is irradiated continuously using a 55Fe X-ray source of energy 5.9 keV. The chamber is operated with Ar/CO2 gas mixture in

continuous flow mode. The gain and energy resolution of the chamber are calculated from the 5.9 keV X-ray peak and studied as a function of time. The applied voltage, divider current and also the environmental parameters (ambient temperature, pressure and relative humidity) are recorded continuously. It is observed that at a fixed applied voltage, the divider current of the detector is changing with time and as a result, the gain of the detector also changes. A systematic investigation is carried out to understand the probable reasons behind the observed variation in divider current and also to find its possible remedies.

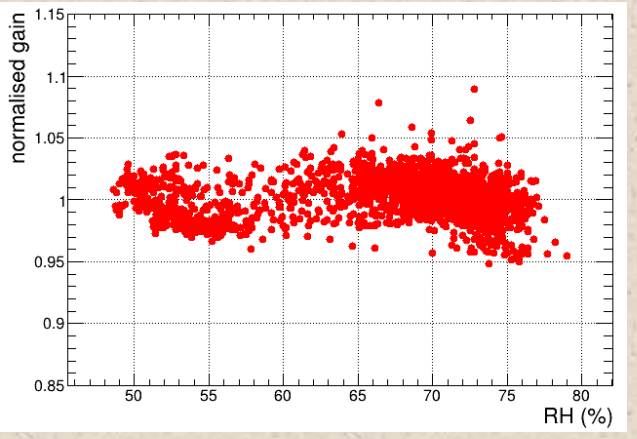


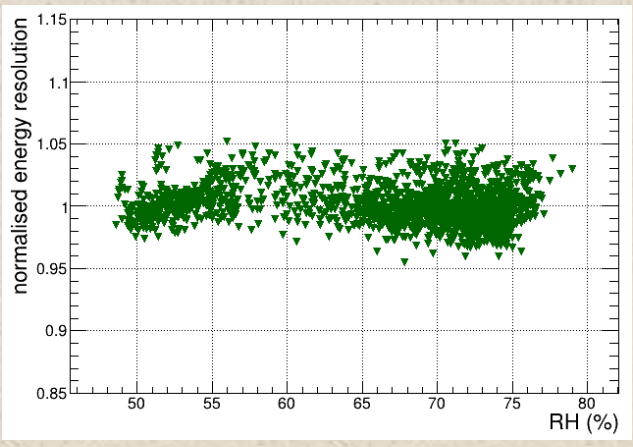


Left: variation of T/p normalized gain and divider current as a function of time. Right: correlation between the divider current and T/p normalized gain.

Effect of relative humidity on the long-term operation of a single mask triple GEM chamber. (With S. Chatterjee, A. Sen, S. Das)

The effect of relative humidity on the performance of the SM triple GEM chamber is investigated after eliminating the effects of T/p variation on the gain and energy resolution of the chamber. No significant correlation is observed between T/p normalised gain and energy resolution with the relative humidity.





Variation of normalised gain (left) and energy resolution (right) as a function of RH.

Bakelite RPC prototype with new method of linseed oil coating. (With A. Sen, S. Chatterjee, S. Das)

Resistive Plate Chamber (RPC) is a very popular gaseous detector used in High-Energy Physics (HEP) experiments for triggering and tracking.

Keeping in mind the requirements of detectors having high-rate handling capability, cost-effectiveness, and large area coverage to be used in future HEP experiments, commercially available bakelite plates with moderate bulk resistivity are used to build RPC prototypes.

In general bakelite RPCs are fabricated with a linseed oil coating on the inner surface to make it smooth which helps to reduce the micro-discharge probability. A new method of linseed oil coating has been developed for the bakelite RPC. In conventional bakelite RPC, the linseed oil coating is done after making the gas gap. In this particular work, the linseed oil coating is done before making the gas gap. After the linseed oil coating, the plates are cured for several days. The advantage of this procedure is that after linseed oil coating it can be checked visually whether the curing is properly done, or any uncured droplet of linseed oil is present. The detector is characterised with Tetrafluoroethane ($C_2H_2F_4$) gas and also with conventional Tetrafluoroethane, Iso-butane ($i\text{-}C_4H_{10}$) gas mixture.

Realizing the dybnamical fluctuation in AMPT generated data for Au+Au collisions at 10 AGeV. (Work done by Somen Gope)

Studies of dynamical fluctuations are among the most important observables in high-energy heavy-ion collisions, offering insights into collision dynamics. Various techniques exist to extract these fluctuations, and we have focused on the scaled factorial moment technique, which provides information on intermittency in heavy-ion collisions. Intermittency is closely related to fluctuations and is a key feature in such studies.

From the present investigation using the Au+Au system at 10 AGeV energy, it has been observed that the intermittency indices for q=5 and 6 are significantly higher in the AMPT (string melting) generated data compared to the AMPT (default) data. This pronounced increase in intermittency indices suggests that the string melting mode, with its more extensive partonic interactions and richer dynamics, leads to stronger and more complex dynamical fluctuations. These findings highlight the string melting mode's heightened sensitivity to the underlying physics, potentially offering deeper insights into the behavior of the quark-gluon plasma and related critical phenomena.

Dr. Sanat Kumar Das

Associate Professor
Department of Physical Sciences

Name of the Participants:
Shahina Raushan Saikh
Abu Mushtaque
Antara Pramanick
Jashvant Kumar Prasad

Research Background and Vision:

The curiosity of knowing the weather is undoubtedly increasing day-by-day and therefore, accurate weather prediction is on demand. However, pollution plays a major role in creation of large uncertainty in the results obtained from different atmospheric models. The reason is uncontrolled and continuous changing its quantity and characteristics. As a result, a large fluctuation is observed in model predictions. The main objective of our investigation is the improvement of present understanding of alteration of cloud-precipitation system that changes the climate as well as agricultural system and thereby, ultimately affects our country's economy. In my lab, our research focuses on aerosols induced global warming, perturbation of cloud formation, and aggravation of air quality index that effects on human health. In recent years, our efforts on meteorological dependency on the variation of diversity of airborne microorganism will help for better understanding of bioaerosols' effect on life.

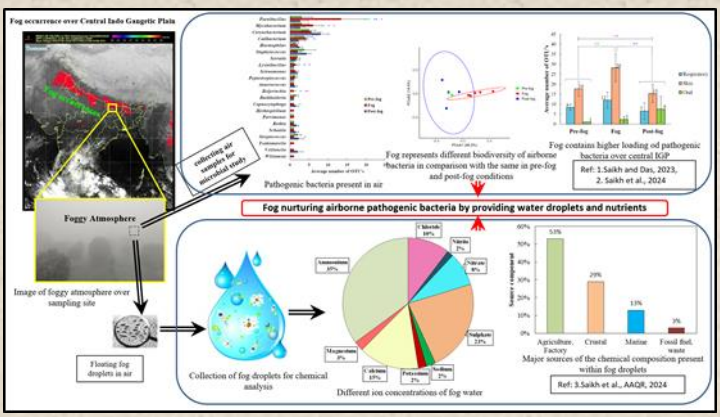
Field of Research:

- Atmospheric Sciences.

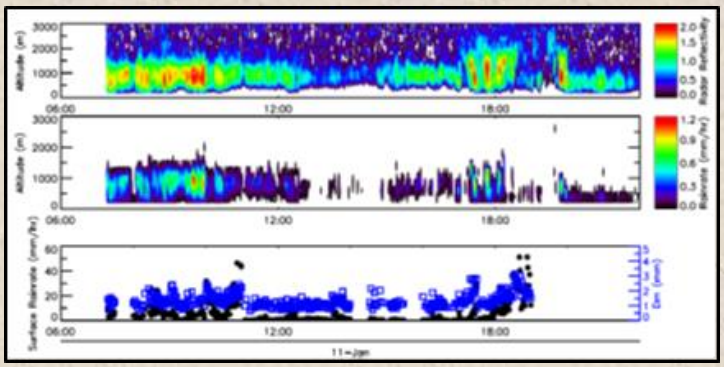
Focused Areas of Research:

- Lower Atmosphere.
- Aerosol and Air quality.

Highlights of Research:



Role of Fog in enhancement of airborne pathogenic bacteria over Indo-Gangetic Plain in India



Temporal variation of vertical distribution of radar reflectivity and retrieved rain-rate using Micro-Rain Radar, and surface rain-rate and rain drop size (Dm) using Optical Rain Gauge with 1-min cadence during an event of south polar precipitation on 11-Jan 2017 at Bharati over eastern Antarctica.

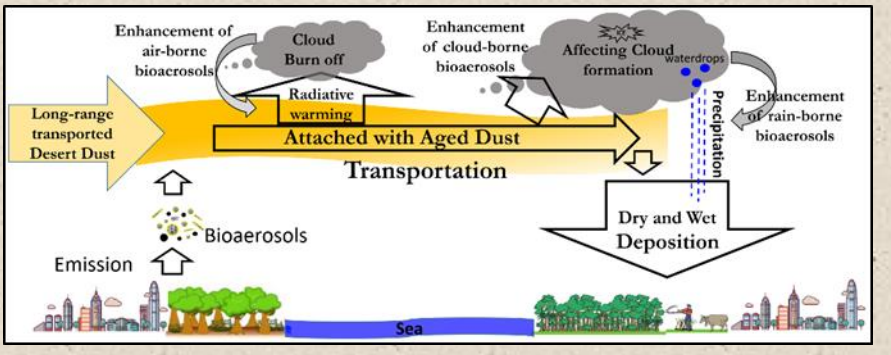


Figure 1: Schematic diagram of transport of bioaerosols attached with aged dust and subsequent precipitation. A role of radiative warming by elevated aerosol layer on enhancement of air-borne bioaerosols and formation of clouds by elevated bioaerosols on the enhancement of cloud-borne & rain-borne bioaerosols are shown here.

Aerosols of biological origin play an important role in the Earth's atmospheric system. The interaction of bioaerosols with the climate via cloud formation and precipitation causes a large impact on public health (Figure 2). Such kind of interactions are considered as atmosphere-

biosphere interactions. Airborne bacteria, fungal spores, pollen, and other microbiomes are essential components in this interaction for the reproduction and spread of organisms across various ecosystems, and causing or enhancing human, animal, and plant diseases. This is their direct effect on human society. In general, it has been observed that long-range transported aerosols carry significant amount of bioaerosols from the source region or over the trajectory regions and ultimately, these long-range transported microorganism attached with aerosols influence the biosphere of the downwind region. Moreover, they can serve as nuclei for cloud droplets, ice crystals, and precipitation, thus influencing the hydrological cycle and climate. Thus, the atmospheric microbiomes are capable of affecting not only health and ecosystem over a region, but also climate processes like cloud formation and precipitation.

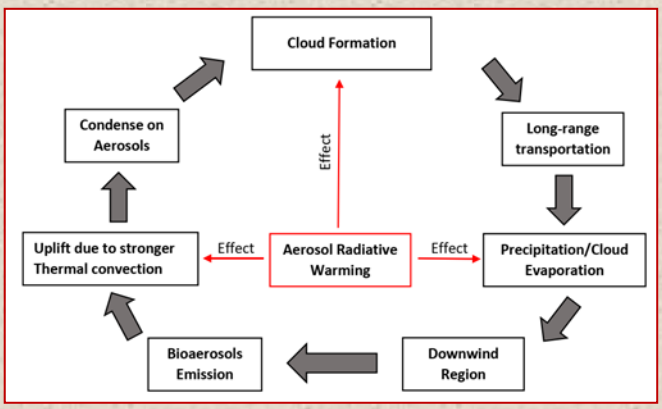


Figure 2: Role of Aerosols and its radiative warming effect on the loading of Bioaerosols in the air, cloud and rain and their transportation

Aerosols play an important role in regional and global climate change due to their potential in altering the radiation budget by scattering and absorbing the incoming solar and outgoing terrestrial radiation, which produces significantly aerosol radiative warming into the atmosphere. As a result, aerosol radiative warming effects can cause uplifting of boundary layer height, which allows atmospheric aerosols to reach at the higher altitudes. Aerosol radiative warming is also responsible for cloud burn off process that evaporates clouds and releases aerosols inside the clouds. Therefore, calculation of radiative warming is very much demanding with less uncertainty. Large variations in physical, optical, and chemical properties of these aerosols and their intense effects on the regional as well as global climate have made them a priority in recent times for the atmospheric research community. As per the present understanding, there is a high uncertainty in the overall radiative effects of aerosols on climate change. The high uncertainty is due to the co-existence of dust and Black Carbon (BC) in the atmosphere. Dust aerosols containing high amounts of iron-rich dust (like hematite) are strong absorbers of solar radiation in the UV region and hence produce significant warming within the atmosphere (Das et al., 2013). Absorbing dust loading into the atmosphere is high over arid region by the strong wind. One of the major anthropogenic components in the atmospheric aerosols is black carbon (BC) or soot, released from incomplete combustion of carbon-based fuels (Andreae and Gelencsér, 2006, Ramachandran et al., 2006). BC has a major contribution toward global warming as it is the second most important component after CO_2 and it has higher direct radiative forcing than that of methane due to its light absorbing capability (Jacobson, 2001, Das et al., 2011). Another uncertainty involved in the estimation of aerosol radiation forcing due to not considering the periodicity involved in the variation of aerosol loading (Das et al., 2011, Ramachandran et al., 2013). Various types of bioaerosols with desert dust (Pointing

and Belnap, 2012) naturally produce by high-wind events in desert storms, and increasingly, also from human activities (Griffin, 2007). The trajectory of transport for these desert dust particles is well established (Griffin, 2007; Lawrence and Neff, 2009; Smith et al., 2013), and includes dispersal over trans-continental (Kellog and Griffin, 2006; Reynolds et al., 2001) and trans-oceanic distance (McKendry et al., 2001; Derimian et al., 2006; Prospero et al., 2012). Aside from the desert dust, anthropogenic particles like BC originating from agriculture or industrial areas by biomass burning/industrial, vehicular emissions also contribute to aerosols transported over the continent (Arimoto et al., 2004; Huang et al., 2015). The radiative warming causes the uplifting of these bioaerosols attached with BC aerosols over agriculture or industrial areas and these elevated aerosols can travel long-distances. Present proposal will be investigated the aspects.

Eastern India is a downwind region of Indo-Gangetic Basin in India. The desert dust coming from Thar Desert are the prime natural aerosols, which provide a base for the urban aerosols and are transported along with them to Eastern India. In the higher altitudes, the environment is extremely harsh where along with urban aerosols, microorganisms survive on the dust particles and wind favors them to reach from source to downwind region. These microorganisms may survive in the higher altitudes until the precipitation occurs. In the relatively wet atmosphere compared to source region, these bioaerosols readily capture water vapor and form water droplets, which later enter into the cloud or help in the formation of clouds. This part of the hydrological cycle is under investigation and demands concrete evidences. The challenge is to collect these bioaerosols during precipitation, identify, and determine the source regions. Thereafter, the effects on human health and ecosystem like mangrove forest also need to be investigated.

Dr. Sidharth Kumar Prasad

Associate Professor
Department of Physical Sciences

Name of the Participants:
Abhi Modak: SRF, Institute Fellow
Prottoy Das: SRF, Institute Fellow
Debjani Banerjee: SRF, DST Inspire Fellow
Mintu Haldar: UGC Fellow
Postdocs
Sanchari Thakur: ALICE Project
Sumit Kr. Saha: ALICE Project
Summer trainees:
Soumyadip Mandal
Collaborations
A Large Ion Collider Experiment (ALICE) at CERN, Geneva
Compressed Baryonic Matter (CBM) experiment at GSI, Germany

Research Background and Vision:

Our research focuses on the study of a new state of matter with partonic degrees of freedom known as Quark Gluon Plasma (QGP) using nucleus-nucleus and hadronic collisions at relativistic speeds. Various properties of QGP are being investigated and their precise measurements are still some of the open questions in our field. We primarily focus on the study of hard probes (QCD jets) and photon production with the ALICE experiment at Large Hadron Collider (LHC), CERN. Instrumentation, detector development, development of computing algorithms and Monte Carlo simulations for detection and reconstruction of particles produced in these collisions are also integral parts of our research program.

Field of Research:

- Experimental High Energy Nuclear Physics.

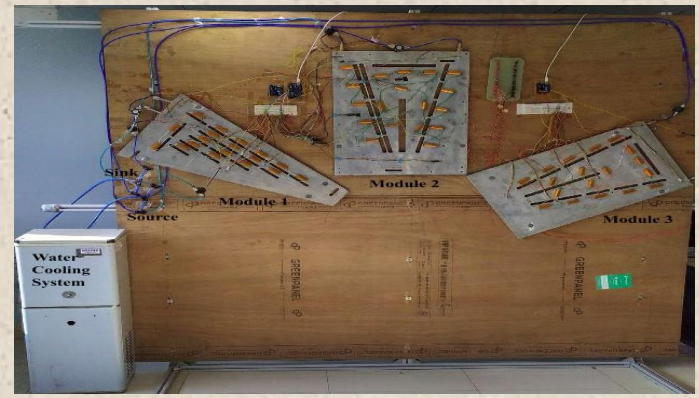
Focused Areas of Research:

Study of relativistic heavy-ion collisions.

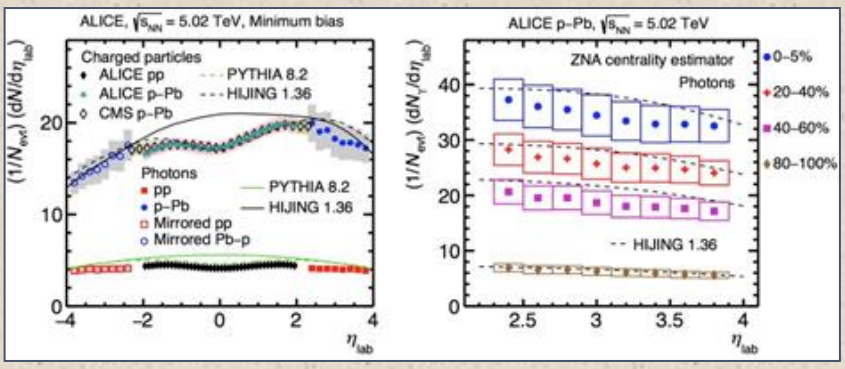
- Understanding the strong interactions and primordial state of matter, Quark Gluon Plasma (QGP), believed to have existing micro seconds after the big-bang.
- Instrumentation and detector development for high energy physics experiments.
- Development of computational framework for physics analysis and detector simulations and data analysis.

Highlights of Research:

A water based cooling system using 10 cm thick aluminium plate with water channels embedded inside is developed over last few years at Bose Institute. The cooling system exploits an arduino based auto control motor system to maintain a constant temperature of the surface of cooling plate. The developed cooling system is successfully installed and running in the mini-CBM experiment at GSI, Germany.



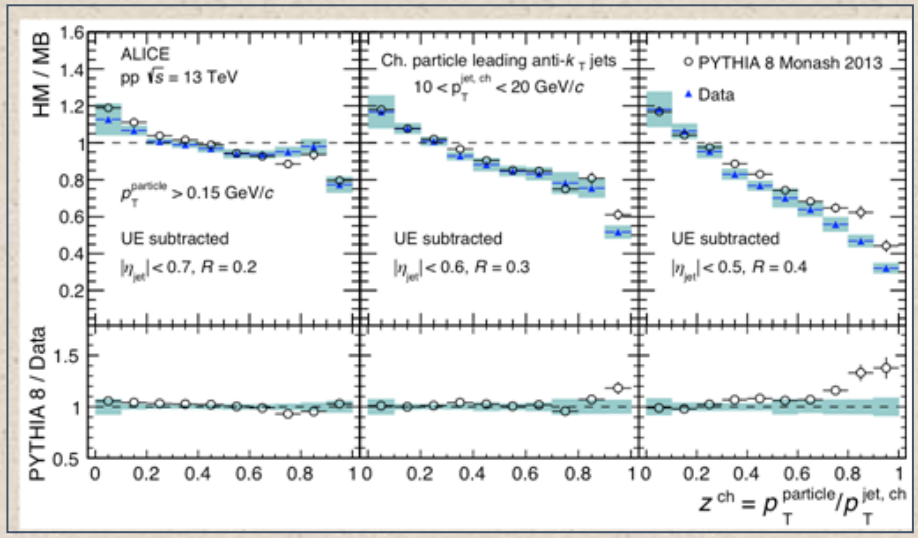
Water based cooling system build at Bose Institute



Measurements of photon multiplicity in forward rapidity is carried out in the ALICE experiment at LHC for the first time using an indigenously built Photon Multiplicity Detector (PMD) in proton-lead collisions at 5.02 TeV.

Pseudorapidity distributions of inclusive photons in pp and pPb collisions

In recent years results from small collisions systems at LHC energy have shown interesting features similar to that in heavy-ion collisions particularly in low transverse momentum region. The origin of these effects is still an open and challenging question. Our multiplicity dependent study of jet properties in proton-proton and proton-lead collisions reported jet modification in high multiplicity pp and pPb collisions at LHC indicating hits of possible QGP like effects using hard probes for the first time. Interestingly similar features are also observed in monte carlo models with no QGP effects implemented within them.



Prof. Somshubhro Bandyopadhyay

Professor
Department of Physical Sciences

Name of the Participants:

Group members:
Arkaprabha Ghosal
Debanjan Roy

Collaborators:
Pratik Ghosal, BI
Saronath Halder, CNT Warsaw, Poland
Vincent Russo, ISARA
Tathagata Gupta, ISI, Kolkata
Ritabrata Sengupta, IISER Berhampur

Research Background and Vision:

Information encoded in quantum systems is quantum information, and therefore, quantum information processing must obey the laws of quantum physics. The discovery of this simple idea has led to novel communication protocols including secure cryptography primitives, exceptionally fast algorithms and many applications in quantum many-body problems.

While quantum information and computation has been the cornerstone of cutting edge research in physics, mathematics, and computer science for many years now, especially because of the promise of revolutionizing the existing technology, our research, however, is mostly aimed at addressing fundamental problems in the resource theory of entanglement, entanglement distribution, quantum state discrimination, quantum channels, quantum protocols and interpretation of quantum mechanics.

Aims and Objectives:

Presently we are working on problems in the following areas:

- Resource theory of entanglement
- LOCC state discrimination
- Quantum non-locality
- Quantum gravity induced entanglement of masses

Research Highlights/Accomplishments:

- Proved a novel property of quantum switches that shows a higher-order quantum switch constructed from two quantum switches can perform qubit communication better than the component switches. We demonstrate this communication advantage over quantum switches that are useful as a resource and those that are useless.
- We obtained necessary conditions for transforming a set of pure bipartite states into another using deterministic LOCC. These conditions are shown to be independent but not sufficient.

Future Plan:

- To obtain the exact entanglement cost and the corresponding optimal resource states in discriminating orthogonal two-qubit bases using LOCC.
- To explore quantum gravity induced entanglement of masses in many-body systems where symmetry is absent.
- To develop a theory based on the techniques of quantum information to address the information paradox in black holes.

Prof. Soumen Roy

Professor
Department of Physics

Name of the Participants:
Deep Nath, SRF
Swati Sharma, JRF
Ramnarayan Bera, JRF
Arijit Roy, JRF

Research Background and Vision:

Diverse natural, engineered, and many other systems all around us are composed of many constituents and sub constituents interacting non-trivially amongst themselves and perhaps even with the environment.

Examples of such systems abound in the physical as well as the living world. We employ a fully interdisciplinary approach using tools from physics, mathematics, network science, computation, statistics, and experiments. Non-linear dynamics and game theory are some other useful tools to study such systems. Whenever possible, we combine both results from both theoretical as well as experimental approaches.

Field of Research:

- Complex systems, Systems biology (theoretical and experimental).

Focused Areas of Research:

- Networks, Statistical Physics, and Information theory: From Classical to Quantum systems.
- Experimental and Computational Approaches to Study Phage-bacteria interactions.

Highlights of Research:

Aureochromes are blue light-responsive light-oxygen-voltage (LOV) photoreceptors cum basic leucine zipper (bZIP) transcription factors (TFs), which are present exclusively in photosynthetic marine stramenopiles. We study aureochromes from Ectocarpus siliculosus, given their full genome sequence. Aureochromes mediate the light-regulated developmental responses therein. The LOV sensor and bZIP effector both show overall sequence-structure conservation. The compatibility of dimerization partners by screening is addressed through heptad repeats. The relative stability of these structures is investigated from a graph-theoretic perspective using measures like energy of the graph, average participation coefficient, and, betweenness centrality. We also undertake an information-theoretic analysis using hitherto understudied measures like network information centrality and Kullback-Leibler divergence. All our results are in very good accordance with each other.

Prof. Supriya Das

Professor
Department of Physical Sciences

Name of the Participants:
Md. Asif Bhat, SRF
Rudrapriya Das, JRF

Research Background and Vision:

Within the experimental high energy physics group, we are involved in the study of matter at extreme temperature such was believed to be present immediately after the creation of the universe through big bang and/or density that occur in the core of neutron stars. Typically similar conditions are realized by colliding heavy-ions at relativistic speed using large particle accelerators. The system created in such collisions is then characterized by detecting the particles and radiation emerging from them using detectors. During the said period we have studied the jet modification in absence of QGP and investigated the role of multipartonic interaction and color reconnection in it. We have also started a work to study net baryon fluctuation in Au-Au collisions at FAIR energies to look for a predicted critical point in the phase diagram of QCD matter.

Research Highlights/Accomplishments:

- A new approach to calculate the energy density in hadronic collisions.
- Study of jet modification in absence of QGP.
- Study on charging up in GEM.

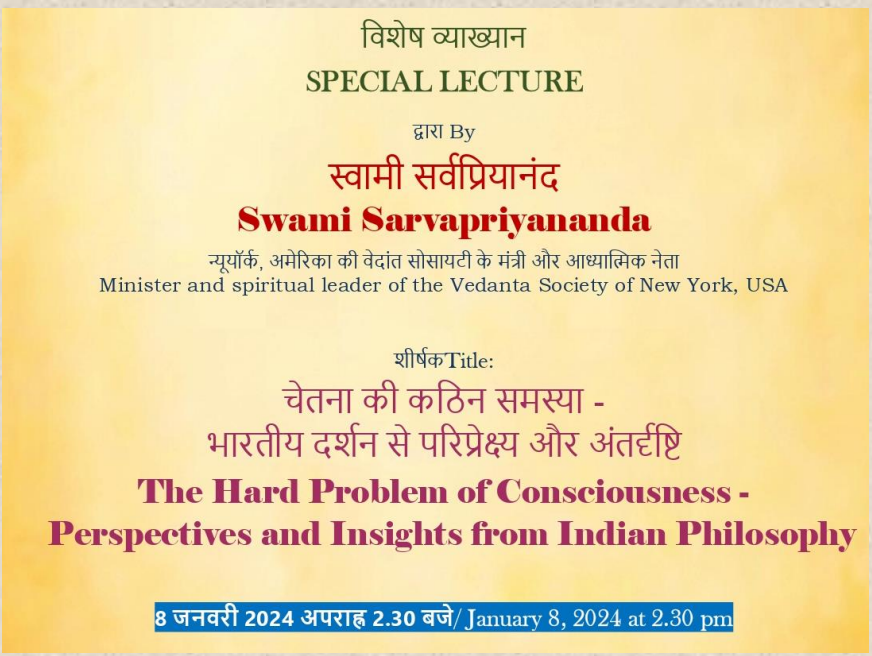
Future Plan:

- Improvement of particle identification framework in CBM.
- Study of net proton fluctuation to characterize matter at high baryonic density.

SERVICE DEPARTMENTS/SECTIONS

47th International Kolkata Book Fair

Bose Institute participated in the 47th International Kolkata Book Fair held in 18th January to 31st Jan 2024 at Central Park Maidan, Salt Lake City, Kolkata.



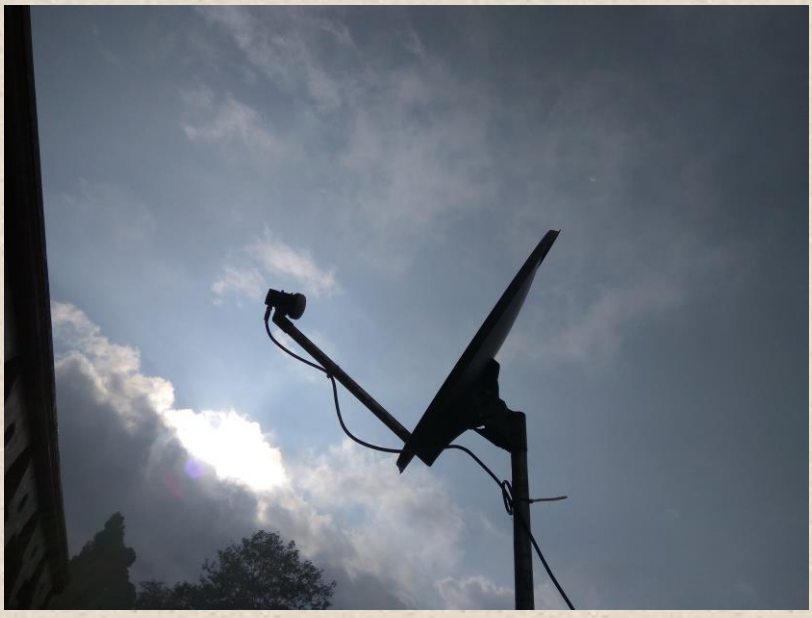
CENTRE FOR ASTROPARTICLE PHYSICS & SPACE SCIENCE

Overview:

A national facility for the observational studies on Cosmic Ray and atmospheric phenomena has been developed at Darjeeling campus of Bose Institute under the IRHPA scheme of Department of Science & Technology, Govt. of India. The main objectives of this center are to understand the interaction characteristics of Cosmic Ray at low and high energy, search for exotic phenomena in Cosmic Rays, studies of the changing Airspace Environment in Eastern Himalayas in the context of regional climate change along with the studies to understand the connection between the cosmic Ray and Cloud. In order to fulfil these objectives observational facilities for monitoring the various aspects of Cosmic Ray and atmospheric phenomena have been created at Darjeeling.

- Commercially available polymer polyethylene terephthalate (PET) has been standardized and calibrated for use as Nuclear track detector. These have also been deployed at Darjeeling along with Ooty and Hanley for cosmic ray measurements.
- An Air Shower array using active detectors is being developed to study the energy spectrum and components of primary cosmic rays. Infra structural facilities like detector tanks and metal frames have been designed and fabricated in-house at the Bose Institute workshop.
- Vertical profile of rain rates, drop size distributions, radar reflectivity, fall velocity of hydro meteors and other rain parameters are being measured using Micro Rain radar (MRR).

- Vertical profile of water vapour mixing ratio and many other aerosol and cloud related quantities are being measured using Raman Lidar.
- Several automated online atmospheric trace gas analyzers e.g. SO , NO , CO, O etc have been running to study the gaseous pollutants in the atmosphere.
- Particulate matter present in the atmosphere are being studied using high volume sampler, online particulate matter monitor for number and mass concentrations and condensation particle counter to study the ultrafine particulate matter.



- Black carbon or soot particle in the atmosphere over Darjeeling is being studied using Aethelometer.
- Cloud Condensation Nuclie counter is being run for the study of finer aerosol particles which forms cloud.
- Sunphotometer is being run for the study of Aerosol Optical Depth i.e. the attenuation of incoming solar radiation due to loading of aerosol particles in the atmosphere.
- Automatic weather station is installed to collect meteorological data along with a sonic anemometer for different components of wind velocity
- Lightning detector and electric field monitor has been installed to study the variation of atmospheric electric field
- Organic and elemental carbon in the ambient atmosphere are being monitored continuosly.
- The size-segregated cloud condensation nuclei is being monitored under different ambient conditions in different seasons.
- The scattering coefficients of aerosols are being monitored under different humid conditions
- Atmospheric electricity is being studied under fair weather conditions covering all the seasons.
- Chemical characterization of wet precipitation is being studied during monsoon.

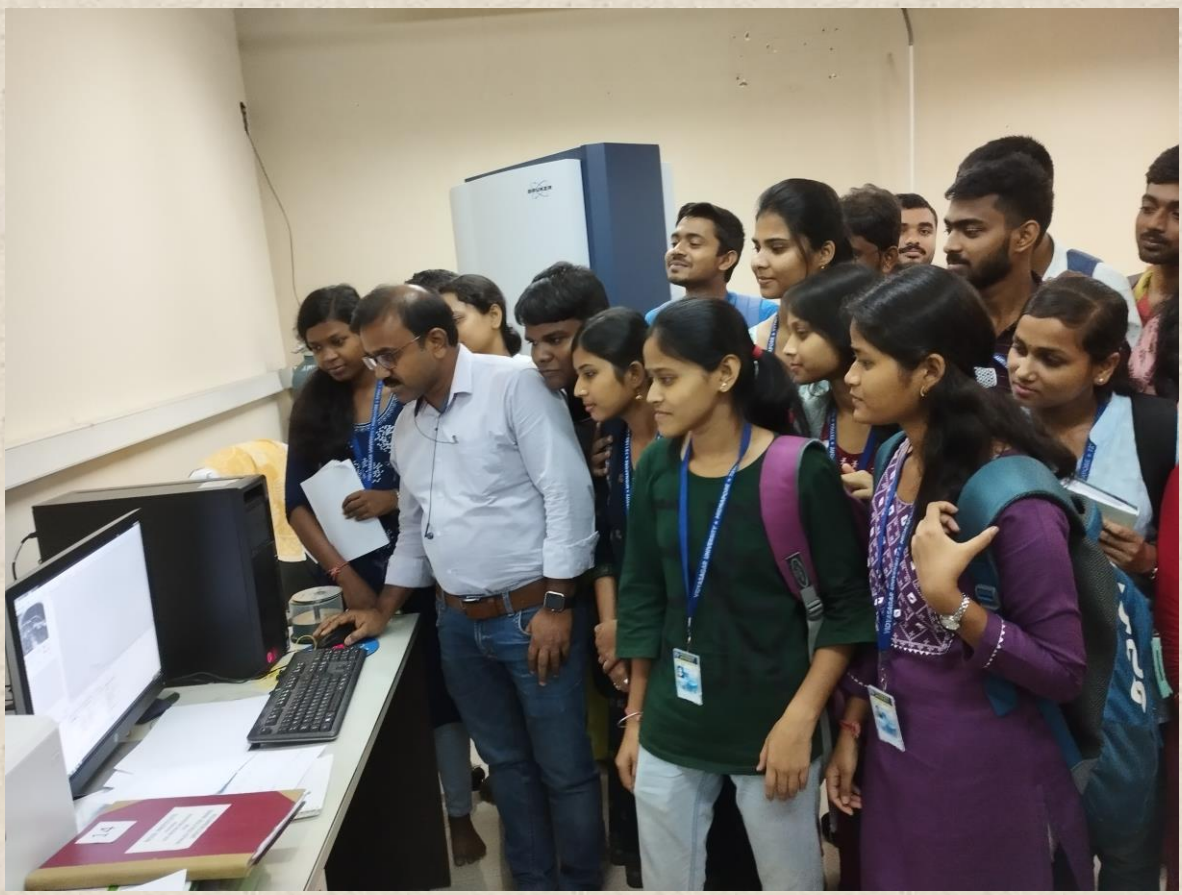
CENTRAL INSTRUMENT FACILITY (CIF)

Overview

The Central Instrument Facility (CIF) has played a pivotal role in supporting research activities at Bose Institute, mainly in biological and chemical sciences. Research in science and technology these days depend on sophisticated equipment which has to be operated collectively and not individually. The CIF at Bose Institute fosters an ideal ecosystem for scientists and students to develop skills and implement their ideas through cooperation and with a partnership spirit.

Beginning with a small facility to train postdoctoral fellows in the late '80s, the CIF has grown in size and complexity. The facility provides an opportunity for researchers from this Institute but also from neighboring ones to use not just high-end equipment such as a confocal microscope, NMR and mass spectrometers, but also basic ones such as documentation systems, PCR, and UV-VIS spectrophotometers.

One of the more recent additions in the CIF is the LC/MS/MS system. This system has generated a significant amount of interest among internal as well as external users for proteomic and metabolomic studies. In recent times, Ayush, the Govt of India's organization that deals with Ayurvedic and traditional medicine research, has shown keen interest in using the LC/MS/MS and has started analyzing their samples here.

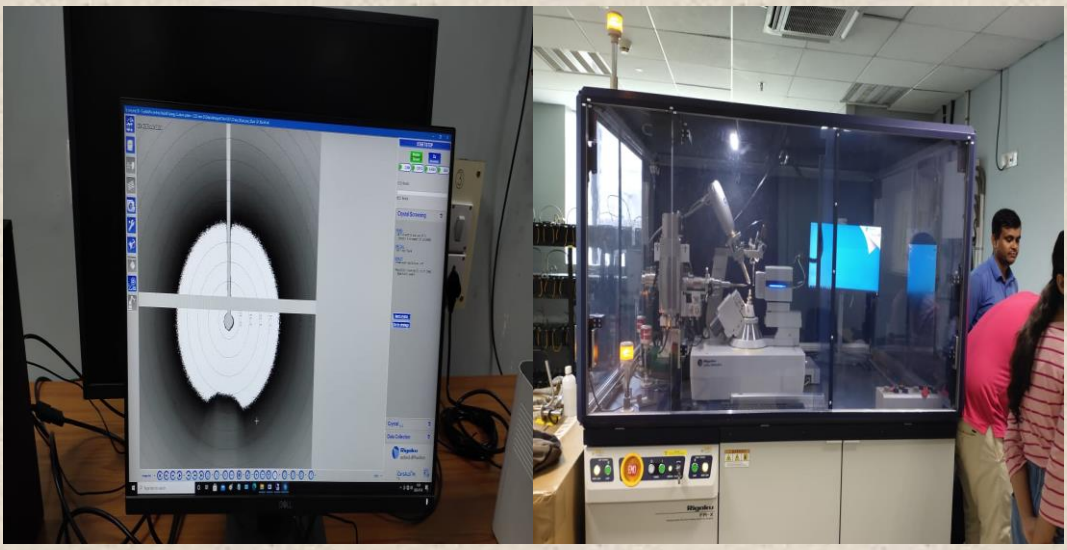


The CIF has also been successful in functionalizing its first NGS platform. A series of novel bacteria and bacterial metagenomes have been sequenced, leading to several important publications in microbiology and geomicrobiology. Apart from this two equipment, the NMR facility has contributed immensely towards the Institute's scientific output. It has been used extensively to design novel peptides with biological activity and understand the structure-function relationship of peptides and proteins.

The herculean task of moving the entire CIF to the new campus has been initiated. We expect to procure more sophisticated equipment to be placed in the CIF labs in the new campus. The list includes an advanced confocal microscope, an X-Ray generator for studying proteins' structure. In the future, CIF in the new campus will also house equipment related to research in physical and environmental sciences. One such example is the state of the art tip-enhanced Raman Spectrometer which is in the process of procurement.

The following instruments were available at CIF:

- FACS
- Confocal Microscope
- DNA Sequencer
- GC-MS
- HPLC



XRD Spectra

- NMR 500Mhz & 700Mhz
- Maldi TOF/TOF
- RT-PCR
- Circular Dichroism spectrophotometer
- Gel Doc, XR+
- Fluorescence spectrophotometer
- SEM
- Liquid Scintillation counter (PerkinElmer)
- FPLC
- Peptide Synthesizer
- AAS
- Single Protein Crystal Diffractometer(XRD)
- SPR

NGS & ACCESSORIES (THERMO FISCHER)

LC-ESI-MS/MS Q-TOF (WATERS)

Management Committee: Prof. Jayanta Mukhopadhyay, In-charge CIF, Dr. Abhijit Chatterjee, Dr. Abhrajyoti Ghosh, Prof. Achintya Singha, Prof. Ajit Bikram Datta, Prof. Anirban Bhunia, Prof. Atin Kumar Mandal, Prof. Kaushik Biswas, Prof. Pallob Kundu, Prof. Shubho Chaudhuri, Prof. Srimonti Sarkar, Prof. Tapan Kumar Dutta, Dr. Zhumur Ghosh, Mrinal Das, Ranjan K. Dutta, Dr. Wriddhiman Ghosh (Convener).

CENTRE FOR TRANSLATIONAL ANIMAL RESEARCH (CENTRAL ANIMAL HOUSE & RESEARCH FACILITY)

Scientist-in-Charge: Prof. Kaushik Biswas.

CPCSEA, Ministry of Environment, Forests & Climate Change, Govt. of India Registration Number: 1796/GO/EReBiBt/S/14/CPCSEA (Education, Research for Educational purpose, breeding in-house and breeding for trading of small animals)

CTAR was inaugurated by Honorable Union Minister, Ministry of Science & Technology & Earth Sciences, Govt. of India, Dr. Harsh Vhardhan on 2nd May, 2015 with sole objective of translating laboratory science in experimental small laboratory animals, for eg. from demonstrating simple biological phenomena in animal system, through studying and identifying functions of unknown genes or gene products targeting a particular disease in a feasible disease model, to identify and characterize bio-active products from natural sources, including but not limited to plant products, or chemicals obtained from synthetic chemical reactions in targeted models using experimental animals.

This is a state of the art translational animal research centre (CTAR) with environmentally controlled "Centralized Animal House" along with all facilities for breeding, maintenance, experimentation on small laboratory animals. This Animal facility is utilized for experimental research in accordance with the principles of good laboratory practices and CPCSEA (Committee for the Purpose of Control and Supervision of Experiments in Animals), Ministry of Environment, Forest & Climate Change, Government of India guidelines. Further, it envisions facilitation of research and development activities in partnership with academic Institutions, Industries and

funding agencies for drug discovery-cum-validation for translational medical research with the sole objective of advancement of biological knowledge which is useful for improving the quality of life and /or alleviating the suffering of human being, animals and plants. The Centre is also involved in skilled manpower development through education and training in laboratory animal care and experimental techniques. The **CTAR** also provides services and resources for investigators to accomplish animal related Bio-medical research activities.

The main objective of the Centre is to supply defined strains of laboratory animals like mice, rats, guinea pigs, hamsters and rabbits for Bio-medical Research to the Scientific Community of Bose Institute and other Institutes of the Eastern and North eastern part of India.

Future Plan of the Centre:

In view of global competitiveness, there is an urgent as well as strong need to synthesise novel molecules which may be considered for IPR protections, provided data on these entities can be generated in specific genetically engineered strains, species and animal models for diseases like Diabetes, Hyperlipidaemia, Immunodeficiency and Cancer, as well as infectious diseases like Malaria and Tuberculosis etc. It becomes crucial for the laboratories to develop facilities where these activities are thoroughly evaluated and labs are able to provide data, which is acceptable to regulatory authorities. Unless we are able to get these opportunities more within the Country, it would be extremely difficult for the Scientists as well as institutions to obtain global marketing rights for drugs**. Hence, it is an utmost need to set up here a state-of-the-art well-equipped transgenic/ knockout/ Xenograft mouse laboratory for the Scientists of Eastern & North Eastern part of India.**

FALTA EXPERIMENTAL FARM

In Charge: Prof. Pallob Kundu

Bose Institute Falta Experimental Farm (FEF) is located in Falta Village, South 24 Parganas, about 80 km away from the Bose Institute Unified Academic Campus. This farm serves as a focal point for Bose Institute outreach activities, where we conduct rural biotechnology research and training programs. Additionally, we cultivate various crops throughout the year using proper planning, dedicated efforts, and scientific methods, resulting in the production of high-quality and hygienic crops annually. Student groups from different schools and colleges visit the farm to learn about its activities. Furthermore, the farm is used for internal meetings, brainstorming sessions, and scientific retreats.

This year following school and college groups have visited the farm.

(1) Jadabbati Mahakali Pathsala Free Primary School, Jaddabati, South 24 Parganas on 13th December 2023.

(2) Benapur Abaitanik Prathamik Vidyalaya, Benapur, South 24 Parganas on 13th December 2023.

(3) Diamond Habour Kishalay Nursery & K.G. School, Diamond Harbour, South 24 Parganas on 13th December 2023.

School visit of Falta Experimental Farm

J. C. BOSE CENTRE
(PUBLICATION AND MUSEUM)

J C Bose Centre comprises the Museum dedicated to J.C. Bose and the Publication unit. The museum is a special attraction in the Main Campus. It nestles a permanent exhibition on the life, research contributions and works of Acharya Jagadis Chandra Bose. Presently the Museum is a repository of the significant scientific instruments designed by J.C. Bose, commemorative items, and rare and significant archival documents. Guided tours are conducted on special occasions for group visits of school/college/university students. New acquisitions from various Libraries, Institutes and other Museums from both India and abroad are undertaken every year. The Museum takes part in different National-level Science Fairs and Exhibitions. Detailed information on J.C. Bose is available in the archives which are helpful for researchers/professionals for any sort of academic work in this field. A large number of original Laboratory/College notebooks have been digitized and kept on display during important occasions. Further development of our museum is under progress.

Paticipation in Science Exhibition/Fairs:

1. Bose Institute participated in the 26th National Exhibition organized by the Central Calcutta Science and Culture Organisation for Youth from 24th to 27th August 2023 at Central Park Maidan, Salt Lake, Kolkata. The theme was "Contribution to make an advanced, powerful and great India".

2. Bose Institute participated in the **46th International Kolkata Book Fair 2023** held in 31.01.23 to 12.02.23 at Central Park, Salt Lake City, Kolkata.

Since its inception in 1980, the Publication Section has been entrusted with the responsibilty of bringing out publications of Bose Institute on a regular basis. The Annual Report (both English & Hindi Versions) and Bose Institute Newsletter (BI News) are published each year. Posters, pamphlets are regularly published as per the requisition during different Symposia, Seminars and Training Programmes. The following publications are presently available for sale : J. C. Bose and Microwaves – A Collection Rs.200.00; Science and Society – Reflections Rs.1050.00; Acharya J.C. Bose -A Scientist and A Dreamer – Vol. 1 Rs.1250.00; Vol. II Rs.1250.00; Vol. III Rs.600.00; Vol. IV 1500.00 ; Vol. V Rs.550.00; Patrabali (Bengali) Rs.350.00; Acharya Jagadis Chandra Bose (Bengali) Rs.12.00; Abyakta (Bengali book written by Sir J.C. Bose) Rs.80.00; Acharya Jagadis Chandra Bose (Bengali Combined) Rs.325.00; BoseInstitute-Myself & Ribosome Rs. 200.00; In the Realm of Bose (the diary of a teenager's brief sojourn at Bose Institute) Rs. 180.00; An Appraisal of J. C. Bose – In the context of Sociology of Science Rs. 350.00; Nivedita Commemoration Volume Rs. 500.00; D.M. Bose-A Scientist Incognito Rs. 350.00; Basu Vigyan Mandir –O-Amar Karmojibon Rs. 200.00.

BOSE INSTITUTE LIBRARY

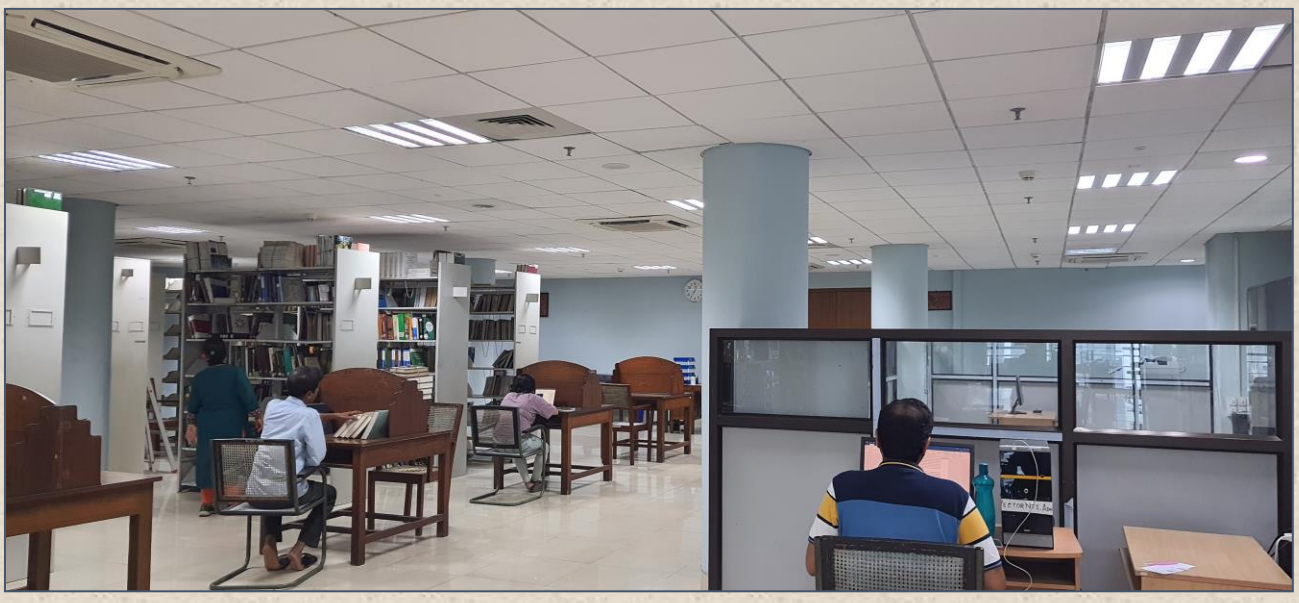
The Institute Library system is one of the best 'Science Reference Libraries in Eastern India, set up on the main campus in 1917 by Acharya Jagadish Chandra Bose, and a wing at the 'Centenary Building' was opened in 1983. In the year 2007, a small library was set up in the Salt Lake Campus of the Institute. In 2021, the library started functioning in its new building, Unified Academic Campus, Saltlake, Kolkata. The library provides the latest information to the BI faculty, researchers, staff members, and students of the Integrated M.Sc.-Ph.D. program. The library extends its physical Library facilities as well as online resources access to other Institutions /Universities /R&D

organizations in and around Kolkata. The library also regularly provides document delivery services and other services to Faculty/researchers/students of the institute as well as faculty/scholars/researchers of DST and CSIR Institutes in India as a mandate of National Knowledge Resource Consortia (NKRC), Govt of India. The library aims to reach the informational and educational needs of its user community by providing pinpointed relevant personalized information services. Total 21nos. of thesis added during the year.

Library has joined with the National Knowledge Resource Consortia (NKRC) since 2008 which is joint consortia of CSIR and DST Institutes for accessing more than 5000+ online journal packages. Through this consortium faculty members/scholars of this institute can access more than 5000+ online resources, SCIFINDER of ACS, Web of Science, Patent databases, etc.

Library Collection:

- Books
- Bound Volumes of Journals
- Theses
- Online journals through National Knowledge Resource Consortia (NKRC)
- Sir J.C. Bose Collection
- Scientific Software(s) and Database(s)
- Reports, Newsletters, Annual Reports of other Institute(s),
- Publication of Bose Institute etc.
- Hindi books
- Books on Bengali literature.



Library Services

I. Bibliographic services.

II. Reprography Services.

III. Lending Services

IV. Inter-Library Loan.

V. Document Delivery Services.

VI. Plagiarism checking software

VII. Tool for Grammar Checking.

VIII. E-resources

IX. Institutional Repository

X. Technical Query Service

XI. Bibliographic & Full-text Search Services

XII. Software & Database:

Sl. No.	Software(s)	Database(s)
1.	ENDNOTE X8 Multi-User Download-Research Software	SCOPUS the largest abstract and citation database
2.	iThenticate-anti-plagiarism software	Web of Science Core Collection
3.	Grammarly: Free Writing AI Assistance	SciFinder®

MADHYAMGRAM EXPERIMENTAL FARM (MEF)

Madhyamgram Experimental Farm (MEF) is the translational research hub of Bose Institute. Its main componentis the agricultural fields where the plant scientists grow their experimental crops in different seasons for seed multiplication, collection of specific plant parts other than seeds, selfing and to raise selfed seeds, hybridization between desired parents, the study of agro-morphology, etc. The J C Bose Innovation Centre in MEF comprises of Transgenic Plant Research Laboratory and Greenhouses. The Greenhouses are presently fourteen in number, some of which are dedicated to transgenic plant research, while the rest are for routine hardening and transplantation of tissue culture plantlets. The laboratory is a fully equipped one with standard biotechnology and molecular biology research.

The on-going research programmes of the plant scientists of DPB at MEF are as follows:

Prof. Shubho Chaudhuri: Growing of transgenic lines of rice at dedicated green-house (28°C-30°C) in connection to the research programme on "Understanding the regulatory role of rice epigenome during abiotic stress (salinity and cold)".

Prof. Gaurab Gangopadhyay: Prof Gaurab Gangopadhyay has grown different improved sesame genotypes over the last few years in Madhyamgram Experimental Farm. The germplasm of Sesame (INGR22090) has been registered by the Plant Germplasm Registration Committee (PGRC) of the Indian Council of Agricultural Research (ICAR) on 08.07.2022. Presently his group is working on developing sesame with synchrony in pod maturation.

Prof. Pallob Kundu: 'Development of CRISPR/Cas9-based optimized toolkit for gene regulation in tomato' and 'Significance of specific miRNA-mRNA interactions in tomato stress-biology.' We had raised tomato Microtom transgenic plants with altered expression of some of the purported disease tolerance genes using the CRISPR/Cas9 technology. We

utilized the Madhyamgram glasshouse for the growth and maintenance of these tomato transgenics till seed setting. Additionally, this multifunctional glasshouse has also helped us effectively grow other varieties of tomatoes, such as Pusa Ruby, and tobacco plants all year round.

Dr. Anupama Ghosh: Deciphering host-defence responses against specific pathogen effectors proteins – *Zea mays* against *Ustilago maydis* causing corn smut disease, and *Oryza sativa* against *Rhizoctoniasolani* causing sheath blight disease of rice.

In Charge: Prof. Shubho Chaudhuri (present Scientist-in-charge)

Notable event

The Botany undergraduate students and their teachers of Shri Shikshayatan College Kolkata made a field trip to the Madhyamgram Experimental Farm of Bose Institute on 01.06.2023. It was in connection with the study of the cultivation processes of cereal, oilseed, and other food crops, along with the related laboratory demonstration under the CBCS syllabus of the University of Calcutta. After attending brief lectures, the students went to the field and observed sesame breeding and selection processes in field conditions. They visited the laboratories and greenhouses of Acharya JC Bose Transgenic Plant Research Laboratory. They also visited the Central Animal House and Research Facility. The students returned with high spirits and ambition for higher studies and research.

SHYAMNAGAR EXPERIMENTAL FARM

Shyamnagar experimental farm is one among the seven campuses of Bose Institute, Kolkata. This campus is located 30 km north from Kolkata and well within the suburban region of the metropolitan city. Prof. D. M. Bose established this campus and dedicated for nurturing the modern science in India. A variety of scientific experiments including microwave scattering, development of gas detectors and monitoring of raindrop size distribution are conducted within this campus. Experiments mainly related to atmospheric sciences are initiated at this campus after successfully achieving the goal of the project "Studies on Microwave Scattering (SMS)" , namely, the detection and imaging of the microwave scattering patterns and radar cross section measurements, sponsored by DRDO, Ministry of Defence, Govt. of India. World-class research & development (R & D) laboratories are presently under constructed within this campus for the development of gas detectors for High Energy physics experiments as well as the development of instruments for atmospheric observations. At present two extramural projects sponsored by CSIR and MoEF respectively, are also running at this campus. The CSIR project is related to the measurement of hygroscopic growth factor of aerosols during fog. The MoEF project corresponds to the measurement of emission factor of Black carbon coming into the atmosphere from biomass burnings. Shyamnagar campus provides a suitable environment of fog occurrence in winter and thereby, becomes the ideal location for these two projects.

WORKSHOP

The Workshop is the nucleus of the maintenance activities including the seven campuses of the Bose Institute. Workshop is situated at Main Campus, Unified Campus and its branches are i) Machine Shop ii) Carpentry section iii) Store iv) Transport & v) Electrical unit at Main Campus and at Centenary Campus. The activities of the said units are as follows.

i) **Machine Shop** – The shop consists of a few nos. of lathe, shaping, drill, grinding machine etc. This shop is actually named as mechanical section because under the umbrella of this section there are some other units like fabrication wing, the wing where the prototype models of the instruments (using which Sir J.C. Bose conducted his various famous experiments) as well as various types of instruments like gradient mixtures, gel tray etc. are being manufactured against the requisitions of internal Scientist and Officers.

ii) **Carpentry Section-** This section deals with all furniture manufacturing, repairing jobs etc. as per the requirements of Scientists, officers etc.

iii) **Store-** Workshop store maintains the materials (civil, electrical, mechanical ,plumbing, building and furniture related materials etc) required for all seven campuses.

iv) **Transport :-** Workshop Superintendent personally deals with the allocation of internal transports as per requirement of Scientists, different internal offices, outside guests etc. Except this outside transports are being utilized as per requirement when internal transports are not affordable.

v) **Electrical Unit:-** This section attains all the electrical related problems specifically of Main Campus, Centenary Campus & Unified Academic Campus. Except the above this unit also deals with the breakdown problems and execution of new project in other campuses.

The remarkable jobs as well as other maintenance job of Workshop in the year 2023-24:-

i) Study & monitoring of all the electrical drawings of Unified Campus including planning for execution of substation etc. are being done to give a proper shape of the electrical system.

ii) Study & day to day monitoring of HVAC & other related issues including various civil part of Unified Academic Campus to ensure that the building should be run smoothly.

iii) Monitoring of the Electrical Installations of the seven campuses.

OUTREACH AND MAN POWER DEVELOPMENT

Bose Institute has been actively involved in promoting the well being of SC/ST/weaker sections, through the Rural Biotechnology / scheduled tribe specific rural biotechnology programs. Using the Falta Experimental Farm as the hub the actual outreach programme was started in 2008. Later a core grant was obtained from the DST for expanding our activities. In this programme Bose Institute has adopted a holistic approach to train tribal people in generating their livelihood. Among several programmes undertaken, notable are, trainings and distribution of units of pisciculture, apiary, mushroom cultivation, vermicompost production, rain water harvesting, kitchen gardening, duck rearing, goat rearing, sericulture. The rural biotechnology program of Bose Institute covered 140 villages spread over 6 districts of West Bengal involving 35 NGOs, 105 trainers. In total as many as 7000 tribal families benefitted from the program, many of them continued developing the unit they had received till 2019, or cessation of the project due to the alteration of DST funding head. The success of the project, as seen by income augmentation, women empowerment and enthusiasm among beneficiaries, prompted us to develop another project for continuation of the outreach activities.

Objectives:

(i) Utilization and further extension of existing network of NGOs for mapping of current livelihoods, natural resources endowment based on secondary data, current needs of target beneficiaries, mapping of technological gaps and needed S&T Interventions.

(ii) Improvement of existing technologies of rain water harvesting, organic farming, kitchen gardening, conservation agriculture etc. and implementation in SC/ST villages for poverty alleviation and better natural resource management.

(iii) Women empowerment and further skill development in plant tissue culture.

(iv) Research targeting encouragement of cultivation of marginal crops for nutritional and livelihood security of the SC/ST community of West Bengal.

Rural Biotechnology programme:

The project entitled "Improvement and broad-scale implementation of different biotechnology-oriented programmes for the socio-economic upliftment of Scheduled Tribes community of West Bengal", PI: Dr. Pallob Kundu; Co-PI: Dr. Gaurab Gangopadhyay; Co-PI: Dr. Shubho Chaudhuri, Division of Plant Biology, funded by the Tribal Sub Plan of DST SEED programme is being implemented. This project will allow us to continue our biotechnology-based outreach activities and bring knowledge of modern agricultural practices to the marginal people of West Bengal.

We have recruited one Project Associate and two Project Assistants through nationwide advertisement and selection. We have also shortlisted candidates for the post of four master trainers for interviewing.

The project review meeting was held on 28th February 2023 at Bose Institute. Several officials from the DST SEED division and external experts were present in this review meeting. The committee assessed the status of the projects being implemented at Bose Institute (BI), the Indian Association for Cultivation of Science (IACS), Ramakrishna Mission Vivekananda Educational and Research Institute (RKMVERI), and interacted with the Central Leather Research Institute (CLRI). In this meeting, Prof. Pallob Kundu presented the progress made in the project work. Prof. Gaurab Gangopadhyay presented his research observations on the sesame crop and explained his plan to encourage sesame cultivation in farmers' fields. Our collaborator Prof. Somnath Bhattacharyya from Bidhan Chandra Krishi Viswavidyaylaya (BCKV), also presented his observations on cultivating multiple lentil varieties. He has also insisted on popularizing lentil cultivation in Scheduled Tribe farmers' fields. The review committee took cognizance of the activities and recommended implementing the proposed studies through NGOs.

Selection of facilitating NGOs: We have screened and shortlisted 110 NGOs from 192 applications. We invited all 110 NGOs to present their proposal and interact with the selection committee. The selection committee meeting in the presence of external experts and DST SEED officials was held from 1st March to 2nd March 2023 at Bose Institute, Unified Academic Campus. Finally, the committee selected 35 NGOs to participate in this project and facilitate the implementation of the project in different villages of West Bengal.

Plan of outreach activities in the near future:

We will continue the proposed works and studies in the new project. Our plan is to involve upto 34 NGOs in the programme, and in collaboration with NATMO, DST and Bidhan Chandra Krishi Viswavidyalaya we will perform an initial survey to understand the current conditions, available resources, current needs of target beneficiaries, technological gaps and needed S&T Interventions. We wish to bring as many as 1000 beneficiaries under the programme and organize 15 training camps on site. Two camps at the Falta Experimental farm to provide training to at least 50 people will also be organized.

STATEMENT OF ACCOUNTS FOR THE YEAR 2023-24

Dr. Archana Sharma, Principal Staff Scientist at CERN, and recipient of the Pravasi Bhartiya Samman (2023) by the President of India, visited Bose Institute and delivered the Bose Institute Colloquium on December 29, 2023.

Research Scholar's Symposium on "Recent Trends in Natural Sciences" organized by Bose Institute from 27-29th November, 2023 as a part of celebration of 75th year of Independence "Azadi ka Amrit Mahotsav".

INDEPENDENT AUDITOR'S REPORT

To the Members of the Council

Qualified Opinion

We have audited the accompanying financial statements of BOSE INSTITUTE (the Institute), which comprise the Balance Sheet at 31s March, 2024, and the Income & Expenditure account, Receipts & Payment Account for the year ended on that date, and notes to the financial statements, including a summary of significant accounting policies and other explanatory information. In our opinion and to the best of our information and according to the explanations given to us, except for the effect of the matter described in the Basis for Qualified Opinion section of our report, the accompanying financial statements give a true and fair view of the financial position of the Institute as at 31stMarch, 2024, and of its financial performance for the year then ended.

Basis for Qualified Opinion

1. The Institute has accounted for expenses on cash basis in the financial statements in few cases which are contradictory to the Schedule 24 clause 4.1 of the "Significant Accounting Policies and Notes to Accounts" as well as the fundamental accounting assumptions as per AS 1, notified by the Institute of Chartered Accountants of India. The total impact is not ascertainable.

2. Refer to in clause 18 of Schedule 24 in Notes to Accounts, Falta land is being inserted in the books of account from the year 2022-23 at a nominal value of Rs. 1/- since the value of the land is not ascertainable. The impact of taking nominal value on future period is not ascertainable at this stage..

   Fixed Assets have not been periodically physically verified. In respect of Equipment under schemes, no register is available. The same is recorded under respective Scheme sub ledger. In view of this it is not possible to opine on correctness or otherwise of fixed assets. No Impairment testing has been performed during the year under audit. Refer point no. 2.7(c) in notes to Accounts.

   Refer Schedule 24 clause 2.2 of Notes on Accounts on Fixed Assets. The Institute has taken up initiatives to prepare a comprehensive Fixed Asset Register. Up to 2019-20 is prepared and work for preparation of Fixed Asset Register for 2020-21

   onwards not taken-up till to the date of our audit, When the Fixed Asset Register will become ready, then the nomenclatures and order mentioned in Schedule 8 (old form schedule 4) will be taken into account.

   Refer Schedule 24 clause 2.4 (c) of the "Significant Accounting Policies and Notes to Accounts" identification of assets, impaired if any, as required in AS – 28 (Ind AS 36) issued by ICAI, has not been done.

3. (Refer Schedule 3 of Balance sheet Liability under "Earmarked /endowment Fund-Development Fund (Planning commission) closing balance as on 31.03.2024 Rs. 85605296.00 and corresponding Assets Schedule 10 "Investment from Earmarked/

Endowment Fund Asset acquired under for development and modernisation fund amounting to Rs. 66657578.15 have been held under "investment and under earmarked fund" and has not been capitalised thereby understating the fixed assets to that extent. Consequent impact on depreciation and current year's profit is not ascertainable.

4. Refer Schedule 3 of Balance sheet Liability under "Earmarked /endowment Fund-Development Fund (Planning commission) closing balance as on 31.03.2024 Rs. 85605296.00 and corresponding Assets Schedule 10 "Investment from Earmarked/ Endowment Fund Asset acquired under for development and modernisation fund amounting to Rs. 66657578.15 have been held under "investment and under earmarked fund" and has not been capitalised thereby understating the fixed assets to that extent. Consequent impact on depreciation and current year's profit is not ascertainable.

5. Capital WIP to the tune of Rs. 364162.00 represents Import of equipment which has no movement since long. Current status of work and consequential impact on the books of accounts is not ascertainable. (Refer Schedule 8C of Financial Statements – Capital W.I.P).

6. Refer Schedule 24 clause 4.2 of the "Significant Accounting Policies and Notes to Accounts" Consumable stores are charged to expenditure after purchase. No stock record is maintained by the Institute

7. The unidentified receipt under the head 'Grant in aid unallocated' amounting to Rs. 518404.00(Cr.)shown in B.R.S and Rs. 1198440/- shown in the ledger account, Bank suspense amounting to Rs. 17085.22 (Cr.) and Stale Cheque amounting Rs. 301629.00 (Cr.) have been appearing since long and the consequential impact on the books of account is not ascertainable.

8. Liability towards gratuity and leave encashment is not ascertainable as no actuarial valuation was undertaken, and the same are accounted on cash basis contrary to requirements of AS-15 notified by the Institute of Chartered Accountants of India. The impact on current year Financial Statement is not ascertained.

9. Interest earned by RITES from the fund received from Bose Institute amounting to Rs. 34263787/- taken into accounts by RITES as funds received from Bose Institute but the same has not been accounted for in Bose Institute Accounts. As a result, both the income and fund position has been understated to that extent.

   In this respect it is also noted that T.D.S. on interest deducted by Bank should also be the part of Bose Institute income. Whether the above amount is income is inclusive of T.D.S. or not is not confirmed.

10. Mobilisation Advance (Fund with RITES) of Rs. 7,88,91,868.00 lying unadjusted since 31.03.2021. This is the balance amount lying with RITES. The account has not yet been finalized with RITES. There are some differences in figures shown by RITES as expenses incurred and the amount capitalized by Bose Institute. Total Expenses shown by RITES is Rs. 1787781861.07 whereas the amount capitalized by Bose Institute is Rs. 1666508132.49. The difference amount of Rs. 121273728.58 has not yet been capitalized. Refer clause 15 of Schedule – 24 – Notes on Accounts.

The details are as follows:.

Particulars	Capitalised By Bose Institute	Expenses Incurred by RITES	Difference
ITD Comenation India Ltd.	1320386614.49	1336728774.00	16342159.51
Unique Engineers Pvt. Ltd.	231580966.00	229679699.00	-1901267.00
Hitech Erectors Pvt. Ltd.	93918218.00	98762436.00	4844218.00
Satelite Electronics	20622334.00	20423773.00	-198561.00
RITES Fees	0.00	98120452.86	98120452.86
Other Expenses	0.00	4066726.21	4066726.21
Total	**1666508132.49**	**1787781861.07**	**121273728.58**

11. Refund claim against Service Tax for construction of Unified Campus amounting to Rs. 20283385/- has been claimed on 27.03.2017 but not yet been settled.

12. In respect GST Input Tax Credit (ITC) we observed that Bose Institute erroneously availed and utilized ITC credit amounting to Rs. 34498 for the Financial Year 2023-24 and Rs. 104874/- for the Financial Year 2022-23.

13. In respect of GST TDS we observed that GST TDS deducted during the Financial Year 2023-24 Rs. 715877/- whereas payment made Rs. 707815/-. Difference of Rs. 8062/- for the current financial year not yet deposited.

We conducted our audit in accordance with the Standards on Auditing (SAs) issued by ICAI. Our responsibilities under those standards are further described in the Auditor's Responsibilities for the Audit of the Financial Statements section of our report. We are independent of the Institute in accordance with the ethical requirements that are relevant to our audit of the financial statements in India, and we have fulfilled our other ethical responsibilities in accordance with these requirements. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our qualified opinion.

Emphasis of Matter

We draw attention to the following matters:

14. As per Schedule 24 Clause 16 of Notes on Accounts on Implementation of 7th Central Pay Commission recommendations at Bose, a due drawn statement has been prepared up to April 2020 as follows:

SI No.	Particulars	Updated up to	Quantum of excess amount paid (Rs.)
1	Existing employees (137 Nos.)	Apr, 2020	13,46,61,260.00
2	Pensioners / Family pensioners (153 Nos.)	Aug, 2020	21,31,39,077.00
	Total		34,78,00,447.00

The detailed calculation is submitted to DST for its necessary action for placing the same to Ministry of Finance for waiver of recovery of the excess payments as mentioned above and the matter is pending till date.

15. Refer Schedule 24 clause 14 of Notes on Accounts on Long Un-Reconciled Balance. There are un-reconciled balances appearing in books of account. The total impact is not ascertainable. Details are as follows:

Head of Account	Amount (Rs)	Remarks
Bank Suspense	46029.90/-	Lying unadjusted prior to 2012-13
Adhoc Advances	5000/-	No details available
Festival Advance	64010/-	Lying unadjusted since 07.09.2015. Employee wise details not available.
TA Advance	118000/-	Outstanding since 03.01.2018 against Mr. Sanat Kumar Das
Imprest Advance	15000/-	Outstanding since 30.05.2012 against Mr. Sujoy Dasgupta
Loan To GPF	3057657/-	2016-17 Rs. 1110000/- 2019-20 Rs. 1947657/-
Medical Advance	21000/-	Outstanding since 2010. No details available.
Party Advance (EPF)	156500/- (Cr)	Deducted from M/S A.G. Enterprise during 2016-17 due to the fact that they did not deposit P.F. of their casual employees but the same has not been adjusted till date.
Staff Welfare Advance	7500/- (Cr)	Excess deducted from Festival Advance during 2015-16 but not yet adjusted. Employee wise details not available.
Loan to CPF	750000/-	Paid to Mr. Ajoy Singh on 31.03.2020 wrongly from council Bank Account instead of CPF Bank Account.
Receivable from Co-Operative	18000/-	Outstanding from 30.06.2018
Co-Operative Account	20414/-	Unadjusted since 2021-22.
Adjustable Security Deposit	10000/-	Unadjusted since2009-10.

Advance Labour Welfare Cess	76901/-	Unadjusted since 2016-17. Corresponding Liability in Labour Welfare Cess Account Rs. 254869/- lying unadjusted since 2020-21
AECD Fund with SBI	6213/-	Lying unadjusted since long. No details available
Group Insurance Account	81422/-	Unadjusted since 2018-19
Receivable from Employees	728608/-	Old outstanding unadjusted for a long period of time. The impact on current year Financial Statement is not ascertained.
Receivable from Party	78877/-	Party wise and age wise list as on 31.03.2024 not provided to us. The impact on current year Financial Statement is not ascertained.
Platinum Jubilee Committee	28411/-	Unadjusted since 2009-10
RSIC Unit	562590/-	Unadjusted since 2009-10
Payable to staff (Dr. D.Home) C.P.F. A/C	202160/-	Unadjusted since 31.03.2019
Receivable from Bose Institute C.P.F. A/C	707074.00 (Dr.)	Unadjusted for a long period of time
Loan liability C.P.F. A/C	109482.00	Unadjusted for a long period of time
G.P.F. (Loans & Advance)	475118/-	Staff wise list not available
IRPHA (A.Lohia)	9910048.67	Excess expenditure on project coming from 01.04.2013 not yet adjusted.
IRPHA (S.Raha)	161089/- 180922/-	Advance & Receivable from Staff Lying unadjusted from 01.04.2014
Payable to Pensioner	62088/-	As explained to us legal heir of the deceased employee not yet attended.
T.D.S pension	16000/-	Unadjusted from 2010
Payable to Lawyear	514/-	Unadjusted for a long period of time
Stale Cheque	10000/-	Unadjusted for a long period of time
Arrear P.Tax	1570/-	Unadjusted for a long period of time

CPF Employee Contribution	91330/-	Unadjusted for a long period of time
CPF Employer Contribution	13810/-	Unadjusted for a long period of time
CPF Voluntary Contribution	1064/-	Unadjusted for a long period of time
Labour Welfare Cess	254869/-	Unadjusted for a long period of time
Party Income Tax (20%)	4290/-	Unadjusted for a long period of time
Payable to CPF	383290/-	Unadjusted for a long period of time
Expert Committee Meeting	10428/- (Dr)	Unadjusted for a long period of time
Party Income Tax	18882/- (Dr)	Unadjusted for a long period of time
Party Income Tax (194J)	174101/- (Dr)	Unadjusted for a long period of time

16. Refer Schedule 24 clause 11 of Notes on Accounts on Contingent Liability, no contingent liability has been ascertained. Though, there are several pending cases against the Institute.
17. Refer Schedule 24 clause 3.2 of Notes on Accounts, the Institute has charged full depreciation for whole year on Written down Value Method as per given rates, irrespective of dates of putting the same to use.
18. Unspent amount is not matching with the Deposits created for such funds as follows:

Name of the Fund	Fund Balance (Rs.)	Deposit (Rs.)
Fund for other Development	90828397.57	73452522.00
Employees Welfare Fund	3466017.31	391407.00
Development Fund – Planning Commission	85605296.00	66657578.17

19. No separate trust has been created in respect of Contributory Provident Fund, General Provident Fund and Employees Pension Fund. Refer clause 6 of Schedule 24 – notes on Accounts.
20. In Assignment of Fund an amount of Rs. 8,00,00,000/- was allotted for the Financial Year 2023-24 as capital fund. Out of that Rs. 3,49,98,774/- was utilized. Balance amount of Rs. 45001226/- was not utilized and the same was refunded.

21. In respect of internal control commensurate in accounts department regarding data entry and privacy of date we are in the opinion that the same needs to be strengthened with respect to the nature and size of the organization.

22. GST Annual Return GSTR 9 and GSTR 9C (reconciliation statement) has not been submitted. This is to be noted that as per section 44 of the CGST Act read with rule 80(1) of CGST Rules Every Registered person other than any department of the Central Government or a State Government or a Local Authority, whose books of account are subject to audit by the C & AG of India or an auditor appointed for auditing of the accounts of local authorities under any law for the time being in force are required to file Annual Return GSTR9 and GSTR 9C. Bose Institute does not fall under above category as the same is an autonomous body and required to file GSTR 9 and GSTR 9C

Our opinion is not modified in respect of these matters.

Key Audit Matters

Key audit matters are those matters that, in our professional judgment, were of most significance in our audit of the Financial Statements of the current period. In this audit we have not determined any specific Key Audit Matter to be addressed separately.

Responsibilities of Management and Those Charged with Governance for the Financial Statements

Management is responsible for the preparation and fair presentation of the financial statements in accordance with the aforesaid Accounting Standards, and for such internal control as management determines is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error. In preparing the financial statements, management is responsible for assessing the Institute ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless management either intends to liquidate the Institute or to cease operations, or has no realistic alternative but to do so. Those charged with governance are responsible for overseeing the Institute financial reporting process.

Auditor's Responsibilities for the Audit of the Financial Statements

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion.

Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with SAs will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

Place: Kolkata
Dated: 03.10.2024
UDIN: 24061616BKFWNR4142

For A.N.Chatterjee & Co.
Chartered Accountants
F.R.N. 302143E
Avijit Auddy
(Partner)
M.No. 061616

BOSE INSTITUTE
BALANCE SHEET AS ON 31ST MARCH 2024

Corpus /Capital fund and liabilities	Schedule	2023-24 (₹)	2022-23 (₹)
Corpus /Capital fund	**1**	1,73,06,52,385.62	3,20,17,89,731.28
Reserves and surplus	**2**	-	-
Earmarked/Endowment funds	**3**	1,32,24,79,746.96	1,18,,23,86,757.99
Secured loans and borrowings	**4**	-	-
Unsecured loans and borrowings	**5**	-	-
Deferred credit liabilities	**6**	-	-
Current liabilities and provisions	**7**	99,99,76,349.25	33,39,85,202.99
Total		**4,05,31,08,481.83**	**4,71,81,61,692.26**
Assets			
Fixed Assets	**8,8A,8B**	2,29,35,01,692.47	2,31,10,86,656.35
Capital Work in Progress	**8C**	11,33,73,227.20	11,55,30,608.20
Investments-others	**9**	42, 36,54,828.72	41,73,24,200.72
Investments -from earmarked/endowment Funds	**10**	14,98,11,186.15	14,47,66,303.18
Current assets, loans, advances etc.	**11**	1,07, 27,67,547.29	1,72, 94,53,923.81
Miscellaneous expenditure (to the extent not written off or adjusted)			
Total		**4,05,31,08,481.83**	**4,71,81,61,692.26**
Significant accounting policies and notes on accounts	**24**		

Place : Kolkata
Date : 03.10.2024
UDIN :24061616BKFWNR4142

Signed in terms of our separate Report of even date.
For A.N. Chatterjee & Co.
Chartered Accountants
Firm Registration No. 302143E
Avijit Auddy
Partner
Membership No. 061616

Sd/-	Sd/-	Sd/-	Sd/-
Shaubhik Ghosh	Kamal Sing	Vikash Kumar	Achintya Mukherjee
UDC	Accountant (Cash)	Audit & Finance Officer	Accounts Officer

Sd/-	Sd/-
Prof. Ajit Bikram Datta	Prof. Kaustuv Sanyal
Registrar(O)	Director

BOSE INSTITUTE
INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31.03.2024

	Schedule	2023-24	2022-23
		₹	₹
INCOME			
Income from Sales and Services	**12**	37,27,270.29	39,50,344.00
Grants/Subsidies	**13**	85,44,03,235.50	55,29,48,166.54
Fees/Subscriptions	**15**	-	-
Income from Investments (Income on Investment, from earmarked /endowment Funds transferred to Funds)	**14**	-	-
Income from royalty, publication etc .	**16**	-	-
Interest Earned	**17**	-	-
Other Income	**18**	13,38,630.87	31,79,435.26
Increase/ (decrease) in stock of Finished goods and work-in-progress	**19**	-	-
Total (A)		85,94,69,136.66	56,00,77,945.80
EXPENDITURE			
Establishment Expenses	**20**	50,55,74,225.00	46,80,93,970.88
Other Administrative Expenses	**21**	29,89,05,540.00	27,26,88,304.09
Expenditure on Grant, Subsidies etc.	**22**	-	-
Interest	**23**	-	-
Fund for capital Expenditure	**23A**	4,86,58,928.75	3,28,04,158.00
Depreciation (Net Total at the year end corresponding to Schedule 8)		-	6,52,87,466.79
Depreciation for UAC	**8A**	-	14,86,02,660.47
Total (B)		85,31,38,693.75	98,87,02,684.22
Balance being excess of Income over Expenditure (A-B)		63,30,442.91	-42,86,24,738.42
Transfer to Special Reserve (Specify each)			
Prior Period Items		-14,65,663.00	
		48,64,779.91	-42,86,24,738.33
Last Year Unspent Balance /overspent balance		**-43,72,04,553.30**	**5,01,16,558.13**
Balance of Unspent Balance After Adjustment		-43,23,39,773.39	-85,79,814.87
		1,32,42,22,316.78	
Depreciation Adjustment		1,32,42,22,316.78	
Amount Surrendered to DST		53,80,74000	
Balance being Surplus/(deficit) carried to corpus/capital fund		**35,38,08,543.39**	**-43,72,04,553.21**
Significant accounting policies and notes on accounts	24		

Place : Kolkata
Date : 03.10.2024
UDIN : 24061616BKFWNR4142

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For A.N. Chatterjee & Co.
Chartered Accountants
Firm Registration No. 302143E

Sd/-
Shaubhik Ghosh
UDC

Sd/-
Kamal Sing
Accountant (Cash)

Sd/-
Vikash Kumar
Audit & Finance Officer

Sd/-
Achintya Mukherjee
Accounts Officer

Sd/-
Prof. Ajit Bikram Datta
Registrar(O)

Sd/-
Prof. Kaustuv Sanyal
Director

BOSE INSTITUTE
RECEIPTS & PAYMENT ACCOUNTS FOR YEAR ENDED 31ST MARCH 2024 (COUNCIL A/C)

Receipts	Sch. No.	Amount (Rs.)	Payments	Sch. No.	Amount (Rs.)
Opening Balance	1	1,04,57,34,387.09	Overtime		3,229.00
Receipt against Establishment Expenses	2	13,06,085.00	Prior Period Items		2,44,700.00
Receipt against Laboratory Expenses	3	89,58,004.00	Establishment Expenses	2	50,27,04,204.00
Receipt Against Other Administrative Expenses	4	34,50,170.00	Laboratory Expenses	3	12,01,56,409.92
Receipt from Indirect Income	9	1,68,71,523.29	Other Adminstrative Expenses	4	19,49,40,033.56
Receipt from Grant in Aids form Scheme	9	90,00,00,000.00			
Receipt from other Assets	10	13,69,600.00	Payment for Indirect (Other) income	9	33,803.00
			Grant in Aid	9	4,55,96,764.50
Receipts from Current Assets	8	2,71,15,300.25	Payments for Fixed (Other)Assets	10	3,40,40,934.75
			Payments for the current assets	8	2,33,57,809.00
Receipts from Statutory Liabilities	7	10,45,89,579.71	Payment for Statutory Liabilities	7	10,30,36,953.00
Receipts from Current Liabilities & Other Liabilities (except Statutory Liabilities)	5&6	1,26,12,016.00	Payment for Current Liabilties & other Liabilities (except Statutory Liabilities)	5&6	1,12,90,174.00
			Intellectual Property Development Fund		-
Employees General Provident Fund		-	**Inter Unit Account**		
			FAIR		
			Scheme/Project Grant-in-aid		-
Inter Unit Account			Scheme/Project		78,22,20,017.00
FAIR		23,55,450.00	ST-Rural		-
Scheme/Project Grant-in-aid		-	Governing Body		5,900.00
Scheme/Project		1,72,931.00			
ST-Rural		-	Closing Balance	1	30,69,04,114.61
		2,12,45,35,046.34			2,12,45,35,046.34

Place : Kolkata
Date : 03.10.2024
UDIN : 24061616BKFWNR4142

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Firm Registration No. 302143E

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Sd/-
Achintya Mukherjee
Accounts Officer

Sd/-
Prof. Ajit Bikram Datta
Registrar(O)

Sd/-
Prof. Kaustuv Sanyal
Director

BOSE INSTITUTE
RECEIPTS & PAYMENT ACCOUNTS FOR YEAR ENDED 31ST MARCH 2024 (Project)

RECEIPTS	Sch. No.	Amount Rs	PAYMENTS	Sch. No.	Amount Rs
OPENING BALANCE	1	**28,01,35,217.77**			
Receipt from projects	2	11,48,75,208.98	Payment from Projects	2	11,55,19,212.38
Receipt from projects from Adhoc /RA / PDF	3	1,54,59,840.00	Payment from Adhoc/RA/PDF	3	1,50,60,530.12
Receipts from Other Than Scheme / Projects	4	8,76,730.00	Payment for other than Scheme/Project	4	62,50,506.00
Receipts from IFCC (Indo-FAIR Project)		21,32,99,126.00			
			Payment OF IFCC (Indo-FAIR Project)		30,53,89,604.30
Receipts from St Rural		11,58,97,444.00	Payment of ST-Rural		11,59,00,070.80
Receivable From Scholars'		-	Receivable From Scholars'		-
Branch/Inter Unit					
Bose Institute		87,90,69,035.00	**Branch/Inter Unit**		
			Bose Institute		65,81,63,134.04
Margin cum FD		8,84,61,587.00			
			Margin cum FD		-
			CLOSING BALANCE	1	49,17,91,131.11
		1,70,80,74,188.75			**1,70,80,74,188.75**

Place : Kolkata
Date : 03.10.2024
UDIN :24061616BKFWNR4142

Signed in terms of our separate Report of even date.
For A.N. Chatterjee & Co.
Chartered Accountants
Firm Registration No. 302143E
Avijit Auddy
Partner
Membership No. 061616

Sd/-	Sd/-	Sd/-	Sd/-
Shaubhik Ghosh	Kamal Sing	Vikash Kumar	Achintya Mukherjee
UDC	Accountant (Cash)	Audit & Finance Officer	Accounts Officer

BOSE INSTITUTE
Bose Institute Employees' Pension Fund
Balance Sheet as at 31 March 2024

In ₹ (Rupees)

	Particulars	Schedule No	as at 31-March-2024	as at 31-March-2023
I.	**Capital Fund**	1	**17,15,39,096.05**	**16,08,51,099.05**
	Current Liabilities and Provision	2	**5,27,46,377.00**	**4,63,78,446.00**
	Total		**22,42,85,473.05**	**20,72,29,545.05**
II.	**ASSETS**			
1	**Other Current Assets**	3	**16,000.00**	**(31,360.00)**
	Bank Balance and Fixed Deposits	4	**22,4269,473.05**	**20,72,60,945.05**
	Total		**22,42,85,473.05**	**20,72,29,545.05**

Place : Kolkata
Date : 03.10.2024
UDIN :24061616BKFWNR4142

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For A.N. Chatterjee & Co.
Chartered Accountants
Firm Registration No. 302143E
Avijit Auddy
Partner
Membership No. 061616

Sd/-
Shaubhik Ghosh
UDC

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Vikash Kumar
Audit & Finance Officer

Sd/-
Achintya Mukherjee
Accounts Officer

Sd/-
Prof. Ajit Bikram Datta
Registrar(O)

Sd/-
Prof. Kaustuv Sanyal
Director

BOSE INSTITUTE
Bose Institute Employees' Pension Fund
Statement of Income & Expenditure
for the year ended 31-March-2024

In ₹ (Rupees)

	Particulars	Schedule No	1-April-2023 to 31-March-2024	1-April-2022 to 31-March-2023
I	**Revenue from Operations**		-	-
II	**Other Income**		**1,06,87,997.00**	**9,72,80,688.00**
III	**TOTAL REVENUE (I + II)**	5	**1,06,87,997.00**	**9,72,80,688.00**
IV	**EXPENSES**			
	Other Expenses	6	-	8,27,16,015.00
	TOTAL EXPENSES		-	**8,27,16,015.00**
V	Profit before Exceptional and Extraordinary Items and Tax (III-IV)		**1,06,87,997.00**	**1,45,64,673.00**
VI	Exceptional Items		-	-
VII	**Profit before Extraordinary Items and Tax**		**1,06,87,997.00**	**1,45,64,673.00**
VIII	Extraordinary Items		-	-
IX	**Profit Before Tax**		**1,06,87,997.00**	**1,45,64,673.00**
X	**Tax Expense**		-	-
	Current Tax		-	-
	Deferred Tax		-	-
XI	**Profit/(Loss) for the period from Continuing Operations(IX-X)**		**1,06,87,997.00**	**1,45,64,673.00**
XII	Profit/(Loss) from Discontinuing Operations		-	-
XIII	Tax Expense of Discontinuing Operations		-	-
XIV	**Profit/(Loss) from Discontinuing Operations (after tax)(XII-XIII)**		-	-
XV	**Profit(Loss) for the Period (XI+XIV)**		**1,06,87,997.00**	**1,45,64,673.00**

Place : Kolkata
Date : 03.10.2024
UDIN :24061616BKFWNR4142

Signed in terms of our separate Report of even date.
For A.N. Chatterjee & Co.
Chartered Accountants
Firm Registration No. 302143E
Avijit Auddy
Partner
Membership No. 061616

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Achintya Mukherjee
Accounts Officer

Sd/-
Prof. Ajit Bikram Datta
Registrar(O)

Sd/-
Prof. Kaustuv Sanyal
Director

BOSE INSTITUTE
Bose Institute Employees' General Provident Fund
Balance Sheet as at 31 March 2024

In ₹ (Rupees)

	Particulars	Schedule No	as at 31-Mar-2024	as at 31-Mar-2023
I.	Capital Fund	**1.00**	**16,21,74,702.06**	**17,29,58,605.06**
	Current Liabilities and Provision	2.00	**3,71,88,611.94**	**3,71,30,008.94**
	Total		**19,93,63,314.00**	**21,00,88,614.00**
II.	**ASSETS**			
1	Other Current Assets	3	**1,48,35,847.00**	**1,38,39,411.00**
	Bank Balance and Fixed Deposits	4	**18,45,27,467.00**	**19,62,49,203.00**
	Total		**19,93,63,314.00**	**21,00,88,614.00**

Place : Kolkata
Date : 03.10.2024
UDIN :24061616BKFWNR4142

Signed in terms of our separate Report of even date.
For A.N. Chatterjee & Co.
Chartered Accountants
Firm Registration No. 302143E
Avijit Auddy
Partner
Membership No. 061616

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UDC

Sd/-
Vikash Kumar
Audit & Finance Officer

Sd/-
Achintya Mukherjee
Accounts Officer

Sd/-
Prof. Ajit Bikram Datta
Registrar(O)

Sd/-
Prof. Kaustuv Sanyal
Director

BOSE INSTITUTE
Bose Institute Employees' General Provident Fund
Statement of Income & Expenditure
for the year ended 31-March-2024

In ₹ (Rupees)

	Particulars	Note No.	1-Apr-2023 to 31-Mar-2024	1-Apr-2022 to 31-Mar-2023
I	Revenue from Operations		-	-
II	Other Income		1,19,14,988.00	1,14,72,456.00
III	TOTAL REVENUE (I + II)		1,19,14,988.00	
IV	EXPENSES			
	Other Expenses		1,18,56,385.00	1,10,71,086.00
	TOTAL EXPENSES		-	
V	Profit before Exceptional and Extraordinary Items and Tax (III-IV)		58,603.00	4,01,370.00
VI	Exceptional Items		-	-
VII	Profit before Extraordinary Items and Tax		58,603.00	4,01,370.00
VIII	Extraordinary Items		-	-
IX	Profit Before Tax		58,603.00	4,01,370.00
X	Tax Expense		-	-
	Current Tax		-	-
	Deferred Tax		-	-
XI	Profit/(Loss) for the period from Continuing Operations(IX-X)		58,603.00	4,01,370.00
XII	Previous Year Excess of Income over Expenditure		2,19,02,522.94	2,15,01,152.94
XIII	Tax Expense of Discontinuing Operations		-	-
XIV	Profit/(Loss) from Discontinuing Operations (after tax)(XII-XIII)		-	-
XV	Profit (Loss) for the Period (XI+XIV)		2,19,61,125.94	2,19,02,522.94

Place : Kolkata
Date : 03.10.2024
UDIN :24061616BKFWNR4142

Signed in terms of our separate Report of even date.
For A.N. Chatterjee & Co.
Chartered Accountants
Firm Registration No. 302143E
Avijit Auddy
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Registrar(O)

Sd/-
Prof. Kaustuv Sanyal
Director

SIGNIFICANT ACCOUNTING POLICIES & NOTES TO ACCOUNTS

Schedule 24

1.0 Change in Accounting Policy:

The Statement of Accounts has been drawn in the specified form applicable to Central Autonomous Bodies (NPOs) and Similar Institutions from the Financial Year 2013-14. To adopt the changes some account heads are clubbed or splitted and represented differently to suit the requirements of new format. The Balance Sheet has been drawn by consolidating statement of accounts of Council and the Governing Body with schedules thereon without incorporating the consolidated transactions in the Income and Expenditure Account. Further, the transactions of the Governing Body have not been incorporated in the books of Council. This principle of accounting has been consistently followed from year to year. In case of Governing Body, Pension Fund and Indo FAIR Coordination Centre, since no format was prescribed for Annual Accounts, they are maintained in the same format as before. The accompanying financial statements have been prepared on historical cost convention and conform to the fundamental accounting assumptions.

2.0 Fixed Assets:

2. 1 Land at Madhyamgram

The Institute got possession of 18.73 acres out of 40.99 acres land allotted for Experimental Farm by Govt. of West Bengal. The Governing Body of the Institute decided on 31.07.1989 not to claim the balance land in dispute from the Government considering other related factors.

2.2 Fixed Asset Register

The Institute has taken up initiatives to prepare a comprehensive Fixed Asset Register and Fixed Asset Register up to 2019-20 is completed and for 2020-21 to 2023-24 is underway. This initiative will also cover the assets acquired in the year 1991-92 from “Institute Development and Modernisation Fund” (provided by Planning Commission). When the Fixed Asset Register will become ready, then the nomenclatures and order mentioned in Schedule 8 (old form schedule 4) will be taken into account.

2.3 Work-in-Progress

The particulars of fixed assets which are under construction/installed are shown in Schedule 8 as WIP (old form schedule 4).

2. 4 Valuation of assets

a. The valuation of Fixed Assets has been made at cost less depreciation for the years 1990-91 till date.

b. The assets related to terminated projects have been identified up to 2005-06. Further identification of the assets relating to the years 2006-07 to 2022-24 is in progress and will be included in the Fixed Asset Register.

c. The identification of assets, impaired if any, as required in AS-28 (Ind AS 36) issued by ICAI, has not been done.

3.0 Depreciation:

3.1 As per the approval of the Finance Committee of the Institute, the Accumulated depreciation of Rs. 132,42,22,316.78 during the period of financial year 2013-14 to 2022-23 has been charged to Capital Fund to depict to Actual Assets and fund position.

3.2 The depreciation is calculated on Written Down Value Method as per the following rates irrespective of dates of putting the same in use:

i. Building – 10%
ii. Equipment – 15%
iii. Books & Journals – 10%
iv. Furniture – 10%
v. Vehicles – 15%
vi. Air Conditioner – 10%
vii. Electric Installation – 10%
viii. Computer & Internet Peripherals – 60%

3.3 Depreciation is not provided for on the assets of Governing Body and ST Specific Rural Biotechnology Programme, as these are not part of BI Council.

4.0 Revenue Recognition & Grant in Aid:

4.1 During financial year 2023-24, Grant-in-Aid for Council has been received under the head General, Salaries and Capital in the form of Assignments and not in the physical form. Grant-in-Aid under General and Salaries have been treated as revenue grant. All incomes and expenses other than Government Grant and Bank Interest are accounted for on cash basis.

4.2 Consumable Stores are charged to expenditure after purchases.

4.3 EMR Grants received during the financial year are shown in the Income & Expenditure Account and surplus/deficit during the current financial year is reflected in the Balance Sheet.

4.4 Bose Institute has adopted a policy to create a provision for interest earned on Govt. Grant-in-Aid/EMR Projects during the financial year. This amount will be deposited/surrendered through “Bharatkosh” to Government of India.

5.0 Retirement/Post Retirement and Staff Benefits:

5.1 The interest on loans, being recoverable after realisation of principal amount is accounted for as and when it becomes receivable and the said interest is credited to the House Building Advance Fund. This is done as per Central Govt. Guidelines.

5.2 The Institute has General Provident Fund, Contributory Provident Fund and Pension Fund.

5.3 All the terminal benefits of the staffs during the year are accounted on cash basis.

6.0 System of Fund Accounts

6.1 The suggestion of Jt. Secretary and F.A. Dept. of Science and Technology, Govt. of India in the Finance Committee meeting held on 24.09.1996 for managing the Provident Fund through Trust Committee is yet to be implemented.

6.2 Although by virtue of the provision 9 of the Bose Institute Employees Pension Scheme Regulations approved by the Dept. of Science and Technology, Govt. of India and Rule 3.3 of the Bose Institute Contributory Provident Fund Rules, the Pension Fund, General Provident Fund and Contributory Provident Fund vest with the Bose Institute, separate Statement of Account with Income and Expenditure Account & Balance Sheet in respect of GPF and CPF are maintained in New prescribed format.

7.0 Earmarked Funds:

Earmarked Funds shall be treated as a liability on their creation.

Income on investments out of Earmarked Fund is recognised and credited to Earmarked Fund wherever accrued. Any expenditure of a revenue nature which is incurred specifically on selected Scheme/Project is charged to the relevant Earmarked Fund.

8.0 Foreign Currency Transactions:

Transactions in foreign currency are recorded at the exchange rate applicable on the date of transaction.

9.0 Research and Development Costs:

Research and Development costs are charged to the Income & Expenditure Account for the year in which these are incurred.

10.0 Advances:

A sum is included under "Advance Council" is shown in the Balance Sheet under the head Advances (Schedule-11) which include a sum of pending recovery/adjustment prior to 2019-20 amounting to Rs. 3,40,914.00.

11.0 Contingent Liability:

Legal expenses include the cost to defend the court cases lodged against the Institute; contingent liability for such cases is not ascertained.

12.0 Previous year's Figures:

The previous year's figures have been re-grouped and re-arranged in conformity with the figures of current year.

13.0 General Provident Fund:

GPF figures have been reconciled and properly incorporated in accounts.

14.0 Long Un-Reconciled Balance:

There are some old un-reconciled balances before introduction of computerized accounting in the year 2010-11. The same is under re-conciliation.

15.0 Capitalisation of Assets of Unified Academic Campus of Bose Institute:

Bose Institute has constructed its Unified Academic campus (UAC) at Plot No. 80, Block EN, Sector V, Salt Lake City, Kolkata 700091. M/s. DCPL was appointed as the architect of the

project. Underground piling work has been completed by M/s. Macintosh & Burn Limited. M/s RITES Limited was engaged as Project Management Consultant (PMC). They have supervised the entire construction work and had appointed various contractors for entire construction package wise. The construction costs arrived at are as follows as per the certification of M/s. RITES Limited:

Sl. No.	Contractor	Package Description	Actual Completion Cost (Rs.)
1.	M/s. ITD Cementation	Construction of Superstructure (G+15) for UAC.	132,03,86,614.49 (excluding GST)
2.	M/s. Hitech Erectors	Supply, Installation, Testing and Commissioning of External Power Distribution system for UAC.	9,39,18,218.00
3.	M/s. Unique Engineers	Supply, Installation, Testing and Commissioning of centralised HVAC, Mechanical Ventilation & VRV System at UAC.	23,15,80,966.00
4.	M/s. Satellite Electronics	Modelling of Auditorium Interior Design for Construction of UAC.	2,06,22,334.00

Above packages are completed at different dates, but Bose Institute has received the Completion Certificate and hand over during 2019-2020 financial year and due to non availability of various information capitalisation work can't be done. Since handover is taken by Bose Institute and occupancy has been started, it is required to be taken in the books of accounts at as per prudent accounting policy and applicable accounting standards.

The capitalisation is done only for accounting propose at the given completion cost by PMC, M/s. RITES Limited and the same will be subject to various audit and will be revised accordingly and will have no connection with the giving recognition of the costs given by PMC. Some final payments are yet to be made after settlement of Final Bill and completion of Defect Liability Period (DLP) and the construction costs will also be revised accordingly. Further As per AS 10 & Ind AS16 the other associated costs in connections with the construction (like preparation of project reports, site plan, fees paid to various bodies in connection with the land and construction, fees of architect etc.) will be suitably attributable with the construction cost of different packages.

Finally the completion costs given by M/s. RITES limited are taken into account to reflect the True and Fair view of the Accounting Statements prepared by Bose Institute which may revise in future due to Audit and inclusion of direct and indirect attributable costs in connection with the construction of UAC.

16.0 Implementation of 7th Central Pay Commission recommendations at Bose Institute

The Department of Science & Technology (DST), conveyed the report of Group of Officers (GoO) vide its letter no. No. AI/1/40/BI/2019, dated: 16th Oct 2019 with a observation that Bose Institute was following time scale promotion for its Non-Academic employees (both technical and administrative) on the basis of BI OM No. R/82/08/1699, dated: 08.04.2008 & R/82/08/1799, dated: 15.04.2008, which is more beneficial as compared to the corresponding categories of the Central Government employees. They recommended that the

above BI OMs No. R/82/08/1699, dated: 08.04.2008 & R/82/08/1799, dated: 15.04.2008, "were illegal, arbitrary and without approval of the competent authority and hence shall be made null and void."

The committee also recommended that "grant of higher pay scales, above the norms of the Government of India, in respect of those categories of employees will be put on hold till such time the issue is examined and decision is taken by the competent authority" (Para 3 (ii). Further it was recommended to prepare a "due drawn statement in respect of all the employees, for the period 22.12.2005 onwards till the date of withdrawal of the effect of BI OMs dated 08.04.2008 & 15.04.2008 shall be prepared within two months time, and the quantum of recovery shall be calculated in respect of each employees/retirees/personnel died in harness. While preparing the due drawn statement, the excess payment made on account of disbursement of pension and pensionary benefits in respect of retired employees/died in harness employees shall also be taken into account. Settled TA cases and LTC cases shall not be reopened. However, excess leave encashment payments shall be brought out separately for appropriate direction of M/o Finance."

After a detailed calculation as per the guidelines given by GoO in its report the final due drawn statement has been prepared up to April 2020 and depicted in the following table:

Sl No.	Particulars	Updated up to	Quantum of excess amount paid (Rs.)
1	Existing employees (137 Nos.)	Apr, 2020	13,46,61,260.00
2	Pensioners/Family pensioners (153 nos.)	Aug, 2020	21,31,39,077.00
	Total		34,78,00,447.00

The detailed calculation is submitted to DST for its necessary action for placing the same to Ministry of Finance for waiver of recovery of the excess payments as mentioned above and the matter is pending till date. From the month of May 2020 the salary of 137 numbers of existing employees has been re-fixed and implemented. The above mentioned amount is subject to verification and audit.

A number of legal court cases were filed against Bose Institute in objection of the above settlement and theses cases are also pending at the courts of law.

17.0 Capitalisation of Assets created under FAIR project at Bose Institute

The facility for Anti-Proton and Ion Research (FAIR) is a global facility being created in Darmstadt, Germany under a multi-country partnership. FAIR project is managed by FAIR company (FAIR GmbH). FAIR will be one of the largest accelerator facilities in the world and also one of the mega science projects recommended by the Steering Committee on Science & Technology set up by the Planning Commission for the 11th Five Year Plan. FAIR project is taken up as part of DAE & DST joint collaboration under a MoU signed between DAE & DST.

A joint declaration was signed on 07.02.2007 by the Minister for Science & Technology and Earth Sciences, Govt. of India and the Federal Minister for Education & Research, Federal Republic of Germany concerning the participation in construction and operation of the international facility for Anti-proton and Ion research. A joint statement was issued by the Chancellor of Republic of Germany and Prime Minister of India on 30.10.2007 in this regard. On 04.10.2010, the international agreement on the construction of FAIR was signed by nine

countries, namely Germany, Finland, France, India, Poland, Romania, Russia, Slovenia and Sweden. Latter on United Kingdom also joined as a partner. India's contribution to the FAIR consortium has been estimated at 42.79 million Euro at July 2010 prices which is equivalent to Rs. 260.00 Crore (Approximately). According to the MoU between DAE & DST, the overall cost of Rs. 260.00 Crore is to be borne equally by DAE & DST. The sanction was subsequently revised vide OM no SR/MF/PF-02/2010(E-6133) dated 08.10.2021 to Rs 615.00 Crore.

Department of Science & Technology (DST), under the Ministry of Science & Technology, Govt. of India vide its Memo No. SR/MF/PS-01/2011 dated 04/03/2011 mentioned under clause 11 that "financial aspect will be issued in due course" but the same has not been received till date. However the present executive council takes both operational and financial decision.

Further, Accounting of FAIR project is unique and it is maintained in the old format as before, without changing in format for Central Autonomous Institutes.

Bose Institute, Kolkata has been designated as the Indian shareholder in the FAIR Company and the Nodal Indian institution for management of the FAIR programme in India. So far, the assets created from Indian participation was not taken under the purview of Bose Institute and was not shown in its Balance Sheet up to F.Y. 2020-21, but now Finance Committee of Bose Institute in its meeting dated 23.11.2021 has directed to show funds received under FAIR project from DST and DAE has to properly accounted for in the financial statements. The asset created under FAIR project should be capitalised first and reflected in Institutes financial Statement and also transfer entry should be made if the assets are transferred to FAIR project. Accordingly now from this year (F.Y. 2021-22) onwards the IN-KIND ITEMS already sent to FAIR Germany till date, have been capitalised and shown in the attached statement under 'Schedule – 4' & 'Schedule – 08 B' of Bose Institute Council Books of Accounts and the balance quantity which is yet to be delivered to FAIR and is under progress is shown as CWIP (Capital Work In Progress).

18.0 Consideration of Falta Land

Value of Falta land has been shown in Annual Accounts of Bose Institute for the financial year 2022-23 Nominal Value at Rs.1.00. MOF Department of Economic Affairs (Budget Division) in their OM vide F.No 1(2)-B(AC)/2017 dated 19th July 2018 mentioned that in the Guidance Note on accounting for Fixed Assets as approved by C&AG will be applicable for better accountability and informed decision making. As per Para 8.2 of Guidance Note "Where Cost of Fixed Assets (including land) is not ascertainable .it should be measured at nominal value of Rs.1.00.

INDEPENDENT AUDITORS REPORT
To the Member of Council

Opinion

We have audited the accompanying financial statement of BOSE INSTITUTE, FAIR PROJECT (entity), which comprises the Balance sheet as at MARCH 31st 2024 & Statement of expenditure for the year ended on that date and notes to the financial statement, including a summary of significant accounting policies and other explanatory information. In our opinion and to the best of our information and according to the explanations given to us, the accompanying financial statement give true and fair view of the financial position of the entity as at march 31st, 2024 and of its financial performance for the year then ended.

Basis for Opinion

We have conducted our audit in accordance with the Standards on Auditing (SAs) issued by the Institute of Chartered Accountants of India (ICAI). Our responsibilities under those standards are further described in the auditor's responsibilities for the audit of the financial statements section of our reports. We are independent of the entity in accordance with the ethical requirement that is relevant to our audit of the financial statement in India. And we have fulfilled our other ethical responsibilities in accordance with these requirements. We believe that audit evidence we obtained is sufficient and appropriate to provide the basis for our opinion.

Emphasis of Matter

1. The FAIR PROJECT has accounted for expenses on cash basis in the financial statements in few cases which are contradictory to the Schedule 24 clause 4.2 of the "Significant Accounting Policies and Notes to Accounts" as well as the fundamental accounting assumptions as per AS 1, notified by the Institute of Chartered Accountants of India. There are many instances where Expenditure related to the FY 2023-24 has not been accounted for, thereby a short booking of Expenditure has been found. Similarly, Expenditure of earlier period was booked in the FY 2023-24. The Prior period Expenditure so booked is found in 12 instances amounting to Rs. 1569739/-.
2. No Fixed Asset register was provided for our verification. No Physical verification of the Assets was done. The Institute has not carried out test of impairment, if any, in accordance with the requirement of AS 28 notified by the Institute of Chartered Accountants of India (ICAI). In view of this it is not possible to opine on correctness or otherwise of fixed assets..
3. Depreciation is not charged on Office Equipment's valued Rs. 98530/- & Rs. 1772547/- which are used in Bose Institute – FAIR PROJECT, results overstatement of Fixed Assets as well as overstatement of Excess of Income over expenditure as at the end of the year.

Our opinion is not modified in respect of these matters.

Key Audit Matters

Key audit matters are those matters that, in our professional judgment, were of most significance in our audit of the Financial Statements of the current period. In this audit we have not determined any specific Key Audit Matter to be addressed separately.

Responsibilities of management and those charged with governance for the financial statement

Management is responsible for the preparation and fair presentation of the financial statement in accordance with the aforesaid accounting standards, and for such internal control as management determines is necessary to enables the preparation of the financial statements that are free from material misstatement, whether due to fraud and error.

In preparing the financial statement management is responsible for assessing the entity's ability to continue as going concern, disclosing as applicable, matters related to going concern and using the going concern basis of accounting unless management either intend to liquidate the entity or to cease the operation, or has no realistic alternative but to do so. Those charged with governance are responsible for overseeing the entity's financial reporting process.

Auditor's responsibilities for the audit of the financial statements

Our objective is to obtained reasonable assurance about whether the financial statement as a whole free from material misstatement, whether due to fraud error, and to issue and auditor's report that includes our opinion. Reasonable assurance is the high level of assurance but is not guarantee that an audit conducted in accordance with SAs will always detects material misstatement when it exists. Misstatement can arise from fraud or error and are consider material if, individually or in aggregate, they could reasonably be expected to influence the economic decisions of the user taken on the basis of these financial statement.

Place: Kolkata
Dated: 03.10.2024

For A.N.Chatterjee & Co.
Chartered Accountants
F.R.N. 302143E
Avijit Auddy
(Partner)
M.No. 061616
UDIN: 24061616BKFWNP5276

NOTES ON ACCOUNTS

FAIR PROJECTS

The facility for Anti-Proton and Ion Research (FAIR) is a global facility being created in Darmstadt, Germany under a multi-country partnership. FAIR project is managed by FAIR company (FAIR GmbH). FAIR will be one of the largest accelerator facilities in the world and also one of the mega science projects recommended by the Steering Committee on Science & Technology set up by the Planning Commission for the 11th Five Year Plan. FAIR project is taken up as part of DAE & DST joint collaboration under a MoU signed between DAE & DST.

A joint declaration was signed on 07.02.2007 by the Minister for Science & Technology and Earth Sciences, Govt. of India and the Federal Minister for Education & Research, Federal Republic of Germany concerning the participation in construction and operation of the international facility for Anti-proton and Ion research. A joint statement was issued by the Chancellor of Republic of Germany and Prime Minister of India on 30.10.2007 in this regard. On 04.10.2010, the international agreement on the construction of FAIR was signed by nine countries, namely Germany, Finland, France, India, Poland, Romania, Russia, Slovenia and Sweden. Latter on United Kingdom also joined as a partner. India's contribution to the FAIR consortium has been estimated at 42.79 million Euro at July 2010 prices which is equivalent to Rs. 260.00 Crore (Approximately). According to the MoU between DAE & DST, the overall cost of Rs. 260.00 Crore is to be borne equally by DAE & DST. The sanction was subsequently revised vide OM no SR/MF/PF-02/2010(E-6133) dated 08.10.2021 to Rs 615.00 Crore.

Bose Institute, Kolkata has been designated as the Indian shareholder in the FAIR Company and the Nodal Indian institution for management of the FAIR programme in India. So far, the assets created from Indian participation was not taken under the purview of Bose Institute and was not shown in its Balance Sheet up to F.Y. 2020-21, but now Finance Committee of Bose Institute in its meeting dated 23.11.2021 has directed to show funds received under FAIR project from DST and DAE has to properly accounted for in the financial statements. The asset created under FAIR project should be capitalised first and reflected in Institutes financial Statement and also transfer entry should be made if the assets are transferred to FAIR project. Accordingly from F.Y. 2021-22 onwards the IN-KIND ITEMS already sent to FAIR Germany till date, have been capitalised and shown in the attached statement under 'Schedule – 4' & 'Schedule – 08 B' of Bose Institute Council Books of Accounts and the balance quantity which is yet to be delivered to FAIR and is under progress is shown as CWIP (Capital Work In Progress).

Department of Science & Technology (DST), under the Ministry of Science & Technology, Govt. of India vide its Memo No. SR/MF/PS-01/2011 dated 04/03/2011 mentioned under clause 11 that "financial aspect will be issued in due course" but the same has not been received till date. However the present executive council takes both operational and financial decision.

Further, Accounting of FAIR project is unique and it is maintained in the old format as before, without changing in format for Central Autonomous Institutes.

BOSE INSTITUTE (IFCC)
BALANCE SHEET
For the year ended 31ST March 2024

As at 31st March 2023 (₹)	Liabilities	As at 31st March 2024 (₹)	As at 31st March 2023 (₹)	Assets	As at 31st March 2024 (₹)
56,07,13,865.00	Fund for Creation of Asset	69,09,35,866.00	54,732.00	Shares in FAIR GmbH	54,732.00
				Office Equipment Furniture : ₹ 98,530.00 Equipment : ₹17,72,547.00	
			3,97,215.00		18,71,077.00
	Unspent Grant				
48,01,340.77	Grant from Department of Science and Technology (**Schedule-2**)	(0.23)	25,35,96,171.59	Assets Transferred to FAIR **(Schedule-5)**	25,35,96,171.59
			30,66,65,746.41	Assets Under CWIP **(Schedule-5)**	43,54,13,885.41
13,13,00,597.47	Grant from Department of Atomic Energy (**Schedule-3**)	4,47,69,351.17	2,50,000.00	Advance	-
			-	Receivable From Bose Institute	-
-	Interest Earned (**Schedule-4**)	-	-	**Cash Balance** Cash in Hand	-
				Bank Balances	
17,700.00	Audit Fees Payable	17,700.00	13,69,03,543.24	Union Bank of India S.B. A/c -	4,48,13,064.94
	Liability towards TDS (194C) & TDS on GST	26,014.00			
10,33,905.00	Bank Interest (2022-23) nto be deposited in to Bharatkosh (On 'Grant from DST for FAIR & IFCC)	-	-	Fixed Deposits	-
69,78,67,408.24		73,57,48,930.94	69,78,67,408.24		73,57,48,930.94

Place : Kolkata
Date : 03.10.2024
UDIN :24061616BKFWNR4142

Signed in terms of our separate Report of even date.
For A.N. Chatterjee & Co.
Chartered Accountants
Firm Registration No. 302143E
Avijit Auddy
Partner
Membership No. 061616

Sd/-
Shaubhik Ghosh
UDC

Sd/-
Vikash Kumar
Audit & Finance Officer

Sd/-
Achintya Mukherjee
Accounts Officer

Sd/-
Prof. Ajit Bikram Datta
Registrar(O)

Sd/-
Prof. Kaustuv Sanyal
Director

BOSE INSTITUTE (IFCC)
STATEMENT OF EXPENDITURE
For the year ended 31ST March 2024

For the year ended on 31st March, 2023 (₹)	Particulars	For the year ended on 31st March, 2024 (₹)
-	Advertisement Expenses	-
17,700.00	Audit Fees	17,700.00
-	Bank Charges	0.30
38,268.00	Contingency Expenses	13,450.00
1,24,865.00	Meeting Expenses - IFCC	1,11,253.00
13,96,624.00	Salary(Human Resources)	13,44,904.00
-	Student Support	7,06,048.00
9,65,997.00	Travelling Expenses	11,50,066.00
-	Overhead Charges	-
-	Workshop	2,07,189.00
25,43,454.00		**35,50,610.30**

Place : Kolkata
Date : 03.10.2024
UDIN :24061616BKFWNR4142

Signed in terms of our separate Report of even date.
For A.N. Chatterjee & Co.
Chartered Accountants
Firm Registration No. 302143E
Avijit Auddy
Partner
Membership No. 061616

Sd/-
Shaubhik Ghosh
UDC

Sd/-
Vikash Kumar
Audit & Finance Officer

Sd/-
Achintya Mukherjee
Accounts Officer

Sd/-
Prof. Ajit Bikram Datta
Registrar(O)

Sd/-
Prof. Kaustuv Sanyal
Director

BOSE INSTITUTE (IFCC)
RECEIPT & PAYMENT
For the year ended 31ST March 2024

Particulars	Amount (₹)	Particulars	Amount (₹)
Opening Balance			
Cash in Hand	-		
SB A/c: Union Bank of India	13,69,03,543.24		
Fixed Deposits	-		
ZBSA A/c: Bank of Maharashtra	-		
GRANT FROM DST	15,26,00,000.00		
GRANT FROM DST (Unspent Babance of 2022-23 reassigned)	48,01,341.00	GRANT FROM DST (Unspent Babance of 2022-23 reassigned)	48,01,341.00
GRANT FROM DAE	4,00,00,000.00		
Interest on SB A/c	37,23,215.00		
Interest on FD (Term Deposits)	-		
Advance	4,21,000.00		
Income Tax (TDS-194C)	21,91,469.00	Advance	1,71,000.00
Income Tax (TDS-194J)	1,800.00	Income Tax (TDS-194C)	21,89,971.00
		Income Tax (TDS-194J)	1,800.00
TDS on GST (CGST)	12,258.00	TDS on GST (CGST)	-
TDS on GST (SGST)	12,258.00	TDS on GST (SGST)	-
TDS on GST (IGST)	40,60,559.00	TDS on GST (IGST)	40,60,559.00
		Workshop	2,07,189.00
		Travelling Expenses	11,50,066.00
		Bank Charges	0.30
		Meeting Expenses - IFCC	1,11,253.00
		Audit Fees	17,700.00
		Contingency Expenses	13,450.00
		Overhead Charges	-
		Salary (Human Resources)	13,44,904.00
		Student Support	7,06,048.00
		Advertisement Expenses	-
		Office Equipment	14,73,862.00
		Power Converter (In-Kind)	12,87,05,359.00
		Outreach of FAIR Activities, Industries Meet etc.	3,77,892.00
		Beam Stopper (In-Kind)	42,780.00
Inter Unit Account		Bank Interest (2022-23) deposited in to Bharatkosh GRANT FROM DST for FAIR & IFCC))	10,33,905.00
Bose Institute (Council)	23,55,450.00	GRANT FROM DST (Unspent Balance of DST Grant returned to DST on 31.03.2024)	15,35,05,299.00
Scheme/Project	30,62,376.00	**Inter Unit Account**	
		Bose Institute (Council)	23,55,450.00
		Scheme/Project	30,62,376.00
		Closing Balance	
		Cash in Hand	-
		SB A/c : Union Bank of India	4,48,13,064.94
		Fixed Deposits	-
		ZBSA A/c: Bank of Maharashtra	-
	35,01,45,269.24		**35,01,45,269.24**

Sd/-	Sd/-	Sd/-
Shaubhik Ghosh	Vikash Kumar	Achintya Mukherjee
UDC	Audit & Finance Officer	Accounts Officer

INDEPENDENT AUDITORS REPORT
To the Member of Council

Qualified Opinion

We have audited the accompanying financial statements of BOSE INSTITUTE Governing Body (the entity), which comprise the Balance Sheet at March 31st, 2024, and the Income & Expenditure account for the year ended on that date and notes to the financial statements, including a summary of significant accounting policies and other explanatory information. In our opinion and to the best of our information and according to the explanations given to us, except for the effect of the matter described in the Basis for Qualified Opinion section of our report, the accompanying financial statements give a true and fair view of the financial position of the entity as at March 31st, 2024, and of its financial performance for the year then ended.

Basis for Qualified Opinion

1. No Fixed Asset register was provided for our verification. No Physical verification of the Assets was done. The Institute has not carried out test of impairment, if any, in accordance with the requirement of AS 28 notified by the Institute of Chartered Accountants of India (ICAI). In view of this it is not possible to opine on correctness or otherwise of fixed assets.
2. Depreciation is not charged on Fixed Assets which results overstatement of Fixed Assets as well as overstatement of Excess of Income over expenditure as at the end of the year.
3. Cash balance shown Rs. 8150.05 as on 31.03.2024 against which balance confirmation certificate not provided for our verification.
4. Share certificate for the investment of Rs. 6041.67 in 7.5% Preference share of C.E.S.C Ltd. was not available for our verification. Income, If any, accrued or arisen, out of such investment has not been accounted for.

We conducted our audit in accordance with the Standards on Auditing (SAs) issued by ICAI. Our responsibilities under those standards are further described in the Auditor's Responsibilities for the Audit of the Financial Statements section of our report. We are independent of the entity in accordance with the ethical requirements that are relevant to our audit of the financial statements in India, and we have fulfilled our other ethical responsibilities in accordance with these requirements. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our qualified opinion.

Emphasis of Matter

We draw attention to the following matters

1. Following Advances are outstanding for a long period of time against which details and reason for non-adjustment are not available.

   i) Festival Advance Rs. 9300/-

   ii) Advance to Staff Rs. 16820/-

2. In respect of Special Fund which includes “Sri N.R.Sarkar Prize Fund“shows negative balance of Rs. 53055.08/- for a long period of time (Since 31.10.2019). Reason for such negative balance and non-adjustment of such negative balance not made available to us.
3. Following Liabilities are outstanding for a long period of time against which details and reason for non-adjustment are not available.

   i) Outstanding Accounting Charges Rs. 10000/-

   ii) Payable to Sri. D. Ray Rs. 14000/-

Our opinion is not modified in respect of these matters.

Key Audit Matters

Key audit matters are those matters that, in our professional judgment, were of most significance in our audit of the Financial Statements of the current period. In this audit we have not determined any specific Key Audit Matter to be addressed separately.

Responsibilities of Management and Those Charged with Governance for the Financial Statements

Management is responsible for the preparation and fair presentation of the financial statements in accordance with the aforesaid Accounting Standards, and for such internal control as management determines is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error. In preparing the financial statements, management is responsible for assessing the entity's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless management either intends to liquidate the entity or to cease operations, or has no realistic alternative but to do so. Those charged with governance are responsible for overseeing the entity's financial reporting process.

Auditor's Responsibilities for the Audit of the Financial Statements

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion.

Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with SAs will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

Place: Kolkata
Dated: 03.10.2024
UDIN: 24061616BKFWNQ8249

For A.N.Chatterjee & Co.
Chartered Accountants
F.R.N. 302143E
Avijit Auddy
(Partner)
M.No. 061616

BOSE INSTITUTE (GOVERNING BODY)
BALANCE SHEET AS AT 31ST MARCH 2024

	Schedule No.	As on 31/03/2024 Rs.	As on 31/03/2023 Rs.
FUNDS & LIABLITIES			
CAPITAL FUND	1	23,78,583.36	23,17,833.36
ACHARYA JC BOSE CENTENARY FUND			
AS PER LAST ACCOUNT		15,99,768.40	15,99,768.40
SPECIAL FUND			
AS PER LAST ACCOUNT	2	29,62,629.96	29,62,629.96
DEPOSITS & OTHER LIABILITIES	3	11,04,100.66	10,98,200.66
TOTAL		**80,45,082.38**	**79,78,432.38**
PROPERTIES & ASSETS			
FIXED ASSETS			
AS PER LAST ACCOUNT	4	23,74,712.85	23,74,712.85
INVESTMENTS			
AS PER LAST ACCOUNT	5	92,29,176.67	75,48,484.67
RECEIVABLE & DEPOSITS			
AS PER LAST ACCOUNT	6	32,795.00	7,70,488.00
CASH & BANK BALANCES	6	12,64,498.34	12,53,169.34
INCOME & EXPENDITURE A/C			
EXCESS OF INCOME OVER EXPENDITURE		(48,56,100.48)	(39,68,422.48)
TOTAL		**80,45,082.38**	**79,78,432.38**

INCOME & EXPENDITURE STATEMENT FOR THE YEAR ENDED 31ST MARCH 2024

Particulars	2023-24 Rs.	2022-23 Rs.
INCOME		
INTEREST ON TERM DEPOSIT	8,93,578.00	4,30,916.00
INTEREST ON SAVINGS BANK	-	-
TOTAL	**8,93,578.00**	**4,30,916.00**
EXPENDITURE		
SALARY & WAGES	-	-
ACCOUNTING CHARGES	-	-
AUDIT FEES	5,900.00	5,900.00
BANK CHARGES	-	649.00
EXCESS OF INCOME OVER EXPENDITURE FOR THE YEAR	8,87,678.00	4,24,367.00
TOTAL	**8,93,578.00**	**4,30,916.00**
INCOME BROUGHT DOWN AND ADJUSTED WITH LAST YEAR	8,87,678.00	4,24,367.00
BALANCE BROUGHT DOWN FROM LAST A/C	39,68,422.48	35,44,055.48
BALANCE TAKEN TO BALANCE SHEET	**48,56,100.48**	**39,68,422.48**

Place : Kolkata
Date : 03.10.2024
UDIN: 24061616BKFWNQ8249

Signed in terms of our separate Report of even date.
For A.N. Chatterjee & Co.
Chartered Accountants
Firm Registration No. 302143E
Avijit Auddy
Partner
M.No. 061616

Sd/-
Kamal Sing
Accountant (Cash)

Sd/-
Vikash Kumar
Audit & Finance Officer

Sd/-
Achintya Mukherjee
Accounts Officer

Sd/-
Prof. Ajit Bikram Datta
Registrar(O)

Sd/-
Prof. Kaustuv Sanyal
Director

139TH BIRTHDAY OF PROF. DEBENDRA MOHAN BOSE

Bose Institute celebrated 139th Birthday of Prof. Debendra Mohan Bose on November 26, 2023. Dr. RituKaridhal Srivastava, Scientist, U R Rao Satellite Centre, Bengaluru, Karnataka, graced the occasion as Guest of Honour and delivered the D. M. Bose Memorial Lecture 2023 on the topic "Challenges and Accomplishments of Interplanetary Missions". Dr. Debiprosad Duari, Former Director, Research & Academic, M.P. Birla Institute of Fundamental Research, M.P. Birla Planetarium, Kolkata, presided over the programme.

BOSE INSTITUTE

(AN AUTONOMOUS INSTITUTE UNDER
DEPARTMENT OF SCIENCE & TECHNOLOGY, GOVT. OF INDIA)

Main Campus
93/1 APC Road
Kolkata-700 009, West Bengal

Unified Academic Campus
EN-80, Sector-V, Salt Lake
Kolkata-700091, West Bengal

Centenary Campus
P-1/12, CIT Scheme VII (M)
Kolkata-700054, West Bengal