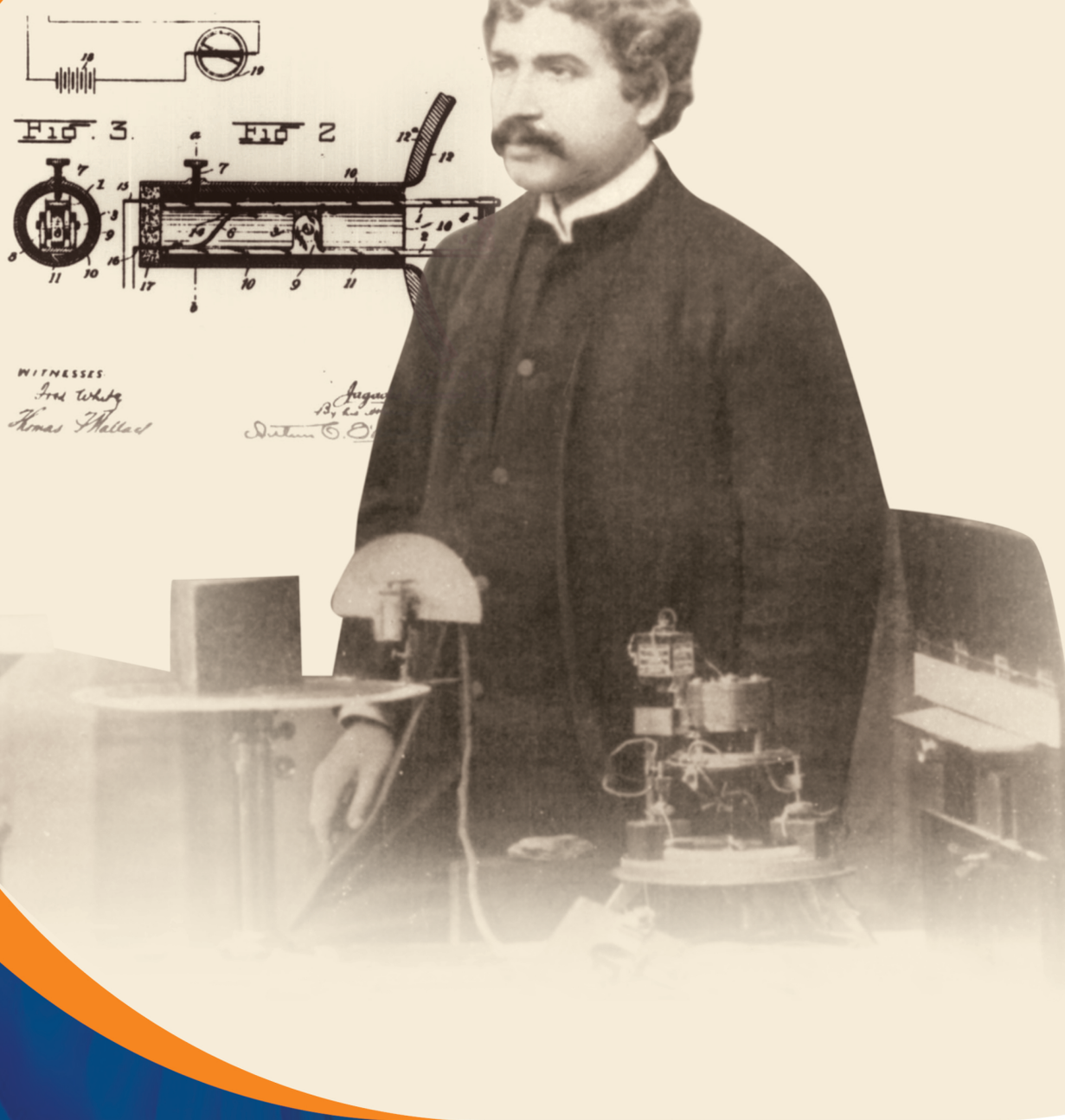
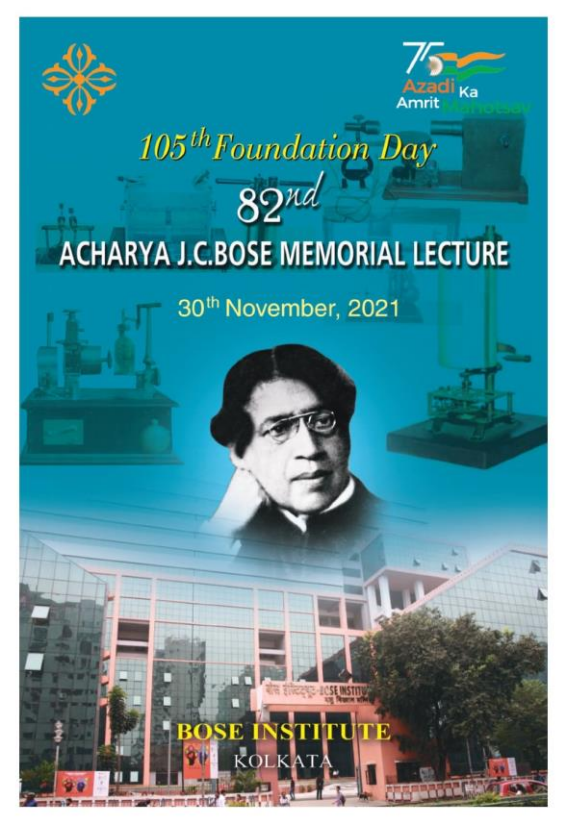
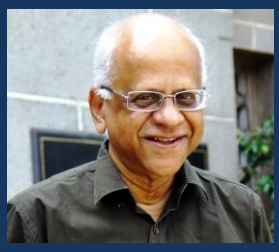
ANNUAL REPORT
2021-2022

Azadi Ka Amrit Mahotsav



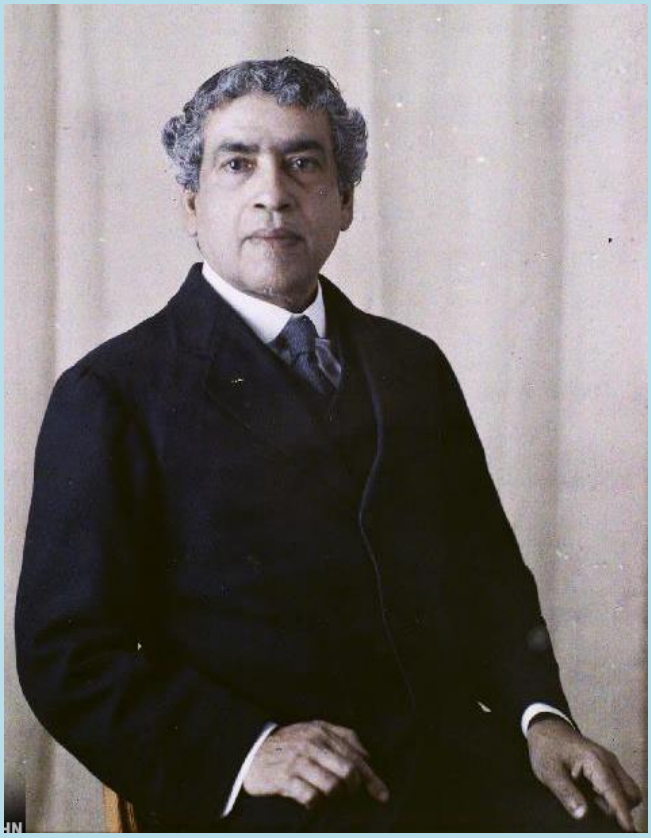
BOSE INSTITUTE
(An Autonomous Institute under Department of Science and Technology, Govt. of India)





The 105th Foundation Day of Bose Institute was celebrated on November 30, 2021. Professor Gautam R. Desiraju, Honorary Professor, Solid State and Structural Chemistry Unit, Indian Institute of Science, Bangalore, delivered 82nd Acharya J.C. Bose Memorial Lecture on "Science and Society. What does Bose Institute owe them?". Prof. Sabyasachi Sarkar, Honorary Professor, Nanoscience and Synthetic Leaf Laboratory at Downing Hall, IIEST, Shibpur, Howrah and Former Senior Professor and Head, Chemistry, IIT-Kanpur presided over the programme. Sir Nilratan Sirkar Prize 2021 was awarded to Ms. Sreyashi Majumdar, Division of Bioinformatics. Prof. B. B. Biswas Outstanding Student Award 2021 was presented to Mr. Anindya Dutta, Department of Biophysics. Prof. Shyamadas Chatterjee Outstanding Student Award (in the area of Physical and Environmental Science) was awarded to Mr. Sreyan Raha, Department of Physics.

BOSE INSTITUTE
KOLKATA



ANNUAL REPORT
2021-2022

BOSE INSTITUTE ANNUAL REPORT 2021-2022

Edited by the members of
J. C. Bose Centre
(Museum and Publication unit)

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FROM THE DIRECTOR'S DESK

I am overwhelmed and privileged as well to present the Annual Report of Bose Institute for 2021-22, depicting a comprehensive picture of the exemplary contribution made by the research scholars, and academic members of the Institute in the forefront of interdisciplinary and multidisciplinary research areas, leading to the academic development of the Institute as well as augmenting the global competitiveness of the country in higher education.

I sincerely would like to extend warm welcome to all the students, academic and non-academic staff of the Institute for their incessant dedicated endeavours in research activities notwithstanding the agony, hardship and myriad difficulties emerged from COVID-19 pandemic situation.

The unprecedented loss due to COVID-19 pandemic worldwide poses challenges to public health, food systems and the working world. The socio-economic disruptions caused by the pandemic are quite devastating. Poverty has engulfed millions of people resulting deadly increase of undernourished/malnourished people all over the world. The lion's share has lost their livelihoods. The workers of informal economy have become vulnerable due to lack of social protection, inaccessibility to quality healthcare and productive assets.

Notwithstanding the miseries, darkness and brooding over the negativities caused by the global pandemic, one must admit a few of its positive impacts viz. (i) Changes in lifestyle emphasizing health awareness and hygienic practices (ii) Increasing the acceptance rate for the use of personal protective equipments such as face mask, hand glove etc. (iii) Cessation in tobacco smoking due to abrupt emergencies of COVID-19 (iv) Less wastage of food (v) Global competition in healthcare innovation and technology development to address same global issues (vi) Mitigating possibilities of contamination due to minimization of physical contact (vii) Increasing the spirit of community (viii) Ensuring digitized and affordable education (ix) Development of innovative tools and software – artificial intelligence including robots, drones employed for healthcare, food and delivery services as well (x) Scientific breakthroughs to keep connected/re-connected (xi) Considerable decrease in air pollution – drastic improvement of air quality index in polluted cities.

COVID-19 has taught us a lot. Under the extreme conditions, Bose Institute was capable of publishing papers in referred journals, organizing a considerable number of webinars/ colloquia/lectures by eminent scientists through virtual mode. It is needless to mention that Bose Institute has always been a torch bearer in catalysing frontier research with tangible global impact. We are actively involved in overseeing the designing, manufacturing and supply of in-kind items (e.g. power converters, beam stoppers etc.) for accelerator and coordinate participation of Indian scientists in the experiments at FAIR, Germany under the project entitled *"India's participation in the construction of Facility for Antiproton and Ion Research (FAIR) at*

Darmstadt, Germany", turning this mission into reality. It is also noteworthy to mention that this in-kind endeavour is boosting the financial growth of different indigenous organizations/companies, invigorating the financial stability of the country as well as industry and science holistically. Different Indian companies are attracted by the foreign investors to provide various in-kind items.

With the coverage of fundamental as well as applied contributions to the repository of scientific knowledge, Bose Institute has been successfully pursuing research on *High Energy Physics – Understanding of Sub-atomic Particles, Quantum Information and Communication, Understanding of Response of Plants 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 etc*. It is praiseworthy to mention that we are always catalysing frontier research in the field of Biomedical Sciences and venturing to find out a new molecules and targets for preventing/curing diseases like Cancer, Alzheimer, Diabetes, Malaria, Tuberculosis and many infectious diseases. I am glad to inform you that our Institute is also aligned with different projects of Government of India and associated with a number of projects/mega projects that are completely aligned with the mandate of Department of Science and Technology, Government of India. We have been successfully accomplishing a number of scientific discourses, visits of students from different schools, colleges and universities and regularly organizing seminars, symposia in hybrid (online/offline) mode, fulfilling our commitment for diffusion of knowledge as envisaged in our objectives set by our illustrious founder Acharya J. C. Bose in 1917.

I feel proud to assert the major accomplishments of the Institute in the fields of *(i) Microbes and Microbiome (ii) Diseases, Therapeutics and Drug Target (iii) Structure Function and Dynamic of Protein (iv) Plant Development, Stress and Yield (v) Biological Systems, Information and Networks (vi) High Energy and Nuclear Physics (vii) Physics of Material and Quantum Systems (viii) Climate Change, Aerosol and cloud Formation.*

During the year 2021-22, Bose Institute had published 202 numbers of full length peer reviewed research papers in referred journals and 20 Books/Book Chapter/Invited Reviews. The Institute had produced 15 Ph.D. students and trained 28 research manpower (B.Tech., M.Tech., M.Sc., Diploma etc.) who are successfully leading their professional lives all over the globe.

To mention a number of notable global and national collaborations with Bose Institute, we may refer:

FAIR, Darmstadt, Germany: Facility for Anti-proton Ion Research (FAIR) - participate and oversee the designing, manufacturing and supply of in-kind items (e.g. power converters, beam stoppers etc.) for accelerator and coordinate participation of Indian scientists in the experiments at FAIR; Compressed Baryonic Matter – Muon Chamber (CBM-MUCH): Compressed Baryonic Matter (CBM) experiment will study and characterize the matter created in the relativistic nucleus-nucleus collisions at FAIR. A large section of the Muon Chamber (MuCh) detector system will be built at Bose Institute in addition to the development of analysis tools and analysis of data from this experiment; A large ion collider experiment (ALICE): a dedicated heavy ion collision experiment at Large Hadron Collider (LHC) at CERN, Switzerland for the understanding of physics of strongly interacting matter at very high energy densities; DBT-NOW: Unraveling the role of PLC in plant drought and heat stress tolerance: Exploring the potential of

PI metabolism to improve crop yield. Hydrogenogenic carbon monoxide conversion under mesophilic condition using anaerobic granular sludge biomass for biodesulpherization with IIT Guwahati, Assam; Multi-Dimensional Research to Enable Systems Medicine: Acceleration using a Cluster Approach with NIBMG, Kalyani, IISER Kolkata, TMC, Kolkata, ISI, Kolkata, IICB, Kolkata; Solid tumor targeting using homing peptides and plasmonicphotothermal technique with CSIRCSIO, CSIR-IIIM, IIT Ropar, AIIMS, Delhi; National Carbonaceous Aerosols Programme (NCAP) WGIII: Carbonaceous Aerosols Emmissions, Source appointment and Climate effects with IIT Bombay and 16 others; Bose Institute has been participating in the National Network program "Metflux" of MoES, Govt of India. Investigation on "Eastern Himalayan coniferous forest: Source or sink of Greenhouse Gases"; Bose Institute has been actively participating in National Mission on Strategic Knowledge for Climate Change (NMSKCC), DST since 2018. We are working on "Relative role of biogenic and anthropogenic air pollutants on cloud formation over eastern Himalaya"; National clean air program: NCAP (MoEFCC, Govt of India) Strategic action plans to mitigate air pollution state-wise. Bose Institute is the Nodal Institute and Dr. Abhijit Chatterjee, ESS is the Nodal Faculty for West Bengal; Fabrication of Infrared Photo-detector based on 2D systems and Tuning the Detection Windows by coupling with Nanostructures with Jadavpur University; 20 Fabrication of Infrared Photo-detector based on 2D systems and Tuning the Detection Windows by coupling with Nanostructures with Jadavpur University.

Bose Institute hosted/organized a significant number of lectures/colloquia/webinars/seminars/ symposia through hybrid mode such as: *Prof. Amitava Raychaudhuri, Emeritus Professor, Department of Physics, University of Calcutta, delivered Professor D M Bose Memorial Lecture 2021 on "Musings on Mass" on 26-11-2021, the 137th Birth Day of Professor Debendra Mohan Bose; Prof. Gautam R. Desiraju, Honorary Professor, IISC, Bangalore, delivered the 82nd Acharya Jagadis Chandra Bose Memorial Lecture on "Science & Society, What does Bose Institute owe them?" on the 105th Foundation Day Celebration of Bose Institute on 30-11-2021; Prof. Ranjeet adinhateeri, IIT, Bombay delivered a colloquium talk on "Physical models to Understand chromatin assembly and inheritance of epigenetic information" on 26-08-2021; Justin Lathia, Vice Chair & Staff, Cardiovascular & Metabolic Sciences, Lerner Research Institute, Cleveland Clinic, Cleveland, USA delivered a colloquium talk on "Sex differences inform glioblastoma progression and reveal potential new immunotherapies" on 05-11-2021; BIC Webinar-VIII on 29-05-2021: Current Research Trends in Bioinformatics- From basics to applications: (a) Dr. Debasree Sarkar, Emory University, School of Medicine, Atlanta, Georgia delivered a talk on "Single Cell RNA-Sequencing of Diabetic Foot Ulcers as a basis for understanding wound healing process" (b) Dr. Sohini Chakraborty, NYU Grossman, School of Medicine, New York, USA delivered a talk on "Cellular heterogeneity in hematopoietic stem cell aging" (c) Dr. Atanu Maity, IIT, Bombay delivered a talk on "Staple (d) diet for entropic penalty of protein-peptide binding"; BIC Webinar-X on 22-06-2021: Perspectives on SARS-COV2: Prof. Syamal Roy, Emeritus Scientist, CSIR-IICB, Kolkata delivered a talk on "Paradise Lost" to "Paradise Regained"- a long haul to know many unknowns about SARS-CoV2; BIC Webinar-XI on 14-09-2021: In-silico Approaches for Cancer Therapy: Prof. G.P.S. Raghava, Head & Professor, Dept. of Computational Biology, IIIT-Delhi delivered a talk on "Computer aided solutions for managing Treatment of Cancer"; BIC Webinar-XII on 25-10-2021: Dr. Dipyaman Ganguly, CSIR-IICB, Kolkata delivered a talk on 'May the force be with you': Piezol for mechanosensing in immune cells.*

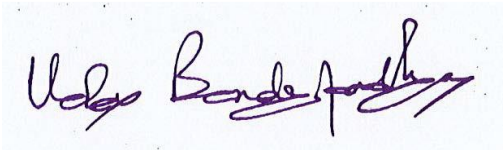
As a part of the celebration of 75th year of Independence "AZADI KA AMRIT MAHOTSAV", Bose Institute organized lectures such as (i) Nov.8-20, 2021: "IV ALICE-India School on Quark-Gluon Plasma" -organized by The High Energy Physics group of the Department of Physics, Bose Institute (ii) November 17, 2021: Keynote Lecture on "The Brownian motion of Corona and Quarks" delivered by Prof. Jan-e Alam, VECC at the Unified Academic Campus, Bose Institute, Salt Lake, Kolkata.

"National Science Day" was celebrated on 28th February, 2022 by organizing one day scientific programme for local school students on "Commonly used Biotechnological Methods" at Falta Experimental farm, Falta. Talks by young researchers of Bose Institute were held at the Unified Academic Campus, Bose Institute, Salt Lake, Kolkata.

A panel discussion on "The Contribution of Women in Science, Science Education & Science Management" was held at the Unified Academic Campus, Bose Institute, Salt Lake, Kolkata as a part of the celebration of "International Women's Day" on 08th March, 2022.

Celebration of "Rashtriya Ekta Diwas (National Unity Day)" was held on 31st October, 2022 in the form of a pledge taking ceremony through virtual mode to commemorate the birth anniversary of Sardar Vallabhbhai Patel as "Rashtriya Ekta Diwas (National Unity Day)" in order to boost sentiments of unity, integrity and security of our Nation.

To conclude, I, on behalf of Bose Institute, would like to convey sincere gratitude to the Hon'ble Chairman and Members of Bose Institute Council for their valued advice, guidance and support from time to time. I am privileged to express my gratefulness to the funding agency, Department of Science and Technology, Government of India, for their continuous financial support and administrative assistance as and when required even during this transition period, securing a disciplined research-based ambience in the Institute thereby elevating the academic development of the country.



Prof. (Dr.) Uday Bandyopadhyay
Director
Bose Institute, Kolkata

"Knowledge is never the exclusive possession of any favoured race; the whole world is inter-dependent and a constant stream of thought had through ages enriched the common heritage of mankind"

- Jagadish Chandra Bose

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

1. **Prof. Gautam R. Desiraju, *Chairman***
   IISc, Bangalore
2. Prof. Dipankar Chatterji
   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

MANAGEMENT OF THE INSTITUTE

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
Department of Biochemistry
IISc, Bangalore

Prof. Prasanta K. Panigrahi, Member
Department of Physical Science
IISER, Kolkata

Prof. Ashwini Nangia, Member
School of Chemistry
University of Hyderabad, Hyderabad

Prof. Arindam Ghosh, Member
Centre for Nano Science and Engineering
Department of Physics, IISc, Bangalore

Dr. Ramesh Venkata Sonti, Member
Indian Institute of Science Education
and Research Tirupati, Tirupati, AP

Prof. J. N. Moorthy, Member
Director, IISER, Thiruvananthapuram
Maruthamala PO, Vithura, Thiruvananthapuram

Dr. Amit Prakash Sharma, Member
ICMR – Bnational 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

ABOUT BOSE INSTITUTE

INTRODUCTION

The doyen of modern science in India, Acharya Jagadish 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

ABOUT BOSE INSTITUTE

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.

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.

ABOUT BOSE INSTITUTE

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 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, MISSION, VISION AND OBJECTIVES

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:-

A. Advancement of knowledge by means of research

B. The diffusion of knowledge by organizing discourses, demonstration and lectures to be given by original workers in it and thinkers.

C. To do all such things as are incidental or conducive to the attainment of the above objects or any of them.

AREAS OF FOCUS

Recent Activities:

Bose Institute pursues research for augmentation of fundamental knowledge-base and developing solutions to national problems 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.

Areas of Focus: Research is pursued in following areas

- High Energy and Nuclear Physics – Understanding of Sub-atomic Particles
- Quantum Information and Communication
- Understanding of Response of Plants 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.

MAJOR ACCOMPLISHMENTS

The efforts of the institute's researchers have yielded several exciting results, which are as follows:

Microbes and Microbiome:

- Identified and isolated the anti-bacterial compound from Cassia fistula Bark that inhibits transcription. The compound is active against MDR-RNA polymerase.
- Understanding of the functional role of DevR- an important transcription factor of *M. Tuberculosis.*
- Introduced an update of DAAB-V2 version of the database of allergy and asthma biomarkers.
- Characterization of an antimicrobial peptide from Pseudomonas aeruginosa revealing broad spectrum antimicrobial activity.
- A series of novel antimicrobial peptides have been synthesized and their antimicrobial activities have been evaluated.

Disease, Therapeutics and Drug Target:

- Established that Serine 106 preserves the tertiary structure, function, and stability of a cyclophilin from *Staphylococcus aureus*.
- A new insight on the molecular mechanism of fibrillation of Amyloidogenic peptide and designing of inhibitors for A-b 40/42, insulin, a-synuclein, Lysozyme, hIAPP etc.
- Identification of several important miRNAs of Parkinson's and Alzheimer's disease from the known drugs, human interactome, and high throughput data.
- Identification of a tetrapeptide (consisting of four amino acid units) that prevents both heat and storage induced insulin fibrillation and thereby loss of effective quantum of insulin.
- Development of piRNAQuest v.2(2nd version of piRNAQuest) which hosts varied information about multi-species piRNAs.
- Identification of a novel GM2-HIPPO-YAP/TAZ signalling axis, as well as a novel micro-RNA regulatory activity of GM2 in inducing EMT and metastasis. Identified selective cyto-toxic role of the plant derived flavonoid Eriodictyol against cancer cells, and uncovered the mechanistic basis for its selectivity.
- Understanding of key divergences between the protein-protein interactions present within the ESCRT complexes of the host and the orthologous complexes of *Giardia lamblia.*
- Synthesizedtwo oligosaccharides containing rare sugars important for antibacterial glycoconjugate vaccinecandidate and selenium incorporated carbohydrate derivatives – medicinally useful novel glycomematics.

MAJOR ACCOMPLISHMENTS

Structure Function and Dynamic of Protein

- Established the molecular mechanisms of microtubule over-stabilizing ligands that act on the α,β-tubulin dimer.
- Established that phosphorylation on the long unstructured loop region of Bcl-2 revises its communication with the primary binding site that directly influences binding of its partner protein Bax, which is an essential part of the mechanism of Bcl2 proteins to regulate apoptotic machinery.
- Proved the existence of a superantigenic motif in nucleocapsid phosphoprotein of SARS COV2, which is analogous to a motif of its Spike protein.

Plant Development, Stress and Yield:

- A set of two extracellular protease inhibitors, OsIn1 and OsIn2 from rice have been demonstrated to induce disease resistance in Nicotiana benthamiana during infection with R. solani.
- Study of the role of Rice Trithorax factor ULTRAPETALA 1 (OsULT1) in regulating transcription during abiotic stress response
- Germplasm (seeds) of a new hinter-specific hybrid sesame has been successfully submitted to the National Bureau of Plant Genetic Resources (NBPGR), Indian Council of Agricultural Research (ICAR) for its registration.
- Demonstrated that tomato TORNADO1 gene's, involved in leaf vein development and reticulation formation, expression is restored by tomato leaf curl virus infection in mature leaves which is otherwise transcriptionally silenced by DNA-methylation.
- Demonstrated that tomato miT6024 negatively impacts plant's resilence against Alternaria Solani.

Biological Systems, Information and Networks

- The spread of diseases on different network topologies have been explored by treating precautions as strategies and S, I, R, and D as states.
- Established new insight on abundance criteria of feed-forward loop motif in terms of signal-to-noise ratio.

High Energy and Nuclear Physics:

- Established a novel scheme for obtaining possible equilibrium conditions of the hadrons yielded in heavy-ion collision experiments.
- Introduced a new technology of oil coating in RPC with bakelite electrodes. Cosmic test showed the viability of this technology.
- First measurement of excitations in ^{7}Be(d,p)^{8}Be* up to 22 MeV showed that contribution of high lying states up to 16.63 MeV in ^{8}Be does not solve the cosmological Li problem.

MAJOR ACCOMPLISHMENTS

Physics of Material and Quantum Systems:

- Achievement of amplification of light collection in the atomically thin MoSSe 2D semiconductor, in a new experiment, exploiting enhanced light scattering and field amplification from Au nanoantennas coupled to the 2D semiconductor
- Demonstrated, for the first time, activation of quantum nonlocality in the scenario of local discrimination of quantum states, as locally available quantum information distributed between several physically separated observers can be locally locked without losing any information.
- Proved that the quantum switch constructed from quantum switches could outperform them even if the individual switches are useful or even useless for quantum communication.

Climate Change, Aerosol and cloud Formation:

- Demonstrated that in the atmosphere aged Hydrophobic black carbon aerosols have been found to act as better cloud condensation nuclei than hydrophilic sea-salt aerosols.
- Established that in the absence of fossil fuel emissions, biogenic VOCs emitted from eastern Himalayan conifer forest play pivotal role in aerosol formation when VOCs get oxidized by enhanced ozone.

J.C. Bose's self designed Apparatus to study Response in Living & Non-Living

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.

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IMPORTANT INTERNATIONAL AND NATIONAL COLLABORATIONS

In its journey of scientific pursuit for more than 100 years, Bose Institute has not only initiated new areas of research, such as Cosmic Ray, plant physiology and others, Institute has also contributed to areas directly relevant for society, such as agricultural innovations. Keeping with the changing time, Institute is now part of the International and National scientific collaborations to unravel the mysteries of nature and new innovations and efforts which would directly help to improve the quality of life.

International Collaborations - Mega Projects

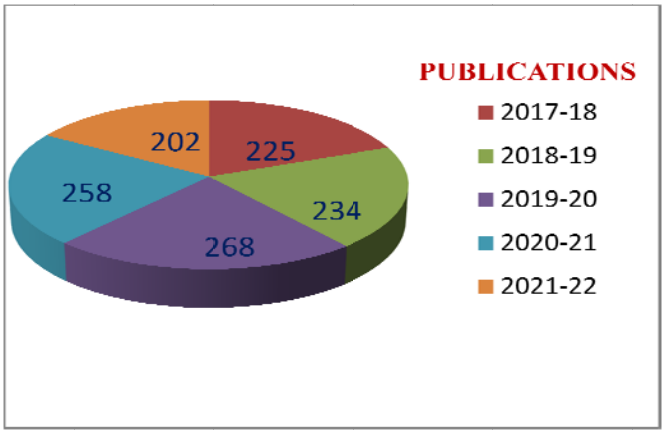
- **F**acility for **A**nti-proton **I**on **R**esearch (**FAIR**) is one of the largest accelerator facilities being built at Darmstadt, Germany. This will facilitate research in low energy atomic physics to high-energy heavy ion collision and physics with high energy anti-protons under the same roof. As a founder member and shareholder of the FAIR, on behalf of DST, Govt. of India, Bose Institute (BI) scientists are responsible to participate and oversee the designing, manufacturing and supply of in-kind items (*e.g.* power converters, beam stoppers etc.) for accelerator and coordinate participation of Indian scientistsin the experiments at FAIR. Physicists from BI are also participants of the Compressed Baryonic Matter (CBM) experiment that will study and characterize the matter created in the relativistic nucleus-nucleus collisions at FAIR. A large section of the Muon Chamber (MuCh) detector system will be built at BI in addition to the development of analysis tools and analysis of data from this experiment.
- **A** **L**arge **I**on **C**ollider **E**xperiment (**ALICE**) is a dedicated heavy ion collision experiment at **L**arge **H**adron **C**ollider (**LHC**) at CERN for the understanding of physics of strongly interacting matter at very high energy densities. BI has been member of ALICE for last several years. Along with the data analysis for the characterization of the system created in the collision, BI scientists have played crucial role in the operation and maintenance of the indigenously built Photon Multiplicity Detector (PMD). Group has also contributed to develop the firmware required for the Common Readout Unit (CRU), a crucial component in ALICE Data Acquisition (DAQ) system.

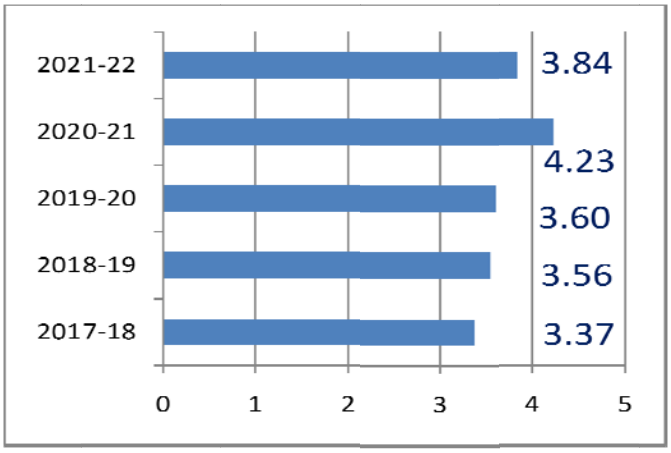
National Collaborations

- DBT-NOW: Unraveling the role of PLC in plant drought and heat stress tolerance: Exploring the potential of PI metabolism to improve crop yield; Hydrogenogenic carbon monoxide conversion under mesophilic condition using anaerobic granular sludge biomass for biodesulpherization with IIT Guwahati, Assam.
- Multi-Dimensional Research to Enable Systems Medicine: Acceleration using a Cluster Approach with NIBMG, Kalyani, IISER Kolkata, TMC, Kolkata, ISI, Kolkata, IICB, Kolkata.
- Solid tumor targeting using homing peptides and plasmonicphotothermal technique with CSIR-CSIO, CSIR-IIIM, IIT Ropar, AIIMS, Delhi.
- National Carbonaceous Aerosols Programme (NCAP) WGIII: Carbonaceous Aerosols Emmissions, Source appointment and Climate effects with IIT Bombay and 16 others.
- Bose Institute has been participating in the National Network program “Metflux” of MoES, Govt of India. Investigation on “Eastern Himalayan coniferous forest: Source or sink of Greenhouse Gases”.
- Bose Institute has been actively participating in National Mission on Strategic Knowledge for Climate Change (NMSKCC), DST since 2018. We are working on “Relative role of biogenic and anthropogenic air pollutants on cloud formation over eastern Himalaya”.
- National clean air program: NCAP (MoEFCC, Govt of India) Strategic action plans to mitigate air pollution state-wise. Bose Institute is the Nodal Institute and Dr. Abhijit Chatterjee, ESS is the Nodal Faculty for West Bengal.
- Fabrication of Infrared Photo-detector based on 2D systems and Tuning the Detection Windows by coupling with Nanostructures with Jadavpur University.

ACADEMIC INPUTS

TOTAL PUBLICATIONS 2021-22	**202**
AVERAGE PUBLICATION IMPACT FACTOR 2021-22	**3.84**
BOOKS/BOOK CHAPTERS/INVITED REVIEWS	**20**
PH.D. AWARDED/THESIS SUBMITTED 2021-22	**15**
NO. OF MANPOWER TRAINED (B.TECH., M.TECH., M.SC., DIPLOMA ETC)	**28**
NO. OF SEMINARS, TRAINING, CONFERENCES, WORKSHOPS, WEBINARS ETC.	**14**



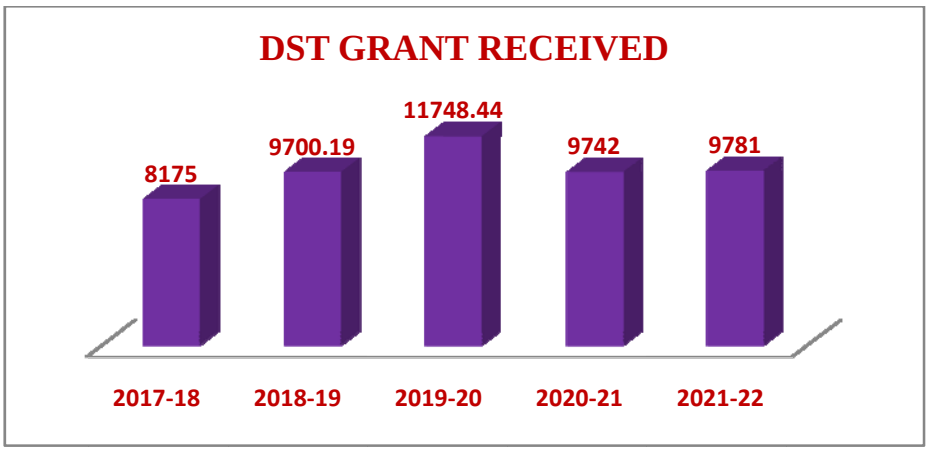


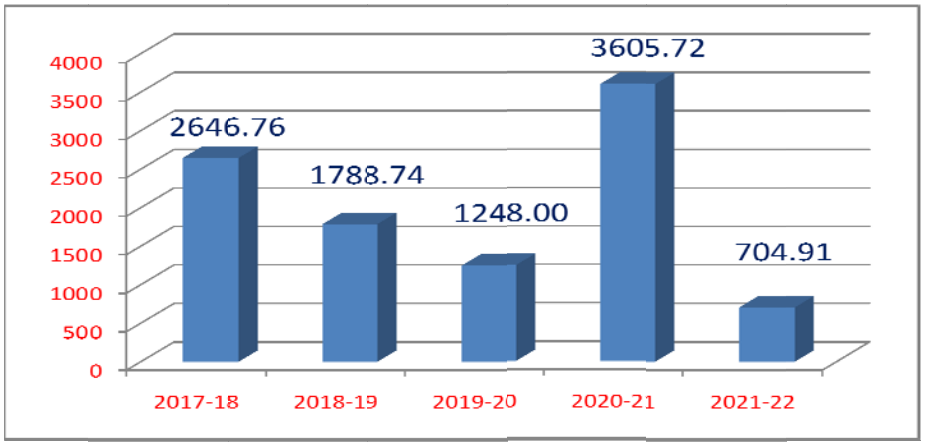
AVERAGE PUBLICATION IMPACT FACTOR 2021-22

FINANCIAL INPUTS

(Rupees in Lakh)

DST GRANT RECEIVED 2021-22	**9,781**
EXTRA MURAL GRANT RECEIVED 2021-22	**704.91**
NO. OF ON-GOING EXTRA MURAL PROJECTS 2021-22	**46**
AVERAGE EXTRA MURAL PROJECTS PER FACULTY	**1.35**





EXTRA MURAL GRANT RECEIVED

LIST OF PERSONNEL (ADMINISTRATION)

Prof. (Dr.) Uday Bandyopadhyay, Director

Prof. Rajarshi Ray, Registrar (Officiating)

Noreen Bhattacharjee, Deputy Registrar	Achintya Mukherjee, Accounts Officer
Sougato Banerjee, Assistant Registrar	Vikash Kumar, Audit & Finance Officer

Mantu Bhattacharya	Tarun Kumar Maji	Vineet Kumar Tandon
Supriya Das	Kamal Sing	Debdas Nandi
Somnath Das	Satyaswaroop Behara	Ananya Malgope
Nitin Sharma	Dr. Ishani Chatterjee	Sumanta Ghosh
Arjun Das	Ruby Sarkar	Sudam Ch. Jana
Babli Marrick	Gopa Dasgupta	Debasish Koley
Angshuman Bhowmik	Sukanta Chakraborty	Sujata Roy
Biplab Malakar	Arpita Bose	Animesh Jana
Ratan Saha	Shaubhik Ghosh	Atanu Deb
Tuhin Saha	Bipul Kr. Nag	Mahendra Nath Shee
Sachchidananda Ram	Kanai Hazra	Sanat Kumar Dhara
Khairul B. Mollah	Sk. Md. Kalu	Prafulla Bhuiya
Duryodhan Nayak	Sarda Devi	Raj Kumari Balmiki
Bablu Mondal	Rajbrat Ram	Hemanta Kr. Sahoo
Goutam Behera	Gourango Paramanick	Tapas Chakraborty

COMPLETION OF SHIFTING AT UNIFIED ACADEMIC CAMPUS, SALT LAKE

Finally, the entire construction of the building including reconstruction of Laboratories, shifting of research equipments, instruments and other infrastructure, was ready. All administrative and Academic activities are henceforth accomplished from this Campus since 14th July 2021. This is indeed a milestone achievement for Bose Institute.

PH.D. AWARDED

Biochemistry

- **Debabrata Sinha:** Studies on an anti-sigma factor from *Staphylococcus aureus*. Supervisor: Prof. Subrata Sau.
- **Mousam Roy:** Structural and Functional Analysis of Heat Shock Proteins from Thermoacidophilic Crenarchaea Sulfolobus acidocaldarius. Supervisor: Dr. Abhrajyoti Ghosh.
- **Chandrima Bhattacharyya:** Exploring the Microbial Diversity in Tea Rhizosphere and an Assessment of Resident Plant Growth Promoting Rhizobacteria (PGPR). Supervisor: Dr. Abhrajyoti Ghosh.
- **Shayantan Mukherji:** Microbiology of Sundarban Mangrove Ecosystem: Insights into Diversity, Distribution and Function of Resident Microbial Communities. Supervisor: Dr. Abhrajyoti Ghosh.

Biophysics

- **Bhisma Narayan Ratha:** Peptide Based Biophysical Studies and Inhibitor Designing For Signalling and Amyloidogenic Class of Proteins. Supervisor: Prof. Anirban Bhunia.
- **Swapna Bera:** Structural Insights of Aβ Peptides in Membrane: Understanding the Role of Fibrillation in Alzheimer's Pathogenesis and Designing of Peptides for Aβ Fibril Inhibition. Supervisor: Prof. Anirban Bhunia.
- **Humaira Ilyas:** Structural And Functional Studies OF Designed Antimicrobial & Anti-Inflammatory Peptides: Prospects In Plants And Animal Disease Control. Supervisor: Prof. Anirban Bhunia.

Chemistry

- **Arijita Subuddhi:** Dissecting the response of macrophages to *Mycobacterium tuberculosis* infection: the role of epigenetic modifications and immune surveillance mechanisms. Supervisor: Prof. Joyoti Basu.

Molecular Medicine

- **Baijayanti Ghosh:** Protein Quality Control Machinery In Modulation of Spinocerebellar Ataxia Type 3 Pathogenesis. Supervisor: Prof. Atin Kumar Mandal.
- **Sayantan Bose**: Regulation of FOXP3 expression in tumor-associated T-regulatory cells. Supervisor: Prof. Gaurisankar Sa.
- **Dia Roy:** Breast tumour-tssociated Th17 tells: Their epigenetic regulation and interrelationship with T-regulatory cells. Supervisor: Prof. Gaurisankar Sa.

Microbiology

- **Apurba Sarkar:** Identification of a Novel Inhibitor of Mycobacterial Growth that Functions by Targeting its Thymidylate Synthesizing Enzyme Thyx. Supervisor: Prof. Sujoy Kr. Das Gupta.

Physics

- **Deeptak Biswas:** Dynamical evolution of matter at extreme conditions. Supervisor: Prof. Sanjay Kr. Ghosh.
- **Pooja Bhattacharjee:** Study of Potential Self Annihilation Signal from Dark matter Particles in some Prospective Astrophysical Dark matter Sources. Supervisor: Dr. Partha Sarathi Joarder (Retd.) and Prof. Dhruba Gupta (Joint Supervisor).
- **Rathijit Biswas:** Study of jet cross-sections and properties in hadronic and heavy-ion collisions with ALICE at the Large Hadron Collider. Supervisor(s): Prof. Sibaji Raha and Prof. Supriya Das.

AWARDS / HONOURS / MEMBERSHIP

Biochemistry

Prof. Srimonti Sarkar:

1. September 2021: nominated as a Member of the Academic Council of Indian Association for the Cultivation of Science.
2. November 2021: nominated as member of the Ph.D. Research Advisory Committee of Department of Genetics, University of Calcutta.

Bioinformatics

Prof. Shubhra Ghosh Dastidar:

1. Selected as the Associate Editor, Frontiers in Molecular Biosciences.

Dr. Zhumur Ghosh:

1. Member of the National Academy of Science.

Biophysics

Prof. Anirban Bhunia:

1. **Editorial Board member** of (i) Journal of Colloid and Interface Science; (ii) Biochimica et Biophysica Acta – Biomembranes; (iii) Scientific Reports (Nature Publishing Group); (iv) PLoS One; (v) Frontiers in Chemistry.
2. Guest Editor of themed issue on "**Protein Disorder in Proteostasis and Pathogenesis**", by Biophysical Chemistry (Elsevier).
3. Miss Dipita Bhattacharyya received "Jharna Rani Samal Best Student Thesis Award" for the year 2021-22 from Nuclear Magnetic Resonance Society (NMRS), India.

Environmental Sciences

Dr. Abhijit Chatterjee:

1. Three tripartite MoUs have been signed between:
   A) Bose Institute, WBPCB and Kolkata Municipal Corporation
   B) Bose Institute, WBPCB and Howrah Municipal Corporation
   C) Bose Institute, WBPCB and Barrackpore Municipality
2. Dr. Abhijit Chatterjee has been working as the Scientific Advisor for the above three urban local bodies to frame the policies and mitigation plans to combat air pollution.
3. The study on air pollution and regional climate over Kolkata metropolis and Sundarban was covered and telecasted in DD News in May 2021.

AWARDS / HONOURS / MEMBERSHIP

Dr. Sanat Kumar Das

Memberships:

1. Subject Expert Committee - Earth & Atmospheric Sciences Areas of "Fund for Improvement of S&T infrastructures in Universities and Higher Educational institutions"(**FIST**) Program of Department of Science and Technology (**DST**), Ministry of Science and Technology, Govt. of India.
2. Institute of Repute (IoR) under the National Clean Air Mission, the Ministry of Environment, Forest and Climate Change (**MoEF-CC**); and Central Pollution Control Board (**CPCB**).

Molecular Medicine

Prof. Kaushik Biswas

1. Editorial Board Member of the Journal PLoS One.

Physics

Prof. Achintya Singha

2. **Member of the Board of Studies (UG**), Department of Physics, Midnapore College, till February 15, 2020.
3. Member of Conference organizing committee: **3rd Annual Conference of Quantum Condensed Matter (Q-MAT : 2020).**

Prof. Soumen Roy

1. Regular Associate of the International Centre for Theoretical Physics (UNESCO), Trieste, Italy.
2. Editorial Board member of: (1) PLOS ONE, (2) Indian Journal of Physics (Springer), (3) Frontiers in Physics.

Dr. Saikat Biswas

1. Selected as member of the Advisory committee in the Workshop on Advanced Radiation Detector and Instrumentation in Nuclear and Particle Physics (RAPID2021) 25-29 October 2021.
2. Chaired a session in the Workshop on Advanced Radiation Detector and Instrumentation in Nuclear and Particle Physics (RAPID2021) 25-29 October 2021.
3. Proud Indian - Georges Charpak Distinguished Scientist Award, 2022 from IMRF, Institute of Higher Education & Research, India.

Dr. Sidharth Kumar Prasad

1. Appointed as the **Physics Coordinator** of the ALICE-STAR India Collaboration to coordinate all Physics activities of the Collaboration in tune with the ALICE Physics activities.
2. Work on "Jet quenching at finite magnetic field" presented by Ms. Debjani Banerjee, received the best oral presentation award in the National Conference on Fundamental and Applied Sciences organized by SVNIT, Surat, Gujrat during October 20 - 21, 2021.

AWARDS / HONOURS / MEMBERSHIP

Mr. Sayak Chatterjee

1. Received the Ernest Rutherford best researcher award 2022 on 26.01.2022 by the International Multidisciplinary Research Foundation (IMRF).

Ms. Kabita Kundalia:

1. Presented the paper "Elastic and inelastic scattering of ^{7}Be on ^{12}C at 5 MeV/A" and received the best poster prize in Nuclear Reaction and Nuclear Astrophysics category at the 65th DAE Nuclear Physics Symposium, BARC, Mumbai, December 1-5, 2021.

Plant Biology

Prof. Shubho Chaudhuri

Elected Fellow of the West Bengal Academy of Science & Technology (WAST).

Prof. Gaurab Gangopadhyay

1. Invited as a guest at Vedantu Career Online Talk Show on 13.11.2021.
2. Selected as the external member for the 'Board of Studies' committee, Department of Biotechnology and Microbiology of Swami Vivekananda University, Barrackpore, Kolkata on 16.01.2022.

Senior Scientists

Prof. Gourisankar Sa

1. Editor-in–Chief: International J Immunology.
2. Sectional Editor: Scientific Reports, Frontiers in Immunology, Frontiers in Oncology, Proceeding of National Academy of Science, India, Section-B, Head & Face Medicine; Austin J. Clinical Immunology, J Cancer Research & Molecular Medicine.

LIST OF PUBLICATIONS

1. Kundu, M; Gucchait, A; Misra, AK; (2021) Synthesis of the pentasaccharide repeating unit of the O-antigenic polysaccharide of enteroaggregative Escherichia coli; TETRAHEDRON O44:H18 strain; Volume: 91 Article Number: 132245 DOI:10.1016/j.tet.2021.132245; Accession Number: WOS:000663121600025; ISSN: 0040-4020; eISSN: 1464-5416.
2. Banerjee, N; Panda, S; Chatterjee, S (2021) Frontiers in G-Quadruplex therapeutics in cancer: Selection of small molecules, peptides and aptamers; CHEMICAL BIOLOGY & DRUG DESIGN DOI: 10.1111/cbdd.13910; Accession Number: WOS:000699996000001; PubMed ID: 34148284; ISSN: 1747-0277; eISSN: 1747-0285.
3. Paul, D; Basu, D; Dastidar, SG (2021) Multi-conformation representation of Mpro identifies promising candidates for drug repurposing against COVID-19; JOURNAL OF MOLECULAR MODELING Volume: 27 Issue: 5 Article Number: 128 DOI:10.1007/s00894-021-04732-1; ISSN: 1610-2940; eISSN: 0948-5023.
4. Roy, M; Bhakta, K; Bhowmick, A; Gupta, S; Ghosh, A; Ghosh, A (2021) Archaeal Hsp14 drives substrate shuttling between small heat shock proteins and thermosome: insights into a novel substrate transfer pathway; FEBS JOURNAL DOI: 10.1111/febs.16226; ISSN: 1742-464X; eISSN: 1742-4658.
5. Ghosh, S; Sikdar, SR (2021) Identification of defence proteins, essential for aphid tolerance in Indian mustard; ARTHROPOD-PLANT INTERACTIONS Volume: 15 Issue: 3 Pages: 337-351 DOI: 10.1007/s11829-021-09824-6; ISSN: 1872-8855; eISSN: 1872-8847.
6. Manna, T; Misra, AK (2021) Synthesis of the sialylated pentasaccharide repeating unit of the capsular polysaccharide of Streptococcus group B type VI; CARBOHYDRATE RESEARCH Volume: 502 Article Number: 108294 DOI:10.1016/j.carres.2021.108294; ISSN: 0008-6215; eISSN: 1873-426X.
7. Dutta, A; Paul, S (2021) Diagnosis of early-stage carcinoma through exosomal FOXP3 detection; ANNALS OF ONCOLOGY Meeting Abstract: 28P Volume: 32 Pages: S369-S369 DOI: 10.1016/j.annonc.2021.08.306 Supplement: 5; ISSN: 0923-7534; eISSN: 1569-8041.
8. Panda, D; Manna, T; Chakrabarti, G; Roy,S (2021) Bhabatarak Bhattacharyya (1944-2021); CURRENT SCIENCE Volume: 120 Issue: 12 Pages: 1940-1941; ISSN: 0011-3891.
9. Sinha, S; Nath, D; Roy, S (2021) Topology dependent payoffs can lead to escape from prisoner's dilemma; EUROPEAN PHYSICAL JOURNAL B Volume: 94 Issue: 4 Article Number: 80 DOI:10.1140/epjb/s10051-021-00087-x; ISSN: 1434-6028; eISSN: 1434-6036.
10. Bhowmik, TK; Sinha, TP (2021) Phase driven magnetic and optoelectronic properties of La2CrNiO6: A DFT and Monte Carlo perspective; JOURNAL OF SOLID STATE CHEMISTRY Volume: 304 Article Number: 122570; DOI:10.1016/j.jssc.2021.122570; ISSN: 0022-4596; eISSN: 1095-726X.
11. Rudra, M; Bhowmik, TK; Tripathi, HS; Kumar, RA; Sutradhar, R; Sinha, TP (2021) Hopping mechanisms, photoluminescence studies toward highly efficient UV-responsive Pr2MgTiO6 photocatalyst; PHYSICA B-CONDENSED MATTER Volume: 619 Article Number: 413213 DOI:10.1016/j.physb.2021.413213;ISSN: 0921-4526; eISSN: 1873-2135.
12. Bhowmik, TK; Sinha, TP (2021) Al-dependent electronic and magnetic properties of YCrO3 with magnetocaloric application: An abinitio and Monte Carlo approach; PHYSICA B-CONDENSED MATTER Volume: 606 Article Number: 412659; DOI:10.1016/j.physb.2020.412659; ISSN: 0921-4526; eISSN: 1873-2135.
13. Sinha, S; Nath, D; Roy, S (2021) Mass Testing and Proactiveness Affect Epidemic Spreading; JOURNAL OF THE INDIAN INSTITUTE OF SCIENCE Volume: 101 Issue: 3 Special Issue: SI Pages: 371-380 DOI: 10.1007/s41745-021-00247-z; ISSN: 0970-4140; eISSN: 0019-4964.
14. Nath, D; Sinha, S; Roy, S (2021) Scale-free networks may not necessarily witness cooperation; Europhysics Letters Volume: 134 Issue: 6 Article Number: 60002 DOI: 10.1209/0295-5075/134/60002; ISSN: 0295-5075; eISSN: 1286-4854.
15. Chatterjee, S; Sen, A; Das, S; Ghosh, SK; Biswas, S (2021) Study of charging-up effect for a single mask triple GEM detector; NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH SECTION, A-ACCELERATORS SPECTROMETERS DETECTORS AND ASSOCIATED EQUIPMENT Volume: 1014 Article Number: 165749 DOI: 10.1016/j.nima.2021.165749; ISSN: 0168-9002; eISSN: 1872-9576.
16. Ghosh, S; Juin, SK; Majumdar, SB; Majumdar, S (2021) Crucial role of glucosylceramide synthase in the regulation of stem cell-like cancer cells in B16F10 murine melanoma; MOLECULAR CARCINOGENESIS Volume: 60 Issue: 12 Pages: 840-858 DOI:10.1002/mc.23347; ISSN: 0899-1987; eISSN: 1098-2744.

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17. Paul, S; Sa, G (2021) Curcumin as an Adjuvant to Cancer Immunotherapy; FRONTIERS IN ONCOLOGY Volume: 11 DOI: 10.3389/fonc.2021.675923; ISSN: 2234-943X
18. Bhowmik, TK (2021) Observation of the magnetic criticality and the magnetocaloric effect in LaMn2Si2 in the vicinity of the phase transition around the room temperature; PHYSICS LETTERS A Volume: 419 Article Number: 127724 DOI: 10.1016/j.physleta.2021.127724; ISSN: 0375-9601; eISSN: 1873-2429.
19. Dattagupta, S (2021) Spin-boson model of quantum dissipation in graphene: Nonlinear electrical response; PHYSICAL REVIEW B Volume: 104 Issue: 8 Article Number: 085411 DOI: 10.1103/PhysRevB.104.085411; ISSN: 2469-9950; eISSN: 2469-9969.
20. Shendge, AK; Panja, S; Basu, T; Ghate, NB; Mandal, N (2021) Ameliorating effects of white mulberry on iron-overload-induced oxidative stress and liver fibrosis in Swiss albino mice; FOOD AND CHEMICAL TOXICOLOGY Volume: 156 Article Number: 112520 DOI: 10.1016/j.fct.2021.112520; ISSN: 0278-6915; eISSN: 1873-6351.
21. Manna, T; Rana, A; Misra, AK (2021) Synthesis of unsymmetrical glycosyl diselenides by the treatment of symmetrical diselenides with glycosyl selenocyanates; TETRAHEDRON Volume: 95 Article Number: 132358 DOI: 10.1016/j.tet.2021.132358; ISSN: 0040-4020; eISSN: 1464-5416.
22. Gucchait, A; Kundu, M; Misra, AK (2021) Synthesis of Pentasaccharide Repeating Unit Corresponding to the Cell Wall O-Polysaccharide of Salmonella enterica O55 Strain Containing a Rare Sugar 3-Acetamido-3-deoxy-D-fucose; SYNTHESIS-STUTTGART Volume: 53 Issue: 19 Pages: 3613-3620 DOI: 10.1055/s-0037-1610777; ISSN: 0039-7881; eISSN: 1437-210X.
23. Dutta, M; Chatterjee, A (2021) Assessment of the relative influences of long-range transport, fossil fuel and biomass burning from aerosol pollution under restricted anthropogenic emissions: A national scenario in India; ATMOSPHERIC ENVIRONMENT Volume: 255 Article Number: 118423 DOI: 10.1016/j.atmosenv.2021.118423; ISSN: 1352-2310; eISSN: 1873-2844.
24. Pandey, B; Dev, A; Chakravorty, D; Bhandare, VV; Polley, S; Roy, S; Basu, G (2021) Insights on the disruption of the complex between human positive coactivator 4 and p53 by small molecules; BIOCHEMICAL AND BIOPHYSICAL RESEARCH COMMUNICATIONS Volume: 578 Pages: 15-20 DOI: 10.1016/j.bbrc.2021.09.020; ISSN: 0006-291X; eISSN: 1090-2104.
25. Paul, S; Roy, D; Pati, S; Sa, G (2021) The Adroitness of Andrographolide as a Natural Weapon Against Colorectal Cancer; FRONTIERS IN PHARMACOLOGY; Volume: 12 Article Number: 731492 DOI:10.3389/fphar.2021.731492; eISSN: 1663-9812.
26. Kundu, M; Misra, AK (2021) Direct Synthesis of Unsymmetrical Glycosyl Disulfides from Glycosyl Bromides; EUROPEAN JOURNAL OF ORGANIC CHEMISTRY Volume: 2021 Issue: 26 Pages:3759-3767 DOI: 10.1002/ejoc.202100606; I The role of microRNAs and long non-coding RNAs in the regulation of the immune response to *Mycobacterium tuberculosis* infection SSN: 1434-193X; eISSN: 1099-0690.
27. Basu, C; Ganguly, HK; Basu, G (2021) Accommodation of Gly-cisPro in a designed beta-hairpin; CHEMICAL COMMUNICATIONS Volume: 57 Issue: 58 Pages: 7172-7175 DOI:10.1039/d1cc02640b; ISSN: 1359-7345; eISSN: 1364-548X.
28. Kundu, M; Basu, J (2021) The Role of microRNAs and Long Non-Coding RNAs in the Regulation of the Immune Response to Mycobacterium tuberculosis Infection; FRONTIERS IN IMMUNOLOGY Volume: 12 Article Number: 687962 DOI:10.3389/fimmu.2021.687962; ISSN: 1664-3224.
29. Ghosh, P; Barman, A; Das Gupta, SK (2021) Induced expression of the zwf gene in the presence of glucose contributes to lowering of glucose 6-phosphate level and consequently reduction of growth rate of Mycobacterium smegmatis; MICROBIOLOGY-SGM Volume: 167 Issue: 7 Article Number: 001067 DOI: 10.1099/mic.0.001067; ISSN: 1350-0872; eISSN: 1465-2080.
30. Banerjee, A; Bej, P (2021) Braess paradox in a quantum network; PHYSICAL REVIEW A Volume: 104 Issue: 5 Article Number: 052622 DOI: 10.1103/PhysRevA.104.052622; ISSN: 2469-9926; eISSN: 2469-9934.
31. Basak, P; Majumder, AL (2021) Regulation of stress-induced inositol metabolism in plants: a phylogenetic search for conserved cis elements; JOURNAL OF PLANT BIOCHEMISTRY AND BIOTECHNOLOGY Volume: 30 Special Issue: SI Pages: 756-778 DOI: 10.1007/s13562-021-00708-7; ISSN: 0971-7811; eISSN: 0974-1275.
32. Sen, A; Chatterjee, S; Roy, S; Biswas, R; Das, S; Ghosh, SK; Biswas, S (2021) Cosmic ray flux and lockdown due to COVID-19 in Kolkata - Any correlation? PRAMANA-JOURNAL OF PHYSICS Volume: 95 Issue: 2 Article Number: 64 DOI:10.1007/s12043-021-02106-z; ISSN: 0304-4289; eISSN: 0973-7111.

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33. Bhattacharyya, M; Basu, S; Dhar, R; Dutta, TK (2021) Phthalate hydrolase: distribution, diversity and molecular evolution; ENVIRONMENTAL MICROBIOLOGY REPORTS DOI: 10.1111/1758-2229.13028; ISSN: 1758-2229.

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178. S. Acharya et al. (ALICE Collaboration); Kaon-proton strong interaction at low relative momentum via femtoscopy in Pb-Pb collisions at the LHC; Phys. Lett. B 822 (2021) 136708.
179. S. Acharya et al. (ALICE Collaboration); First measurements of NN-subjettiness in central Pb−Pb collisions at √sNN=2.76 TeV; JHEP 10 (2021) 003.
180. S. Acharya et al. (ALICE Collaboration); Y production and nuclear modification at forward rapidity in Pb-Pb collisions at √sNN =5.02 TeV; Phys. Lett. B 822 (2021) 136579.
181. S. Acharya et al. (ALICE Collaboration); Jet fragmentation transverse momentum distributions in pp and p-Pb collisions at √sNN = 5.02 TeV; JHEP09 (2021) 211.
182. S. Acharya et al. (ALICE Collaboration); Multi-harmonic correlations of different flow amplitudes in Pb-Pb collisions at √sNN=2.76 TeV; Phys. Rev. Lett. 127 (2021) 092302.
183. S. Acharya et al. (ALICE Collaboration); Energy dependence of φ meson production at forward rapidity in pp collisions at the LHC; Eur. Phys. J. C 81 (2021) 772.
184. S. Acharya et al. (ALICE Collaboration); Production of muons from heavy-flavour hadron decays at high transverse momentum in Pb-Pb collisions at √sNN =5.02 and 2.76 TeV.
185. S. Acharya et al. (ALICE Collaboration); Coherent J/ψ and ψ′ photoproduction at midrapidity in ultra-peripheral Pb-Pb collisions at √sNN= 5.02 TeV; Eur. Phys. J. C 81 (2021) 712.
186. S. Acharya et al. (ALICE Collaboration); First measurement of coherent ρ0 photoproduction in ultra-peripheral Xe-Xe collisions at √sNN =5.44 TeV; Phys. Lett. B 820 (2021) 136481.
187. S. Acharya et al. (ALICE Collaboration); Soft-dielectron excess in protonproton collisions at √s= 13 TeV; Phys. Rev. Lett 127 (2021) 042302.
188. S. Acharya et al. (ALICE Collaboration); Pseudorapidity distributions of charged particles as a function of mid and forward rapidity mutiplicities in pp collisions at √s= 5.02, 7 and 13 TeV; Eur. Phys. J. C 81 (2021) 630.
189. S. Acharya et al. (ALICE Collaboration); Production of pions, kaons, (anti-)protons and φ mesons in Xe-Xe collisions at √sNN = 5.44 TeV; Eur. Phys. J. C 81 (2021) 584.

LIST OF PUBLICATIONS

190. S. Acharya et al. (ALICE Collaboration); Inclusive heavy-flavour production at central and forward rapidity in Xe-Xe collisions at √sNN=5.44 TeV; Phys. Lett. B 819 (2021) 136637.

191. S. Acharya et al. (ALICE Collaboration); Jet-associated deuteron production in pp collisions at √ss=13 TeV; Phys. Lett. B 819 (2021) 136440.

192. S. Acharya et al. (ALICE Collaboration); Long- and short-range correlations and their event-scale dependence in high-multiplicity pp collisions at √s =13 TeV; JHEP 05 (2021) 290.

193. S. Acharya et al. (ALICE Collaboration); Measurement of beauty and charm production in pp collisions at √s = 5.02 TeV via non-prompt and prompt D mesons; JHEP 05 (2021) 220.

194. S. Acharya et al. (ALICE Collaboration); Measurements of mixed harmonic cumulants in Pb-Pb collisions at √sNN = 5.02 TeV; Phys. Lett. B 818 (2021) 136354.

195. S. Acharya et al. (ALICE Collaboration); ΛK femtoscopy in Pb-Pb collisions at √sNN= 2.76 TeV; Phys. Rev. C 103 (2021) 055201.

196. S. Acharya et al. (ALICE Collaboration); First measurement of the |t|- dependence of coherent J/ψ photonuclear production; Phys. Lett. B 817 (2021) 136280.

197. S. Acharya et al. (ALICE Collaboration), Elliptic flow of electrons from beauty-hadron decays in Pb-Pb collisions at √sNN = 5.02 TeV; Phys. Rev. Lett. 126 (2021) 162001.

198. S. Acharya et al. (ALICE Collaboration), Production of light-flavor hadrons in pp collisions at √s = 7 and √s = 13 TeV, Eur. Phys. J. C 81 (2021) 256.

199. S. Acharya et al. (ALICE Collaboration), First measurement of quarkonium polarization in nuclear collisions at the LHC, Phys. Lett. B 815 (2021) 136146.

200. S. Acharya et al. (ALICE Collaboration), Centrality dependence of J/ψ and ψ (2S) production and nuclear modification in p-Pb collisions at √sNN=8.16 TeV, JHEP 02 (2021) 002.

201. S. Acharya et al. (ALICE Collaboration), Transverse-momentum and event-shape dependence of D-meson flow harmonics in Pb-Pb collisions at √sNN=5.02 TeV, Phys. Lett. B 813 (2021) 136054.

202. Seal S, Banerjee N, Mahato R, Kundu T, Sinha D, Chakraborty T, Sinha D, Sau K, Chatterjee S, Sau S. Serine 106 preserves the tertiary structure, function, and stability of a cyclophilin from Staphylococcus aureus. J Biomol Struct Dyn. 2021 Dec 30:1-16. doi: 10.1080/07391102.2021.2021992.

203. Shreya Roy, Sayak Chatterjee, Sayan Chakraborty, Saikat Biswas, Supriya Das, Sanjay K. Ghosh, Sunil K. Gupta, Atul Jain, Indranil Mazumdar, Pranaba K. Nayak, and Sibaji Raha (2021) Interplay between eclipses and soft cosmic rays; PoS(ICRC2021)131.

204. Saikat Biswas (2021) Research and development of scintillation detectors for the study of cosmic ray; Virginia Journal of Business, Technology, and Science, 1(1). https://doi.org/10.51390/vajbts.v1i1.18.

205. Saikat Biswas (2021) R&D of gas filled detectors for high energy physics experiments; Virginia Journal of Business, Technology, and Science, 1(1). https://doi.org/10.51390/vajbts.v1i1.3.

206. S Chatterjee, A Sen, S Das, S K Ghosh and S Biswas (2021) Study of charging-up effect for a single mask triple GEM detector; Nuclear Instruments and Methods in Physics Research, A 1014, 165749.

207. A Sen, S Chatterjee, S Das, S K Ghosh and S Biswas (2022) A new technique of linseed oil coating in bakelite RPC and the first test results; Nuclear Instruments and Methods in Physics Research, A 1024, 166095.

208. Kumar D, Laha S and Gangopadhyay G (2021) *In silico* and expression analysis of Δ^1-pyrroline-5-carboxylate synthetase in rice seedlings under NaCl stress. Research Journal of Biotechnology 16 (5): 31-40 Published online 22.04.2021.

209. Datta D, Prasad R and Gangopadhyay G (2022) Inter-specific hybrid sesame with high lignan content in oil reveals increased expression of sesamin synthase gene. Nucleus 65:7–18 (https://doi.org/10.1007/s13237-021-00354-3) Published online 19.05.2021.

210. Lata, S., Mahatha, A. C., Mal, S., Gupta, U.D., Kundu, M., Basu, J. (2022). Unraveling novel roles of the *Mycobacterium tuberculosis* transcription factor Rv0081 in regulation of the nucleoidassociated proteins Lsr2 and EspR, cholesterol utilization, and subversion of lysosomal trafficking in macrophages. *Molecular Microbiology* 117: 1104-1120

LIST OF PUBLICATIONS

211. Bhar, A., Jain, A. and Das, S. (2021). Soil pathogen, *Fusariumoxysporum* induced wilt disease in chickpea: a review on its dynamicity and possible control strategies. Proceedings of the Indian National Science Academy, 87(2) : 260-274. https://doi.org/10.1007/s43538-021-00030-9.

212. Bhar, A., Jain, A. and Das, S. (2022). Natural therapeutics against SARS CoV2: the potentiality and challenges. Vegetos, pp.1-10. https://doi.org/10.1007/s42535-022- 00401-7.

213. Sarkar, A*., Paul, S.*, Singh, C.*, Chowdhury, N.*, Nag, P.*, …… Ringe, R.P., Das, S. (2022) A novel plant lectin, NTL-125, interferes with SARS-CoV-2 interaction with hACE2. Virus Research 315: 198768. 10.1016/j.virusres.2022.198768

214. Nag, P., Paul, S., Shriti, S. and Das, S. (2022) Defence response in plants and animals against a common fungal pathogen, *Fusarium oxysporum*. Curr Res Microbial Sc. 3: 100135 https://doi.org/10.1016/j.crmicr.2022.100135

215. Nag, P., Mandal, N., Sarkar, J. and Das, S. (2022) *Paraburkholderia bengalensis* sp. nov. isolated from roots of *Oryza sativa*, IR64. Arch Microbiol. 204 : 347 10.1007/s00203-022-02960-4.

216. Roy D, Bose S, Pati S, Guin A, Banerjee K, Saha S, Singhal AK, Chakraborty J, Sarkar DK & Sa G (2021) GFI1/HDAC1-axis differentially regulates immunosuppressive CD73 in tumor-associated FOXP3+Th17 and inflammation-linked classical Th17 cells. *Eur J Immunol*. doi: 10.1002/eji.202048892.

217. Kajal K, Bose S, Panda AK, Chakraborty D, Chakraborty S, Saha S, & Sa G (2021) T-regulatory cell-shed VEGFA induces neo-angiogenesis in tumor micro-environment. *Cancer Immunol Immunother*, doi: 10.1007/s00262-020-02808-0.

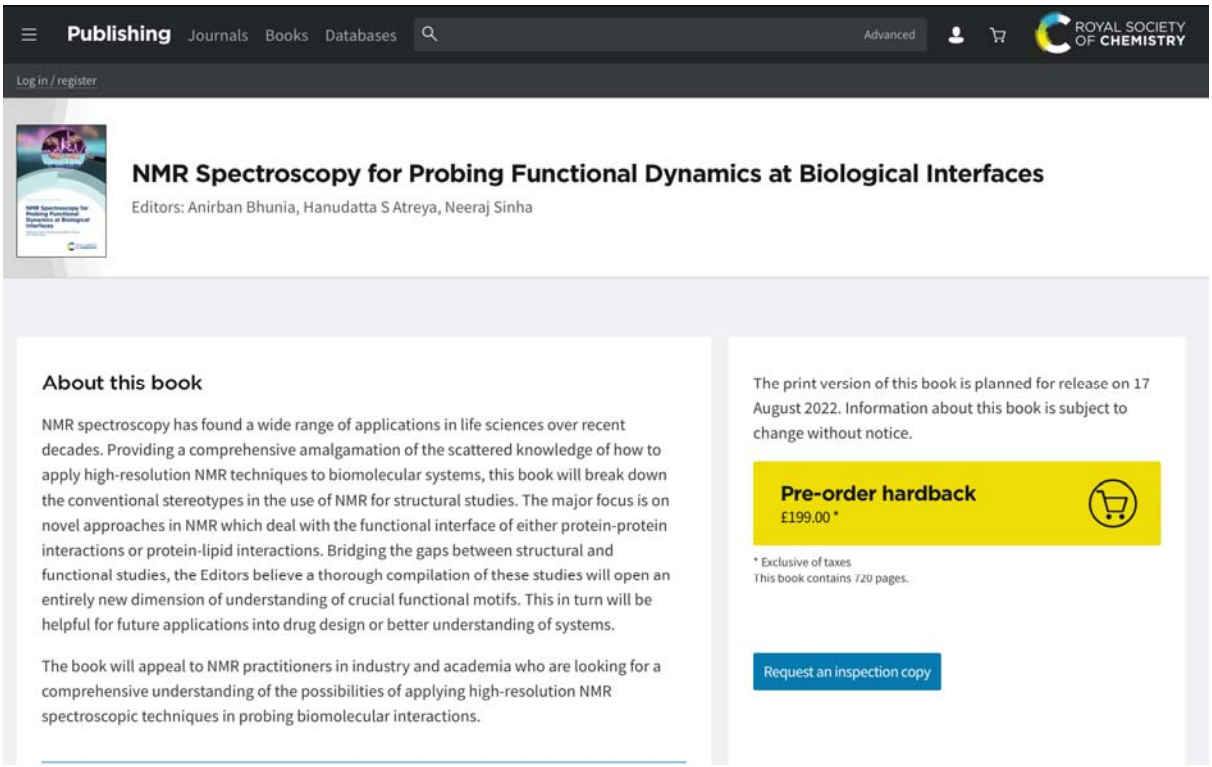
218. Sarkar T, Dhar S & Sa G (2021) Tumor-infiltrating T-regulatory cells adapt to altered metabolism to escape tumor-immune surveillance. *Current Research Immunology*, 2: 132-141. doi.org/10.1016 /j.crimmu.2021.08.002.

LIST OF BOOKS / BOOK CHAPTERS / INVITED REVIEWS

Biophysics

Prof. Anirban Bhunia

1. Edited a book on "NMR Spectroscopy for Probing Functional Dynamics at Biological Interfaces", invited by Royal Society of Chemistry, UK. The price of the book is **£199.00.**



2. Guest Editor of a themed issue on "**Secondary Metabolites and Peptides as Unique Natural Reservoirs of New Therapeutic Leads for Treatment of Cancer and Microbial Infections**" by Frontiers in Chemistry.

Micobiology

Dr. Wriddhiman Ghosh

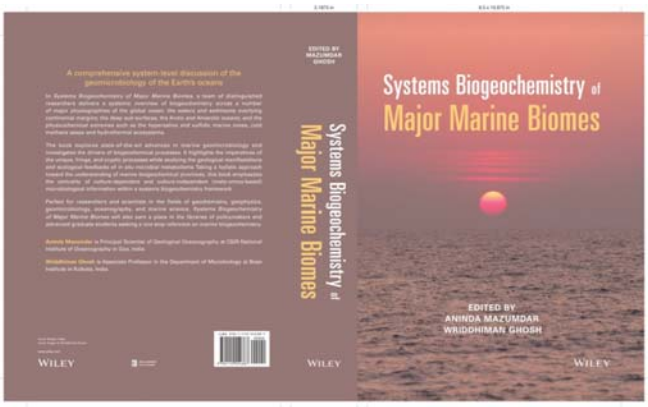
- The monograph (DOI:10.1002/9781119554356) titled "**Systems Biogeochemistry of major Marine Biomes**" - co-edited with Dr. AnindaMazumdar of Geological Oceanography Division, CSIR National Institute of Oceanography, India – was published by John Wiley and Sons, Inc., 111 River St, Hoboken, NJ 07030, USA on 28 March 2022. I have also written three chapters of this book as a corresponding author.

LIST OF BOOKS / BOOK CHAPTERS / INVITED REVIEWS

(i) Sarkar, J., Mondal, N., Mandal, S., Chatterjee, S. and Ghosh, W. (2022). Deep Subsurface Microbiomes of the Marine Realm. In Systems Biogeochemistry of Major Marine Biomes (eds A. Mazumdar and W. Ghosh). https://doi.org/10.1002/9781119554356.ch6.

(ii) Mandal, S., Mondal, N., Bhattacharya, S., Ghosh, W. and Bhadra, B. (2022). Biogeochemistry of Marine Petroleum Systems. In Systems Biogeochemistry of Major Marine Biomes (eds A. Mazumdar and W. Ghosh). https://doi.org/10.1002/9781119554356.ch7.

(iii) Mondal, N., Mandal, S. and Ghosh, W. (2022). Geomicrobiology at a Physicochemical Limit for Life. In Systems Biogeochemistry of Major Marine Biomes (eds A. Mazumdar and W. Ghosh). https://doi.org/10.1002/9781119554356.ch12.



Senior Scientists

Prof. Sampa Das

1. Paul S, Jain A, Shriti S, Das S (2022) Possible bioremediation strategies for arsenic detoxification by consortium of beneficial bacteria. In: Plant-Microbe Interactions. Singh H B and Vaishnao A (Eds.) CRC Press, eBook ISBN: 9781003171416. DOI: 10.1201/9781003171416-18.
2. Jain A, Bhar A and Das S (2021) Improving Biotic and Abiotic Stress Tolerance in Plants: A CRISPR-Cas Approach. In Genome Engineering for Crop Improvement (pp. 217-237). Springer, Cham. https://doi.org/10.1007/978-3-030-63372-1_9.
3. Bhar A, Jain A, Das S (2022) Development and regulation of microbial pesticides in the post-genomic era. In Advances in bio-inoculant science, biopesticides Editor(s): Rakshit A**,** Meena V S, Abhilash P C, Sarma B K, Singh H B, Fraceto L, Parihar M, Singh A K, Woodhead Publishing, pp 285-299, ISBN 9780128233559. https://doi.org/10.1016/B978-0-12-823355-9.00018-3.

PARTICIPATION IN CONFERENCES / SYMPOSIA / WORKSHOPS / INVITED TALKS DELIVERED

Biochemistry

Prof. Subrata Sau

- 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 held in Panaji, Goa during 10 − 13 December 2021.

Prof. Srimonti Sarkar

- Organized PhD Coursework Inauguration Lecture by Prof. Jan-e Alam, VECC.
- Organized International Women's Day Keynote Lecture by Prof. Tanuka Chattopadhyay, University of Calcutta.
- Organized and anchored panel discussion on 'The Contribution of Women in Science, Science Education & Science Management' on the occasion of International Women's Day.
- Delivered an invited lecture entitled ***Giardia lamblia*: An Unusual Model Organism Charts a Different Evolutionary Course** at Amity University, Kolkata, on 18th August, 2021.
- Poster presentation in conference "32nd Molecular Parasitology Meeting" organised by Marine Biological Laboratory, Woods Hole, MA, USA during October 5 − 9, 2021; Title of Poster: **Unique Proteasomal Architecture of *Giardia lamblia* and novel functions of some of its subunits** by Ankita Das, Atrayee Ray and Srimonti Sarkar.
- Poster presentation in conference "32nd Molecular Parasitology Meeting" organised by Marine Biological Laboratory, Woods Hole, MA, USA during October 5 − 9, 2021; Title of Poster: ***Giardia*'s Unique ESCRT Machinery with Altered Inter-subunit Interactions Within Some Complexes** by Nabanita Patra, Nabanita Saha and Srimonti Sarkar.

Dr. Abhrajyoti Ghosh

- Participated as a judge in the poster session and activity session in the 'Vigyan SarvatraPujyate', a program under the aegis of the **Azadi Ka Amrit Mahotsav** (celebrating the 75th Year of Indian Independence) held during February 22 -28, 2022 at Jagadis Bose National Science Talent Search (JBNSTS), Kolkata, West Bengal, India.
- 4th March 2022: Delivered an invited lecture entitled **"Exploring tea rhizosphere microbiome using deep sequencing"** in the **"Peek into Biodiversity and Beyond: A hands-on training workshop on NGS"** organized by the Indian Institute of Science, Education and Research (IISER), Kolkata, India.
- 15th January 2022: Delivered an invited lecture entitled ""Evaluation of Plant Growth Promoting Rhizobacteria and Influence of Rhizodeposition on the Tea Rhizosphere Microbiome of Darjeeling, India" in the **"Lecture series in celebration of AZADI KA AMRIT MAHOTSAV"** organized by the Department of Microbiology, Goa University, Goa, India.
- 4th September 2021: Delivered an invited lecture entitled "Understanding stress adaptation in thermoacidophilic archaea" in the **"Faculty Development Program: Emerging Areas in**

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Biological and Chemical Sciences" organized by the Department of Biosciences and Department of Chemistry, JIS University, West Bengal, India.

- 27th August 2021: Delivered an invited lecture entitled "Deciphering the Role of Toxin Antitoxin System in the archaeal stress adaptation" in the **International Webinar series "New horizons of integrative biology"** curated by the Department of Microbiology, Techno India University, West Bengal, India.
- 24th July 2021: Delivered an invited lecture entitled "A tale of two small heat shock proteins: insights into a novel substrate transfer pathway in archaea" in the ***"Faculty development program: Advancements in life science research: a bird's eye view"*** organized by The Amity Institute of Biotechnology, Kolkata, West Bengal, India.

Bioinformatics

Prof. Shubhhra Ghosh Dastidar

- Keynote at the workshop organized by JIS institute of Advanced studies and research, Kolkata, May 24, 2021
- Popular Science talk to the school students in the Science Day event at Bose Institute, Falta Campus, February 28, 2022
- Talk in the web-conference organized by ACTREC, Mumbai, March 10 − 11, 2022
- Plenary talk at the 15th National Seminar cum Workshop on 'Genomics and Bioinformatics in the High-throughput era' organized by Bioinformatics Facility, University of North Bengal, March 26-27, 2022.

Dr. Zhumur Ghosh

- Delivered an invited talk entitled "Role of Long noncoding RNAs in guiding mammalian development" at the meeting **Perspectives in Computational Biology** from April 1st to 3rd 2021, organised by IISER-Mohali.
- Delivered an invited talk entitled "Regulatory Noncoding RNomics - shaping modern day therapeutics" at **DBT MANAV- Data Science Webinar Series 2021** on 30th September 2021, organized by IISER-Pune.

Dr. Sudipto Saha

- Invited talk on "**LHSpred: a web based application for predicting lung health severity**", at BIC Webinar IX: Computational Biology Approaches to Combat COVID-19, organized by Bose Institute, online June 12, 2021.
- Invited talk on "**Possible Paths Toward Panacea of Allergic Diseases: From Biomarkers to Vaccines**", Health Informatics Summit, organized by IIIT Delhi online, October 17, 2021.

Biophysics

Prof. Anirban Bhunia

- NMRS webinar, Organized by Nuclear Magnetic Resonance Society of India.
- Chemical Biology Society webinar, organized by IISER Kolkata and CSIR-IICB.

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Chemistry

Prof. Jayanta Mukhopadhyay

- Mechanism of functions of delta factor from *B. subtilis*, BioNext 2021, April 2021 Admas University (online presentation).

Environmental Sciences

Dr. Abhijit Chatterjee

- ***Keynote address***: Delivered a popular lecture on the occasion of "International Blue Sky Day Celebration" held on 7th September, 2021 at West Bengal Pollution Control Board (Physical).
- ***Invited Talk***: International Webinar on Geology and Climate (GeoClimate 2021), September 28 – 29, 2021.
- ***International webinar series****: Periodically hosting (in the alternate month) the international webinar series, Air Quality Management Webinar, organized by The University of Wisconsin-Madison, Duke University and Bose Institute since February 2021*.

Molecular Medicine

Prof. Kaushik Biswas

- Presented an invited talk titled "*Understanding Carcinogenesis : Multidirectional Role of Gangliosides in Tumor Growth, Progression and Metastasis*" at the Faculty Development Lecture Series organized by Swami Vivekananda University, on August 06, 2021.
- Delivered an invited talk titled "Genome Editing : Past, Present and Future" in the Faculty Development Programme organized by MAKAUT on February 07 – 11, 2022.

Physics

Prof. Somshubhro Bandyopadhyay

- Participated at Local Organizing Committee ICQIF2022, ISI, Kolkata.

Prof. Dhruba Gupta

- Delivered a lecture on "Measurement of the ^{7}Be(d,p)^{8}Be* reaction at 5 MeV/A" at the ISOLDE Workshop and Users Meeting at CERN, December 14 – 16, 2021, Zoom Meeting Attended EURO-LABS Town Meeting, May 3 – 4, 2021, Zoom Meeting.
- Subhankar Maity gave a talk on "Monte Carlo simulations of nuclear experiments using NPTool" atthe Workshop on Advanced Radiation Detector and Instrumentation in Nuclear and Particle Physics (Online), Jammu University, India, October 25 – 29, 2021.
- Sk Mustak Ali gave oral presentations on "Measurement of ^{7}Be(d,p)* reaction at 5 MeV/A at HIE-ISOLDE, CERN" and "Study of ^{7}Be + p elastic scattering at 5 MeV/A"at the "65th DAE Nuclear Physics Symposium", Bhabha Atomic Research Centre, Mumbai, December 1 – 5, 2021.
- Kabita Kundalia gave an oral presentation on "Study of α- cluster transfer reactions with ^{7}Be in the context of He-Burning processes" and poster presentations on "Composition of different calibration methods for Si-strip detectors" and "Elastic and inelastic scattering of ^{7}Be on ^{12}C at 5 MeV/A"at the "65th DAE Nuclear Physics Symposium", Bhabha Atomic Research Centre, Mumbai, December 1 – 5, 2021. Kabita received the Best Poster Prize in the Nuclear Reaction and Nuclear Astrophysics Category for her poster presentation.

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- Kabita Kundalia gave an oral presentation titled "Elastic scattering and transfer reaction with ^{7}Be on ^{12}C" at the Conference on Low Energy Reaction Dynamics, Aligarh Muslim University, March 7 − 9, 2022.
- Kabita Kundalia gave an oral presentation titled "Study of α−transfer reactions with ^{7}Be in the context of nuclear astrophysics" at @FlipPhysics Workshop, Instituto de Física Corpuscular, Valencia, Spain, March 21 − 25, 2022**.**

Prof. Achintya Singha

- Delivered invited talk in the Webinar and online training program on 'Raman Spectroscopy', during 11 to 12 November, 2021 organized by IIT Kharagpur and HORIBA Scientific India
- Delivered invited talk in the Webinar Internship Course on "Emerging Trends in Nanomaterials for Different Device Architectures (ETNDDA-2021) during 15th September to 28st November 2021 organized by The Council of the Indian Chemical Society.
- Delivered invited talk in Refresher Course in "Advances in Nano-Science and Nano-Technology", conducted by the UGC – Human Resource Development Centre, the University of Burdwan from 26.11.2021 to 09.12.2021.
- Delivered 26th Lecture in Siksha 'O' Anusandhan Weekly Academic Lectures (SOAWAL - 2022) organized by Department of Chemistry, in Siksha 'O' Anusandhan, deemed to be University, Bhubaneswar, Odisha, India on 26th February 2022.

Prof. Supriya Das

- "Statistical Methods and Error Analysis" (Series of 4 online lectures) in 'IV ALICE – India School on QGP', November 2021.
- Organised National Science Day 2022 on February 28, 2021 at Bose Institute.
- "Compressed Baryonic Matter: Peep into the Core of Neutron Stars" – Faculty talk at Bose Institute on March 23, 2022.

Dr. Saikat Biswas

- Delivered two lectures in "IV ALICE-India School on Quark-Gluon Plasma", on "Building of Detectors for High Energy Physics Experiments" November 8 - November 20, 2021.
- Worked as the coordinator of selection of best student award in "IV ALICE-India School on Quark-Gluon Plasma", 8 − 20 November, 2021.
- Participated in IISF 2021- Mega Science Expo, Goa and was in-charge of Bose Institute stall.

Mr. Sayak Chatterjee

- Presented a poster on "Effects of charging-up on Gas Electron Multiplier detector" at the CERN-Fermilab HCP Summer School on August 28, 2021
- Presented a talk on "Characterisation of Gas Electron Multiplier detector for high-rate experiments" at the VIRTUAL SCHOOL ON FLAVOR STRUCTURE OF THE STANDARD MODEL on September 11, 2021.
- Presented a talk on "Charging up effect in triple GEM detector" at the Workshop on Advanced Radiation Detector and Instrumentation in Nuclear and Particle Physics (RAPID2021) on October 26, 2021.
- Presented a talk on "Gain, energy resolution measurement of GEM detector and coincidence setup demonstration using cosmic ray" at the Workshop on Advanced Radiation Detector and Instrumentation in Nuclear and Particle Physics (RAPID2021) on October 27, 2021.

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- Presented a talk on "Characterization of Gas Electron Multiplier Detector" at 3rd National Conference on Frontiers of Modern Physics (NCFMP 2021) on November 26 – 27, 2021.

Mr. Arindam Sen

- Presented a poster on "Bakelite RPC with a New Technique of Linseed Oil Coating" at CERN-Fermilab HCP Summer School, August 23 − September 4, 2021.
- Presented a talk on "Bakelite RPC with and without linseed oil coating" at Workshop on Advanced Radiation Detector and Instrumentation in Nuclear and Particle Physics (RAPID2021), October 25 − 29, 2021.
- Presented a talk on "Gain, energy resolution measurement using GEM detector and coincidence setup demonstration using cosmic ray" (Virtual lab visit) at Workshop on Advanced Radiation Detector and Instrumentation in Nuclear and Particle Physics (RAPID2021), October 25 − 29, 2021.
- Presented a talk on "A new technique of linseed oil coating in Resistive Plate Chamber" at 3rd National Conference on Frontiers of Modern Physics (NCFMP 2021), November 26 - 27, 2021.

Dr. Sidharth Kumar Prasad

1. Conference organised on "ALICE-STAR India Collaboration Meeting August 2021" during 17 − 20 August, 2021.
2. Conference organised on "Hindi Diwas and Hindi Pakhwada 2021" during September 14 – 28, 2021.
3. Organized "IVth ALICE-India school on Quark-Gluon Plasma" during November 08 – 20, 2021.
4. Organized following webinars:
   a. April 22, 2021; Speaker: Prof. Paolo Giubellino, Scientific Managing director, FAIR, Germany on "FAIR: The universe in the lab".
   b. June 06, 2021; Speaker: Prof. Ralf Rapp, Texas A&M University, USA on "In-Medium T-Matrix approach for Heavy Quarks and the sQGP".
   c. September 30, 2021; Speaker: Prof. Sergei Voloshin, Wayne State University, Detroit, USA on "Search for Chiral Magnetic Effect in isobar collisions at RHIC".
   d. February 19, 2022; Speaker: Prof. Peter Braun-Munzinger, Scientific Director, EMMI, GSI (Germany).
   e. March 21, 2022; Speaker: Dr. Archana Sharma, Principal Physicist, CERN, Geneva on "Gaseous detectors: State-of-the-art and future perspective".
5. Delivered a talk on "PMD in ALICE" ALICE-STAR India Collaboration meeting on 17 – 20, August, 2021.
6. Delivered a talk on "ALICE India Physics co-ordination" in ALICE-STAR India Collaboration board meeting on August 19, 2021.
7. Participated and represented Bose Institute on "Multiplicity and transverse spherocity dependent study of inclusive charged jet properties in pp collisions using PYTHIA" in XXIV DAE-BRNS HEP SYMPOSIUM on 14 – 18 December, 2020.
8. Mr. Abhi Modak presented a poster on "India International Science Festival – IISF" during 10 – 13 December, 2021.

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Plant Biology

Prof. Shubho Chaudhuri

- Poster presentation in conference "**From 3D light to 3D electron microscopy**" organised by EMBL, Heidelberg, Germany during 13th- 16th March, 2022; Tittle of Poster: **Unravelling the role of a novel plant exclusive ARID-HMG protein in early stages of pollen grain development** by Ruby Biswas, Sonal Sachdev, Shubho Chaudhuri.

Prof. Gaurab Gangopadhyay

- Acted as the resource person (internal) for the National Science Day Celebration at the Falta campus of Bose Institute on 28.02.2022; delivered the lectures entitled (1) Acharya JC Bose – His transition from a Physicist to Biologist, and (2) Crop improvement: From traditional techniques to the plant molecular biology and biotechnology.
- Invited to deliver a scientific lecture at the Department of Botany, Serampore College, Hooghly for the under graduate and post graduate students on 11.03.2022; delivered the lecture entitled "Plant developmental biology - a molecular insight and a few case studies of plant transgenic technology".

Prof. Pallob Kundu

- Ananya Mukherjee and **Pallob Kundu**, Developing an optimized toolkit for inducible regulation of gene expression in tomato plants" has been selected for an E-poster presentation in the Original Research category at iCRISPR-2021, the National Conference on 'CRISPR/Cas: From Biology to Technology", November 25 – 27, 2021, virtual mode organized by SRM University AP.
- For the celebration of National Science Day, we have organized a One-day scientific programme for local school students on the topic "Commonly Used Biotechnological Methods" at the Falta Experimental Farm, Bose Institute on 28 February 2022. Total 150 students and teachers have participated.

Senior Scientists

Prof. Gourisankar Sa

- 21 Online and offline talk delivered in various International and National Conferences.
- 9 International and National Conferences Sessions were Chaired.

LIST OF ON-GOING PROJECTS

Sl. No.	Funding Authority	Date of Commencement	Date of Termination	Principal Investigator	Title of the Projects	Grant Sanctioned
1	DBT	09-Jan-17	08-Jul-22	Director, Bose Institute	Multi-dimensional Reserch to Enable Systems Medicine: Acceleration using a Cluster Approach' at Kalyani, West Bengal	14,05,32,000
2	DBT	13-Jul-17	12-Jul-21	Prof. Manikuntala Kundu	Transcriptional regulator RegX3-dependent modulation of the macrophage immune response by Mycobacterium tuberculosis	61,84,000
3	DBT	30-Jan-18	29-Jul-21	Prof. Mahadeb Pal	Understand molecular mechanism of action of a protein chaperone inducer azadiradione and its therapeutic development for Parkinson's disease treatment	36,02,000
4	DBT	16-Jul-18	15-Jul-22	Dr. Pallob Kundu	Developing an optimized toolkit for induicible genome editing and regulation of gene expression in tomato plant: implicaitons in adjusting complex traits via synthetic biology approach	78,06,800
5	DBT	24-Sep-18	23-Sep-22	Prof. Gaurisankar Sa	Development of delivery system for miR-325-3p for immunotherapy of cancer	79,29,800
6	DBT-WB	15-May-18	14-May-21	Dr. Gaurab Gangopadhyay	Development of Transgenic Pineapple Over-expressing AcSERK to Combat Fungal Pathogens	19,99,645
7	DBT-WB	02-Jul-18	01-Jul-21	Dr. Shubho Chaudhuri	Investigating the role of Trithorax factor ULTRAPETALA1 in salt stress response in rice	43,31,840
8	DBT-WB	28-Aug-18	27-Aug-21	Prof. Gautam Basu	The significance of feedback loop between ZEB1 and PRMT in Fbroblast growth factore (FGF)-mediated epithelial-mesenchymal transition in Breast Cancer	30,30,000

Sl. No.	Funding Authority	Date of Commencement	Date of Termination	Principal Investigator	Title of the Projects	Grant Sanctioned
9	DST	28-Mar-19	06-Mar-22	Prof. Sanjay K. Ghosh	Development of a cost effective and portable electrooptical system for effective investigation of residual ambient gases using spark emission spectrometry towards the estimation of atmospheric gases compostiton w.r.t. height using high flying drones	24,37,600
10	DST (SPLICE-Climate Change Programme)	22-Mar-18	19-Mar-22	Dr. Abhijit Chatterjee	Understanding the Role of Local and Transported Biogenic and Anthropogenic Aerosols on Microphysical and Chemical Properites of Low Level Clouds Over Eastern Himalaya, India	74,08,800
11	IFCC	01-Aug-16	31-Jul-22	Prof. Sanjay K. Ghosh / Dr. Saikat Biswas	CBM MUCH	28,80,40,000
12	IITM(MOES)	13-Sep-18	12-Sep-21	Dr. Abhijit Chatterjee	Study on Biosphere-Atmosphere Exchange of Carbon Dioxide, Water Vapour and Energy in a High Altitude Forest Canopy at Eastern Himalaya	25,08,000
13	MoEFCC	29-Mar-17	28-Jun-22	Dr. Abhijit Chatterjee	National Carbonaceous Aerosols Programme (NCAP) WGIII: Carbo-naceous Aerosols Emmi-ssions, Source appointment and Climate effects	1,06,08,000
14	SERB	24-Jul-18	23-Jan-22	Dr. Shubho Chaudhuri	Investigating the role of Arabidopsis ARID-HMG protein, AtHMGB15, in the pollen development process	46,29,744
15	SERB	09-Aug-18	18-Jan-22	Dr. Zhumur Ghosh	SERB Women Excellence Award to Dr. Zhumur Ghosh, BIC "LncRNA target connectivity to Small Molecules: Implication in Cancer Therapy"	18,00,000
16	SERB	15-Sep-18	14-Sep-21	Dr. Achintya Singha	Fabrication of Infreared Photo-detector based on 2D systems and Tuning the Detection Windows by coupling with Nanostructures	50,33,714

Sl. No.	Funding Authority	Date of Commencement	Date of Termination	Principal Investigator	Title of the Projects	Grant Sanctioned
17	SERB	11-Oct-18	10-Oct-21	Dr. Jayanta Mukhopadhyay	Evaluating the role and mechanism of function of delta factor of Bacillus subtilis	30,69,000
18	SERB	26-Mar-19	25-Mar-22	Dr. Abhrajyoti Ghosh	Response of B. aryabhattai AB211 to maize root exudates: insights from transcriptome analysis	38,68,803
19	SERB(DST)	03-May-07	02-May-22	Prof. Pinakpani Chakrabarti	Award of J.C. Bose Fellowship to Prof. Pinakpani Chakrabarti	40,00,000
20	SERB(DST)	26-Mar-07	31-Mar-22	Prof. Siddhartha Roy	Award of J.C. Bose Fellowship to Prof. Siddhartha Roy	9000000 (FOR LAST 5YEARS)
21	SERB(DST)	01-Apr-17	17-Dec-25	Prof. Joyoti Basu	Award of J.C. Bose Fellowship to Prof. Joyoti Basu	54,00,000
22	CSIR	01-Aug-19	31-Jul-22	Prof. Gaurisankar Sa	Developmental and functional aspects of newly identified CD8+ T-regulatory cells in tumor microenvironment	21,00,000
23	DBT	20-Dec-18	16-Jun-22	Prof. Gaurisankar Sa	Investigation of the Transcriptional Regulation of miR-325 and Evaluating its Potential as a Therapeutic Agent for Cancer	80,00,000
24	CCRH	01-Aug-19	31-Mar-22	Prof. Gaurisankar Sa	Role of Silica in Cancer regression : A mechanistic study	11,59,830
25	SERB	05-Dec-18	04-Jun-22	Dr. Anirban Bhunia	Intracellular Dyamics of Small Molecules During Novel AMP-mediated Resilience in Planta: A Multidisciplinary Approach	30,70,000
26	SERB	06-Jul-19	05-Jan-23	Dr. Pallob Kundu	Convergent miRNA actions in coordination of stress-response to Alternaria solani infection in tomato lines	52,30,828
27	SERB	07-May-19	06-May-22	Prof. Srimonti Sarkar	Characterization of the cellular roles of the proteasome and its deubiquitinase GIRpn11 of the differently-diverged eukaryote Giardia lamblia	42,33,000

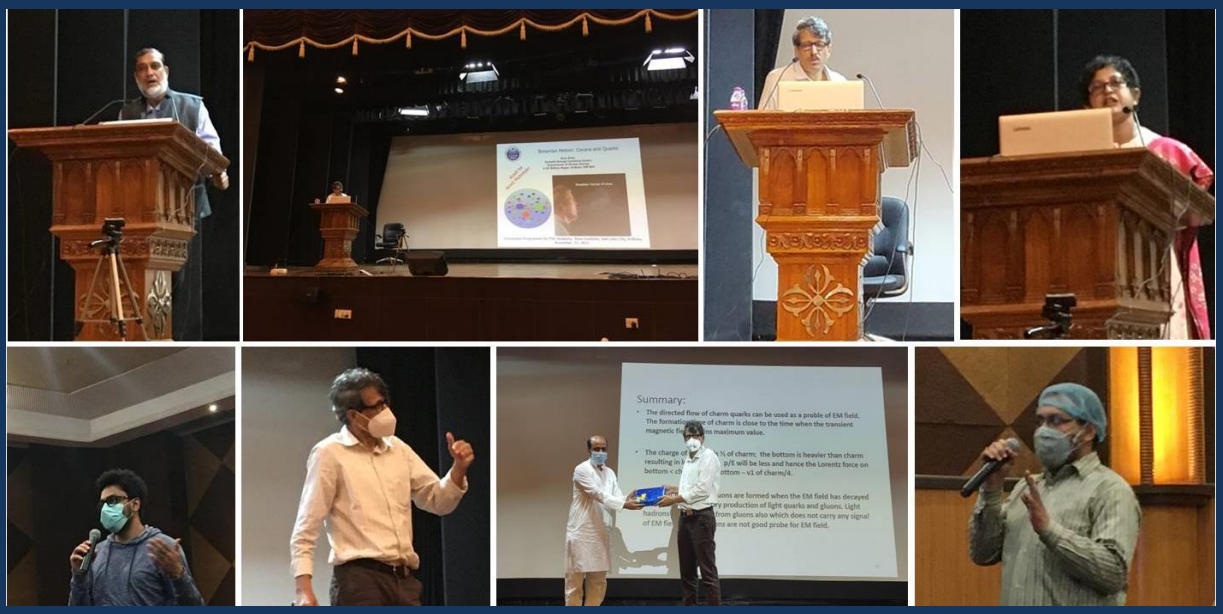
Sl. No.	Funding Authority	Date of Commencement	Date of Termination	Principal Investigator	Title of the Projects	Grant Sanctioned
28	CSIR	01-Sep-19	31-Aug-22	Dr. Sanat Kr. Das	Physico-chemical factors influencing Aerosol Hygroscopicity during fog, its effect on Aerosol Radiative Properties and fog nowcasting: a study in the context of Regional Climate Change over Eastern India	30,52,000
29	CSIR	26-Aug-19	31-Aug-22	Dr. Anupama Ghosh	Deciphering the involvement of programmed cell death in the pathogenic develop-ment of *Ustilago maydis*	19,60,000
30	Indo-Swiss	24-Jun-19	23-Jun-23	Prof. Siddhartha Roy	Next generation advanced therapies for fight β-hemoglobino-pathies via rational intervention in ϒ-globin regulatory network	1,16,21,600
31	ICMR	08-Aug-19	07-Aug-21	Dr. Sudipto Saha	Development of knowledge base on pulmonary diseases for estimating the prevalece and etiology : a pilot study in eastern India	1,66,000
32	DBT	09-Oct-19	08-Oct-22	Dr. Anirban Bhunia	Tailor Made Peptidomimetics Designing Against Human Islet Amyloid Polypeptide (hIAPP) Aggregation: A Therapeutic Approach Associated With Type-2 Diabetes	66,74,500
33	CSIR	26-Aug-19	31-Aug-22	Dr. Abhrajyoti Ghosh	Decipherig the cross-talk between rhizosphere microbiome and the plant: insights from tea rhizosphere microbiome, metabolome and culture dependent analyses	20,00,000
34	ICMR	28-Aug-19	27-Aug-22	Dr. Kaushik Biswas	Understand the epigenetic regulation of GM2-synthase gene in cancer	25,30,000
35	SERB	04-Dec-18	03-Dec-21	Prof. Mahadeb Pal	Understand regulation of heat shock factor 1 activities in human cells	30,65,148
36	SERB	29-Jan-20	28-Jan-23	Prof. Anup Kumar Misra	Synthesis of the polysaccharide fragments of opportunistic human pathogens Providencia strains and their glycoconjugate derivatives	26,02,800

Sl. No.	Funding Authority	Date of Commencement	Date of Termination	Principal Investigator	Title of the Projects	Grant Sanctioned
37	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	23,50,000
38	SERB	18-Dec-20	17-Dec-25	Dr. Smarajit Polley Dr. Atin K. Mandal Dr. 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	28,60,33,520
39	DBT-WB	17-Mar-21	16-Mar-24	Dr. Atin Kumar Mandal	Characterizing the interaction between Phosphodiesterase 8 (PDE8A) and 14-3-3 with CRAF: Gaining insights into CRAF regulation	21,40,000
40	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	14,01,59,760
41	DBT	27-Sep-19	26-Sep-22	Dr. Subhrangsu Chatterjee	Unraveling the mechanism of action of LINC00273 (Long intergenic Non Coding RNA) in inducing Epithelial to Masenchymal Transition in Cancer	69,28,000
42	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	6,15,00,00,000
43	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	52,72,400
44	SERB	24-Jan-22	23-Jan-25	Dr. Anupama Ghosh	Investigating the role of HSP20 in the pathogenic development of Ustilago maydis	29,61,495

Sl. No.	Funding Authority	Date of Commencement	Date of Termination	Principal Investigator	Title of the Projects	Grant Sanctioned
45	DBT	23-Mar-22	22-Mar-27	Prof. Sbhbhra Ghosh Dastidar Dr. Zhumur Ghosh	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, Kolkata	1,87,54,131
46	DST & DAE	03-Nov-21	31-Oct-26	Prof. Supriya Das	Indian Participation in the ALICE Experiment at CERN	5,73,50,000
47	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	38,14,360
48	Wellcome Trust DBT	01-Feb-2016	31-Jan-22	Dr. Smarajit Polley	Wellcome Trust DBT India Alliance Intermediate Fellowship - Understanding the Biochemical and Structural Basis of Signaling Modularity of Kinases in Their Biological Context	3,59,32,160

– SCIENTIFIC REPORT –

DEPARTMENT OF BIOCHEMISTRY



As a part of celebration of 75th year of Independence "AZADI KA AMRIT MAHOTSAV" Bose Institute organised **"Orientation Programme (Bose Institute Ph.D. Coursework)"** on November 17, 2021. Keynote Lecture on **The Brownian Motion of Corona and Quarks,** was delivered by **Prof. Jan-e Alam** from Variable Energy Cyclotron Centre (VECC), Department of Atomic Energy, Salt Lake City, Kolkata.

DEPARTMENT OF BIOCHEMISTRY

OVERVIEW

Since its inception in 1974, research at the Department of Biochemistry has focused on understanding the properties of various biological macromolecules and their interactions with other cellular components. The department's mission has been aimed at finding scientific solutions to various national needs and also to educate and train the next generation of researchers. Our scientists are studying how organisms respond to various kinds of stress, how macromolecular complexes gain specificity, how the biology of pathogenic microbes differs from that of the host, how to contain microbial virulence, and how to alleviate processes contributing to neurodegenerative diseases. Our administrative and technical support staff are a vital part of our research ecosystem. Students who join this department can look forward to a vibrant and supportive research environment. We are proud of our alumni, many of whom have achieved greatness in their chosen research fields.

LIST OF PERSONNEL

Faculty Members: Prof. Pinakpani Chakrabarti (J. C. Bose Fellow), Prof. Subrata Sau, Prof. Srimonti Sarkar (Chairperson), Prof. Ajit Bikram Datta, Dr. Abhrajyoti Ghosh.

Research Scientist : Dr. Tanaya Chatterjee, *DST-(WOS-A)*, Dr. Shreya Sengupta (DST-Woman Scientist) (terminated on 14.02.2022).

Students : JRF/SRF : Avishikta Chatterjee, Pritha Mondal, Trisha Ghosh, Debasmita Sinha, Sangita Mondal, Anurupa Sett, Manish Sarkar, Ankita Das, Mousam Roy, Sayantan Mukherjee (terminated on 21.02.2022), Sayandeep Gupta, Tushar Chakraborty, Kaustav Bhakta, Arghya Bhowmick, Agnita Acharya, Jagriti Das, Nabanita Patra. ***Senior Project Associate:*** Dr. Debarun Acharya (from 01.10.2021). ***CSIR RA:*** Dr. Shyantan Mukherjee (from 15.03.2022). ***RA :*** Dr. Triparna Mukherjee, Dr. Swapan Kr. Jana, ***Project Assistant (J. C. Bose Fellowship of Prof. Pinakpani Chakrabarti) :*** Jesmita Dhar, Supriyo Bera.

Staff Members: Rama Chatterjee, Dipak Ch. Konar, Atanu Pramanik, Kissun Turi.

PROF. SUBRATA SAU
Professor
Department of Biochemistry

Group Members:
Tushar Chakraborty, *SRF*
Debasmita Sinha, *SRF*

Research background and vision:

Staphylococcus aureus remains one of the dreaded health hazards on the earth primarily due to the emergence of antibiotic-resistant strains of this bacterium and the non-availability of a vaccine. The virulence factors and virulence regulators, produced by *S. aureus* for causing diseases, have not been elaborately investigated though these determinants may be exploited in the discovery of new antistaphylococcal agents. To expedite the screening and designing of such agents, we are, therefore, engaged in understanding the structure, function, folding mechanism, and stability of various *S. aureus*-encoded virulence determinants, namely, alternative sigma factor σ^B, anti-σ^B factor RsbW, anti-RsbW factor RsbV, cyclophilin Cyp, and CapF, a capsule-producing enzyme. RsbW not only blocks σ^B but also phosphorylates RsbV. σ^B also manages stress-response in *S. aureus*.

Summary of research during April 1, 2021 – March 31, 2022:

The residues Ser 106 and Trp 136 of *S. aureus* Cyp aligned with an Ala and a Phe residue of other cyclophilins, respectively. To demonstrate their roles, mutants Cyp[S106A] and Cyp[W136A], were constructed by replacing Ser 106 and Trp 136 of Cyp with an Ala residue. Our studies have shown that the inhibitor binding affinity and enzymatic activity of Cyp[W136A] are identical to those of Cyp, whereas these are different in Cyp[S106A]. The stability, tertiary structure, surface hydrophobicity, and Trp accessibility of Cyp[S106A] are also significantly different in comparison with those of Cyp. The computational investigations also agreed with our *in vitro* studies. We have observed that Ser 106 of Cyp, compared to Ala at the same position, generated a higher number of non-covalent bonds with the cognate inhibitor.

To understand the folding-unfolding mechanism of *S. aureus* CapF, urea- and guanidine hydrochloride (GdnCl)-induced unfolding of a recombinant CapF (rCapF) was studied separately. The unfolding of rCapF was reversible but occurred via the formation of multiple dimeric intermediates. While intermediates, rCapF1, rCapF2, and rCapF3, were generated at 1 M, 2 M, and 3 M urea, intermediates, rCapF4 and rCapF5, were produced at 0.5 M and 1.5 M GdnCl, respectively. No intermediate (except rCapF5) lost NADPH binding activity. rCapF3 had a rCapF-like shape, whereas other intermediates had a relatively smaller shape. rCapF4 though lost the maximum extent of shape, its secondary structure remained unaffected. In addition, the tertiary structure and hydrophobic surface area of the intermediates not only varied from each

other but also varied from those of rCapF. At least one of the four Trp residues in the rCapF intermediates also had higher solvent accessibility. Our computational studies have indicated that the region around Trp 137 of CapF is most sensitive, whereas the NADPH binding motif at the N-terminal end of this protein is relatively resistant to unfolding.

A modeling study previously demonstrated that the putative dimeric region at the N-terminal end of RsbW binds σ^{B3}, the domain 3 of σ^{B}. In addition, nine RsbW residues (Arg 23, Leu 24, Ser 31, Arg 32, Ala 35, Tyr 37, Ile 40, Lys 44 and Glu147) form non-covalent bonds with ten residues (Arg 19, Ile 23, Ile 26, Glu 34, Glu 35, Glu 36, Leu 38, Glu 39, Glu 42 and Tyr 47) of σ^{B3}. Our computational studies have suggested that Arg 23, Leu 24, Ser 31, Arg 32, and Lys 44 might be essential for interaction between RsbW and the domain 3 of σ^{B}. To verify the *in silico* data, construction and purification of RsbW mutants are in progress.

Major accomplishment (significant results):

- Ser 106 preserves the tertiary structure, function, and stability Cyp.
- CapF unfolds via the formation of multiple intermediates.
- Constructed and purified additional RsbW mutants.

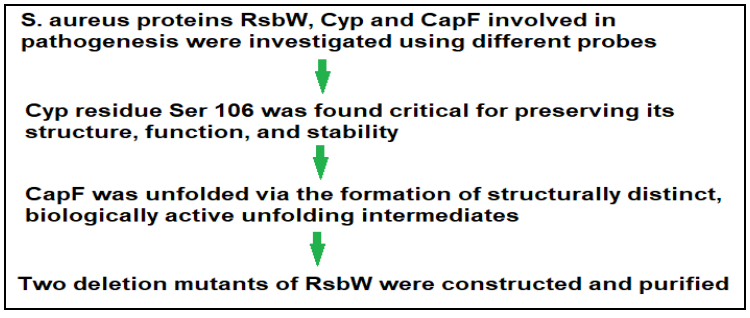
Future plan for 2022-23:

- Understanding the effects of zinc metal ion on CapF.
- Purification and characterization of CapF domains.
- Purification and characterization of RsbW and σ^{B3} mutants.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
01	02	–	01	–	–	–

Average publication impact factor: **3.392**



PROF. SRIMONTI SARKAR
Professor
Department of Biochemistry

Group Members:
Nabanita Patra, *CSIR-SRF Adhoc*
Ankita Das,
INSPIRE Fellow-SRF Adhoc
Avishikta Chatterjee,
INSPIRE Fellow-SRF Adhoc
Pritha Mondal, *CSIR-SRF Adhoc*
Trisha Ghosh, *UGC-SRF Adhoc*
Anurupa Sett, *UGC-JRF Adhoc*

Collaborators:
Prof. Alok Kumar Sil, Dept. of Microbiology,
Calcutta University
Dr. Sandipan Ganguly, Scientist F, Division of Parasitology,
National Institute for Cholera and Enteric Diseases

Research background and vision:

My laboratory is engaged in studying two different model organisms, the parasitic protist *Giardia lamblia* and yeast *Saccharomyces cerevisiae*. We use molecular genetic approaches to interrogate the functions and assemblies of various cellular machineries of *Giardia*. This parasite is the causative agent for giardiasis, a diarrheal disease that is highly prevalent in tropical countries such as India, with reports indicating that ~33% of the population may be affected. We are studying pathways of *Giardia* that are not only important for its survival inside the host, but also its transmission from one host to another. Our aim is to uncover parasite-specific features of such pathways so that these may be targeted for therapeutic purposes. We are also assessing the role of the yeast vacuole in mediating stress response, with the ultimate aim of bioengineering yeast strains in order to make them better suited for food and beverage production.

Summary of research during April 1, 2021 – March 31, 2022:

We have uncovered several parasite-specific attributes within the proteasomal and also the lysosomal protein degradation machinery of *Giardia*. These may be exploited for developing new therapeutic options that will specifically target the parasite and have little or no effect on the host. Although *Giardia* is a basal eukaryote, it has many unique morphological features, including having an intricate and complex microtubule-based cytoskeleton. Our research is revealing that many of the giardial orthologues of well-characterized proteins from higher eukaryotes, have gained additional functions that enable them to associate with subcellular structures that are unique to the parasite.

Major accomplishment:

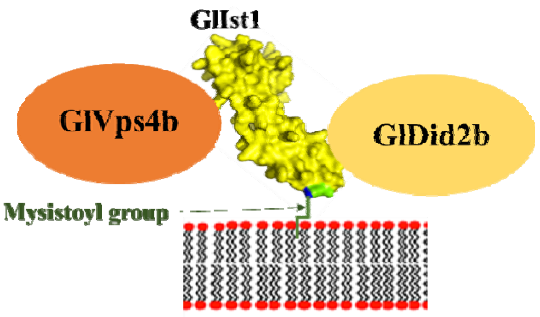
- Revealed an important mechanistic divergence between the host and giardial ESCRT pathways and uncovered a possible role of the ESCRT machinery in sustaining the ventral disc, which is an important virulence factor of *Giardia*
- Detected enhanced binary-interactions between several proteasomal lid subunit pairs, and these are likely to compensate for the absence of lid-stabilizing factors in *Giardia*. Also, a weaker interaction between the GlRpn8-GlRpn11 pair may be necessary to support the extra-proteasomal role of GlRpn11.
- Proteomic studies indicated that the differential phosphorylation status of the GlαSNAPs during encystation may be the underlying reason for their rapid subcellular redistribution during encystation.
- Documented that the shape of the yeast vacuole changes in response to alcohol stress; alcohol also inhibits ESCRT-mediated protein sorting into the vacuole.

Future plan for 2022-23:

- Conduct structure-function studies to uncovered the basis of selective interactions between the paralogues of GlNSF and GlαSNAPs.
- Understand how the giardial ESCRT pathway operates in the absence of Snf7, a key component for membrane deformation in the corresponding host pathway.
- Map the interactions within the TRAPP tethering complex components of *Giardia.*
- Identify cellular factors that contribute towards change in vacuole shape in presence of alcohol.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	–	–	06	01	–	02



Unlike the host orthologue, GlIst1 is myristoylated at an exposed lysine residue. Myristoylation at this peripheral site, will allow the protein to anchor to the membrane while still remaining accessible for binding with GlVps4b and GlDid2b.

PROF. AJIT BIKRAM DATTA
Professor
Department of Biochemistry

Group Members:

Pritam Naskar,
Sayani Sarkar
Shubham Jha

Collaborator:

Prof. M. Dasgupta, Dept. of Biochemistry, University of Calcutta, Kolkata

Research background and vision:

X-ray crystallography and cryo-EM backed by biochemical assays and biophysical experiments can be used to unravel diverse aspects of proteins and other macromolecules in terms of their function and interactions that outline their roles in vivo. Most of the proteins, may be except a few, need to interact with other proteins and macromolecules, such as DNA, RNA, and lipid bilayer, to disburse their biological functions. These "specific" interactions are crucial for cell survival. Thus even a single point mutation in a given protein that alters its interactions with a critical partner can lead to drastic pathophysiological consequences. Our broad goal is to decipher the structural basis behind the specificity of physiologically relevant interactions. To make it a practicable approach, we focus on the interactions in ubiquitination, a post-translational modification process of proteins that regulate numerous cellular processes including transcription, proteostasis, localization, and signal transduction in eukaryotes. Ubiquitination in cells require a concerted effort by three classes of enzymes, namely E1, E2, and E3; and these enzymes interact among themselves in a highly specific and at times in a promiscuous manner to ubiquitinate specific substrate protein(s) to initiate requisite physiological response(s). Our lab works on novel and diverse members from these enzyme classes to understand the basis of their specificity from a structural and biochemical point of view.

Summary of research during April 1, 2021 – March 31, 2022:

Different aspects of the ubiqutination machinery has been investigated this year and is summarized in the following points.

- We previously showed that a class of ubiquitin conjugating E2 enzymes, Ube2Es, undergo intramolecular autoubiquitination in the conserved lysine residues present in their N-terminal extended regions. We probed for the presence of similar auto-ubiquitiation in another E2, Ube2T, implicated in the Fanconi anemia pathway, containing lysines in its C-terminal tail. We observed that Ube2T Cterminal also undergoes ubiquitination similar to Ube2Es. Thus it appears that intramolecular autoubiquitination is a conserved phenomenon across diverse E2s and act as a regulatory mechanism.

- Amongst the 30 E2s coded by the human genome, a few have been found to contain a second ubiquitin binding site distal to the active site cysteine. This "backbinding" enhances the ubiquitin transfer activity of E2s. The mechanism of this activation is yet to be deciphered. We have identified a few amino acid residues which are distal from both the active and the backbinding site, but appears to 'relay" the information from the backbinding site to the active site cysteine causing the allosteric activation.

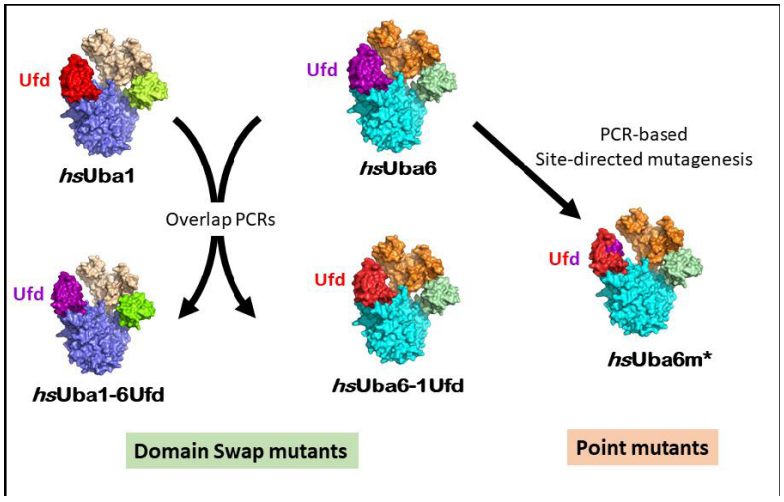
- We also compared the structure of the Uba6 Ufd domain solved in our laboratory with that of the human Uba1 and located large structural differences between them, particularly in the loop regions. We therefore also designed and generated various multiple point mutants of both Uba1 and Uba6 by replacing each of these loops alone or in combination. Purification of these mutant proteins have been carried out along with the cognate E2s.

Major accomplishments (significant results):

- An apparently unrelated network of amino acid residues plays critical role in Allosteric regulation of enzymatic activity of ubiquitin conjugating E2 enzymes via backbinding of a second ubiquitin molecule.
- Non-canonical ubiquin activating E1 enzyme, Uba6, has Ufd Domain that harbors significant structural alterations from the canonical one despite overall similarity leading to altered E2 recogntion pattern.
- Intramolecular autoubiquitination is a common phenomenon in Conjugating E2s and act as a regulatory mechanism.

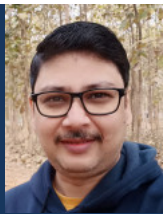
Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	–	–	–	–	–	–



Schematic showing the generation of various clones of human ubiquitin E1 enzymes, Uba1 and Uba6. The structure shown here are only for representative purposes as all E1s share a common domain organization and fold and varies only in smaller details. hsUba6m* , indicates various mutants that have been generated.

DR. ABHRAJYOTI GHOSH
Associate Professor
Division of Biochemistry



Group Members:

Chandrima Bhattacharyya, *INSPIRE Fellow-Adhoc*
ShayantanMukherji, *UGC-Adhoc*
Mausam Roy, *UGC-Adhoc*
Sayandeep Gupta, *CSIR-SRF Adhoc*
Arghya Bhowmick, *CSIR-Adhoc*
Koustav Bhakta, *Institute Fellow*
Dr. Triparna Mukherjee, *ICMR-RA*

Research background and vision:

My laboratory works on understanding the stress response in model organisms as well as microbial communities from different environmental niches. Two different ecosystems are currently under investigation in the laboratory, namely Sundarban mangrove wetland and tea rhizosphere ecosystems. We use a variety of techniques starting with biochemistry, microbiology and genomics to unravel the molecular players important in adaptation and evolution of microorganisms under stress conditions. The long-term vision of the laboratory is to decipher the stress-induced molecular mechanism that led to evolution vis-à-vis pathogenicity of environmental microorganisms.

Summary of research during April 1, 2021 – March 31, 2022:

During last one year, our biochemistry group has been involved in analyzing the cross-talk in the heat shock response pathway of thermoacidophilic crenarchaeal model oraganism *Sulfolobusacidocaldarius*. We we investigated the crosstalk in the heat shock response pathway of thermoacidophilic crenarchaeon *Sulfolobusacidocaldarius*.In the present study, we biophysically and biochemically characterize done of the small heat shock proteins, Hsp14, of *S. acidocaldarius*. Moreover, we investigated its ability to interact with Hsp20 and Hsp60 tofacilitate the substrate proteins' folding under stress conditions. LikeHsp20, we demonstrated that the dimer is the active form of Hsp14, and it forms an oligomeric storage form at a higher temperature. More importantly, the dynamics of the Hsp14 oligomer are maintained by rapid subunitexchange between the dimeric states, and the rate of subunit exchange increases with increasing temperature. We also tested the ability of Hsp14to form hetero-oligomers via subunit exchange with Hsp20. We observed hetero-oligomer formation only at higher temperatures (50 °C–70 °C). Furthermore, experiments were performed to investigate the interaction between small heat shock proteins and Hsp60. We demonstrated anenthalpy-driven direct physical interaction between Hsp14 and Hsp60. Our results revealed that Hsp14 could transfer sHsp-captured substrate proteinsto Hsp60, which then refolds them back to their active form.

Our environmental microbiology group has been involved in analysing tea rhizosphere microbiome in various tea estates of Darjeeling, India. India contributes 28% of the world's tea production,and the Darjeeling tea of India is a world-famous teavariety known for its unique quality, flavour andaroma. This study analyzed the spatial distribution of bacterial communities in the tea rhizosphere of six different tea estates at different altitudes. The organic carbon, total nitrogen and available phosphate were higher in the rhizosphere soils than the bulk soils, irrespective of the sites. Alpha and beta diversities were significantly ($p < 0.05$) higher in the bulk soilthan in the rhizosphere. Among the identifiedphyla, the predominant ones were Proteobacteria, Actinobacteria and Acidobacteria. At the genus level,only four out of 23 predominant genera (>1% relative abundance) could be classified, viz., Candidatus Solibacter (5.36 _ 0.36%), Rhodoplanes (4.87 _ 0.3%), Candidatus Koribacter (2.3 _ 0.67%), Prevotella(1.49 _ 0.26%). The rhizosphere effect was prominent from the significant depletion of more ASVs (n = 39) compared to enrichment (n = 11). The functional genes also exhibit a similar trend with the enrichment of N2 fixation genes, disease suppression and Acetoinsynthesis. Our study reports that the rhizobiome of tea is highly selective by reducing the alpha and beta diversity while enriching the significant functional genes.

Major accomplishment:

- Tea plants are highly selective in shaping their own rhizosphere microbiome in Darjeeling. This feature might contribute towards the quality of tea produced in this region.
- Archaeal small Hsp14 drives the substrate shuttling between sHsps and hsp60 in the absence of co-chaperone Hsp70. This hints towards how heat shock components evolved in all three domains of life.
- Our collaborative effort has introduced a new concept 'Bacteriobot', which takes a drug attached to it in the distal parts of the gut and delivers in a control manner.

Future plan for 2022-23:

- Evaluation of tea rhizobiome of different tea estates across India (Darjeeling, Assam, Palampur, Kangra, and Nilgiri).
- Investigating the role of rhizodeposits in the interaction between plants and beneficial microbes.
- Cross-stress adaptation of thermoacidophilic crenarchaeon *Sulfolobusacidocaldarius*.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	06	–	06	03	–	–

Average publication impact factor: **6.7166**

Observance of Swacchta Pakhwada 2022 at Unified Academic Campus of Bose Institute on 02.05.2022

– SCIENTIFIC REPORT –

DIVISION OF BIOINFORMATICS

On November 18, 2021, Lectures on Nobel Prize Winning Works 2021 was organized by Bose Institute at UAC Auditorium alongwith Ph.D. Orientation Programme 2021. Speakers were Chemistry: Prof. Anup Mishra, Physics: Prof. Soumen Roy, Physiology: Dr. Smarajit Polley.

DIVISION OF BIOINFORMATICS

OVERVIEW

Today's Division of Bioinformatics started its journey three decades ago as a DBT funded BTIS Network's center at Bose Institute to offer Bioinformatics facility and skill-set. Later the full time research was started at the center and thereby it evolved as a 'Centre of Excellence in Bioinformatics', as graded by the DBT. The Bose institute has upgraded this center into its regular Division. The broader objectives of the research carried out in this division are to provide fundamental insights into Biology, to rationalize complex experimental observations, to make applications with long term goal to come up with scientific strategies for modern therapeutic approaches. The division has decent infrastructure of bioinformatics and computational biology research. The scientific expertise of the division covers stem cell bioinformatics and regulatory RNAs, oncogenomics, proteomics, drug design, structural bioinformatics and macromolecular dynamics etc. The products of the divisions include databases software in addition to the human resource development; it routinely conducts training and workshops for students in order to spread scientific and technical skills in bioinformatics.

LIST OF PERSONNEL

Faculty Members: Prof. Shubhra Ghosh Dastidar, Dr. Zhumur Ghosh, Dr. Sudipto Saha.

Students : JRF/SRF : Gourab Das, Troyee Das, Byapti Ghosh, Sreyashi Majumdar, Saran N, Abhirupa Ghosh, Jagannath Das, Paramita Roy, Shazia Firdous, Debarati Paul, Debadrita Basu, Nibedita Ray Chaudhuri, Premananda Basak, Souvik Sinha, ***RA :*** Dr. Sibun Parida. ***Women Scientist :*** Dr. Arpana Verma.

Staff Members: Sanjib Kumar Gupta, Sujata Roy, Birendra Kumar Bari.

SHUBHRA GHOSH DASTIDAR
Professor
Division of Bioinformatics

Group Members:
Debadrita Basu
Debarati Paul
Nibedita Raychaudhuri
Premananda Basak

Research background and vision:

The broader and interdisciplinary areas of interests of our group include Chemistry, Biophysics, Biochemistry, Structural and Molecular Biology, etc. with aims to understand the molecular mechanisms of biological events. We address questions whose answer may need insights not only from the molecular structures but also from their dynamics of their constituent atoms. Our work begins by mimicking such realistic molecular situations using computer simulations and then their events of structural changes and interactions are analysed and utilized for making predictions. We are currently working on the systems like, Bcl2 family of proteins, α,β-Tubulin and microtubules, Kinases etc. and all of them have relevance in the battle against cancer and against several other diseases.

Summary of research during April 1, 2021 – March 31, 2022:

(i) Investigations and analysis of the intrinsic dynamics of the Kinases to obtain an understanding on the possible paths of their conformation switching, from inactive to active states. A manuscripts will be communicated very soon.

(ii) Obtaining a mechanistic insight into the conformational switching of α,β-tubulin dimer under the influence of suitable molecules which can act as the ligands of tubulin; having such a control over tubulins conformation is a possible key to diminish the cell proliferation and the work has the promise for getting applied in designing promising therapeutic molecules against cancers. We already have published several manuscripts, one has been published recently and one more is under preparation.

(iii) Understanding the Allosteric impact of the intrinsically disordered region of Bcl2 portions on the structured region of the protein and how that could constitute an important part of mechanism of the proteins to function. We have been publishing our work in this field and just recently one has been communicated for publication.

(iv) Started to work on the structural variations in the protein aggregates and their structural polymorphism.

(v) Collaborative works, to complements the experimental findings, some of the work is already published/accepted and more are under progress.

Major accomplishment (significant results):

(i) The molecular mechanisms of both the microtubule over-stabilizing ligands of the Taxol binding site (Type1) and microtubule destabilizing ligands of the Colchicine Binding domain (Type 2) upon binding the tubulin dimer, are being investigated at the dimeric level using a

computational based approach, namely Molecular Dynamics Simulation followed by analyses over the generated data. The investigations led to some key findings common to both types of ligands such as: the subtle changes in the angle between the α,β-tubulin, the alteration of the flexibility of the protein, disruption of the interaction patterns of the system, drastic changes in the internal modes of motion, etc. all of which cumulatively determine whether the ligand bound dimers get eligible to fit into the microtubular superstructure or not. One manuscript has been published this year, several published earlier and one more is under preparation.

(ii) Residue phosphorylation in the long unstructured loop region of Bcl-2 revises its communication with the primary binding site that directly influences binding of its partner protein Bax. Phosphorylation increased its interaction with transmembrane domain thereby hindering its release from the binding pocket. These insights would be are important for understanding the roles of Bcl2 family of proteins in apoptosis. One manuscript has been communicated and one is in preparation.

(iii) The current work elaborates on how minimal essential domains of kinase activators can sufficiently sensitize the catalytic domain towards activity by claiming share on the kinase's internal interaction network. These activators can remarkably utilize conserved α-helices of the catalytic domain as 'lever-like' elements to distantly switch active site interactions and that too in a manner that modifies the free energy landscape and creates low energy routes between inactive and active states of the enzyme. One manuscript will be communicated very soon.

(iv) As a part of a collaborative work with experimentalists of other research institutes, a bioinformatics analysis on the possible existence of the super-antigenic motif in the constituent proteins of SARS COV2 was carried out. A recent report in literature from other groups found the existence of such motif in the spike protein which has similarity with the superantigenic motif present in the staphylococcus enterotoxin B. We have identified the possibility of existence of a similar motif in nucleocapsidphosphoprotein of SARS COV2. The work has been accepted for publication and also selected for cover story.

(v) In collaborative works with plant biologists in Bose Institute, we have achieved significant molecular insight on pH sensitivity of some proteins and the work is still under progress.

Future plan for 2022-23:

Our projects on the following direction, which are long term, would continue:

(i) Investigations on the mechanisms of influence of the therapeutic molecules on the α,β-Tubulin dimer and their control over cell proliferation

(ii) Obtaining mechanistic insights into the allosteric activation and regulations of protein kinases and exploring their possible therapeutic applications.

(iii) Probing the structure, dynamics and interactions of the Bcl2 family of proteins, their cooperative interactions to understand their roles in apoptotic machinery and finding molecular strategies to interfere with therapeutic objectives.

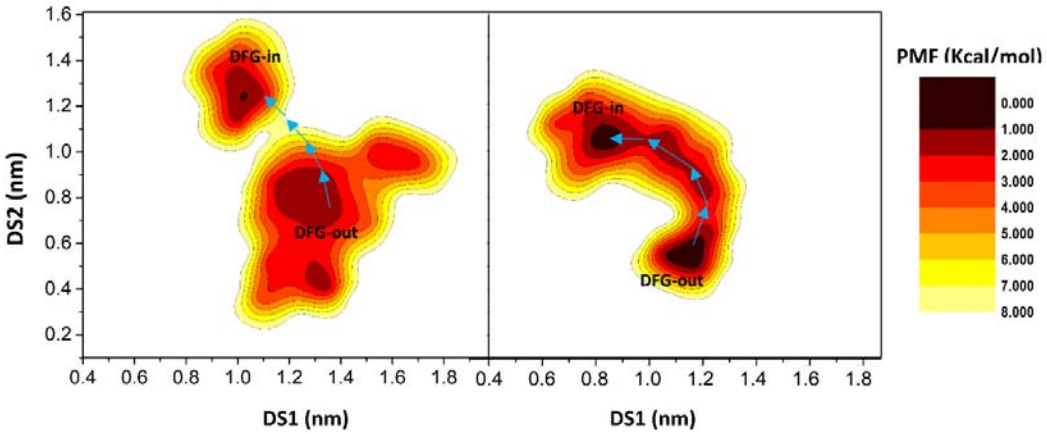
(iv) Obtaining molecular insights into thestructural polymorphism of protein aggregates and their correlations with the diseases, to find possible ways of human interventions.

(v) Various collaborative works with experimentalists to complement their experimental observations with our computational molecular insights.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
01	04	–	04	01	–	01

Average publication impact factor: **2.7**



The figure shows the free energy (2D PMF) landscapes of $DFG_{Out \rightarrow In}$ transitions. 2D PMF profiles, expresses as the functions of distance pairs, DS1 (H154(CA)-F176(CZ)) and DS2 (N161 (CA)-F176(CZ)). The relative values of the free energy at various points in the plot are shown in color scale. The lowest energy path of transitions (shown in blue arrows) between DFG-out and DFG-in states in absence (left) and presence (right) of TBCTD have been shown. (Details provided in Annexure-I).

DR. ZHUMUR GHOSH
Associate Professor
Division of Bioinformatics

Group Members:

Troyee Das, *CSIR-SRF*
Byapti Ghosh, *DST Inspire Fellow*
Gourab Das, *ICMR SRF*
Dr. Arpana Mukherjee, *SERB WOS-A*
Sibun Parida, *Project RA*

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.

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.

Summary of research during April 1, 2021 – March 31, 2022:

a. Investigating the role of piwil interacting RNAs(piRNAs) and long noncoding RNAs(lncRNAs) in cancer and early embryonic development and developing an online resource for multispecies piRNAs (**RNABiol**.,**2021**).

b. Deciphering the role of parental non-coding RNAs in fertilization and early embryonic development.

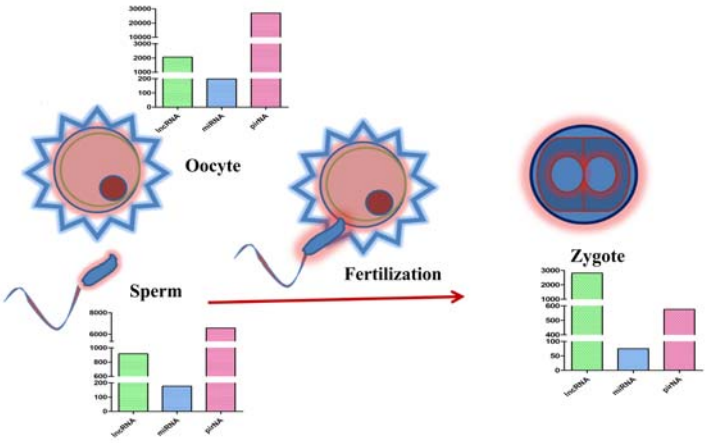
c. Investigating the noncoding RNA mediated epigenetic alterations in stem cell derivatives.

Major accomplishment (significant results):

Developed and launched piRNAQuest v.2(2nd version of piRNAQuest) which hosts varied information about multi-species piRNAs.

Future plan for 2022-23:

- Detecting the role of miRNAs as epigenetic modulators inducing oncogenicity in stem cell derivatives.
- Validating the role of tRNA derived piRNAs in ovarian teratocarcinoma and elucidating their role in maintaining cancer stem cell/progenitor populations.
- Validating the effect of the presence of SNPs within lncRNA loci in ovarian, breast and cervical cancer.



Noncoding RNA profile: Pre and post fertilization stages

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	02	–	02	–	–	01

Average publication impact factor: **4.5**

DR. SUDIPTO SAHA
Associate Professor
Division of Bioinformatics

Group Members:
Shazia Firdous, *SRF*
Abhirupa Ghosh, *SRF*
Saran N, *SRF*
Sreyashi Majumdar, *SRF*
Jagnnath Das, *JRF*
Paramita Roy, *JRF*
Dibakar Roy, *JRF*
Stuti Ghosh, *JRF*

Research background and vision:

My laboratory studies lung diseases including asthma, multi-drug resistant tuberculosis (MDR-TB) with specific goal of understanding and improving diagnosis, prognosis and treatment using bioinformatics and systems biology approaches.

Summary of research during April 1, 2021 – March 31, 2022:

My lab has contributed in three different research areas, during the period. First, we have compiled expression biomarkers of allergic diseases in human and other organisms, along with their single nucleotide polymorphisms (SNPs), gene ontology terminologies, structure and drug information in Database of Allergy and Asthma Biomarkers—version2 (**Majumdar et al., Allergy, 2021**). Second, LHSPred, a web-based prediction server was developed using machine learning techniques that allows to predict lung severity using only six blood test parameters (**Manuscript in 2nd revision submitted, 2022**). Finally, a meta-analysis of sputum microbiome of lung diseases was performed that identifies specific taxonomic and functional signatures in asthma, bronchiectasis, chronic obstructive pulmonary diseases (COPD), cystic fibrosis (CF) and tuberculosis (TB) and healthy smoker (**Manuscript submitted, 2022**).

Major accomplishment (significant results):

- Updated DAAB-V2 version of the database of allergy and asthma biomarkers, which was published in Allergy Journal (IF: 13:146]
- LHSPred (Lung Health Severity Prediction) tool was developed that enables users to determine a score that evaluates the computed tomography (CT) scans, without radiologist intervention, and predict risk of pneumonia with features of blood examination and age of patient.

Future plan for 2022-23:

- Develop a microbiome database of airway diseases with specific references to gut and lung microbiome.
- Study the gut-lung axis in airway diseases
- Generate multi-omics data (Proteomics, transcriptomics, metablomics) from sputum of asthmatics and COPD patients and identify potential biomarkers.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	04	–	02	01	–	–

Average publication impact factor: **7.615**

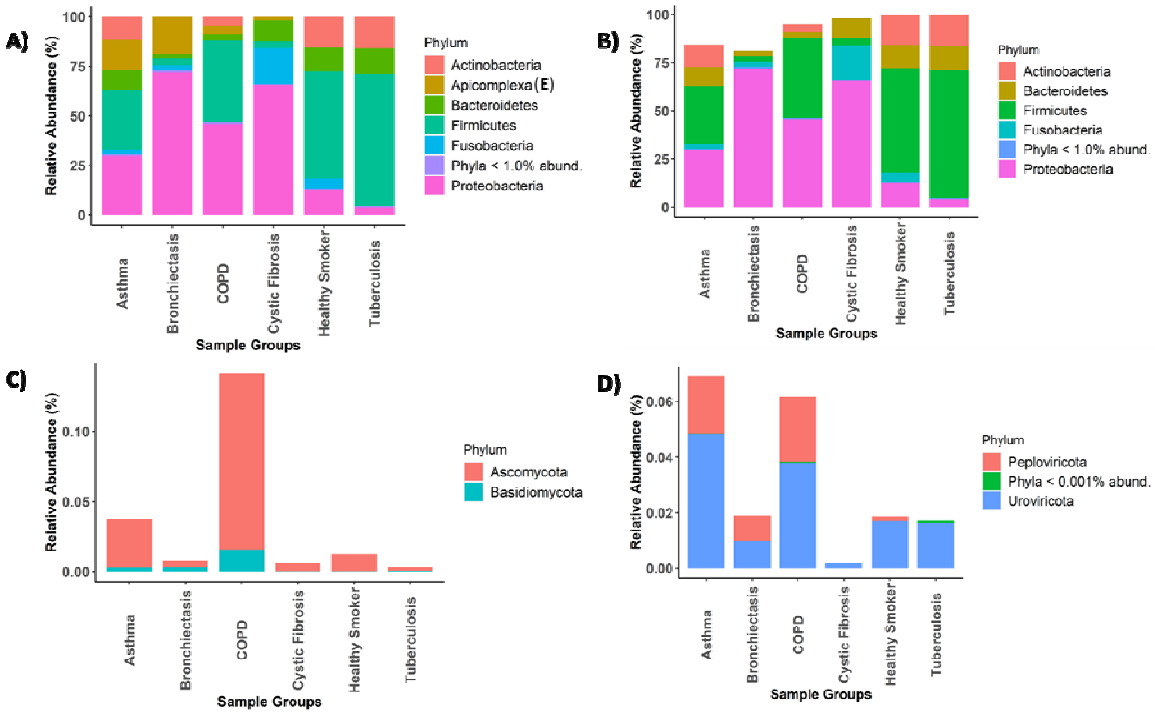


Figure 1: The relative abundances of phyla in terms of read percentages across the groups. A) The abundant phyla among all observed kingdoms, phyla with relative abundances < 1.0% are merged. **B)** The abundant phyla of kingdom Bacteria, phyla with relative abundances < 1.0% are merged. **C)** The fungal phyla. **D)** The abundant phyla of kingdom Virus, phyla with relative abundances < 0.001% are merged. *****The phyla Chordata was removed before converting to relative abundances.

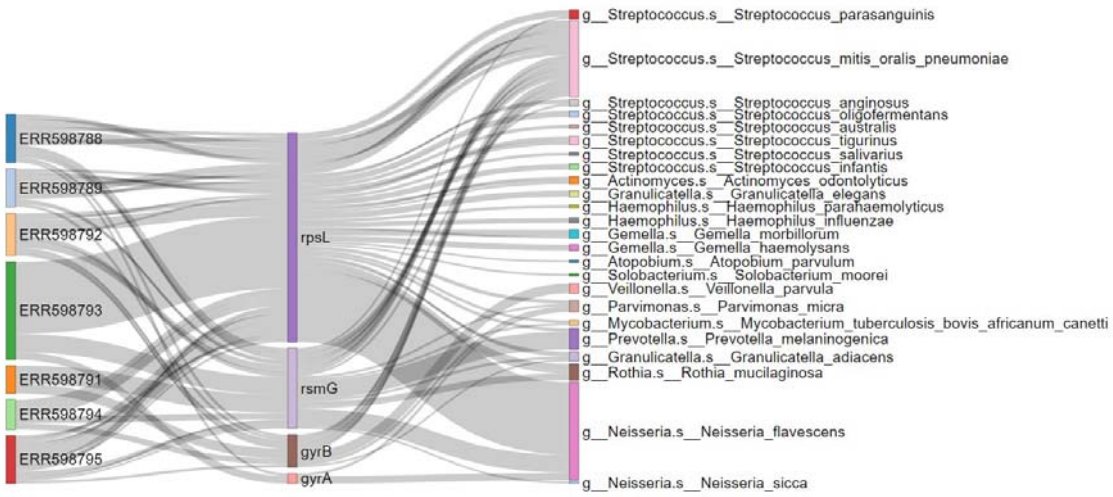


Figure 2: Sankey plot shows few of the DRAGs from various bacterial species present across the samples of tuberculosis group.

Bose Institute

BIC Webinar-X: Perspectives on SARS-CoV2

Organized by the Division of Bioinformatics

Title of the talk: "Paradise Lost" to "Paradise Regained" ~ A Long Haul to Know Many Unknowns about SARS-CoV2

Speaker:

Professor Syamal Roy
Emeritus Scientist
CSIR-Indian Institute of Chemical Biology,
Kolkata

June 22, 2021, 5:00pm –6:00pm (IST)

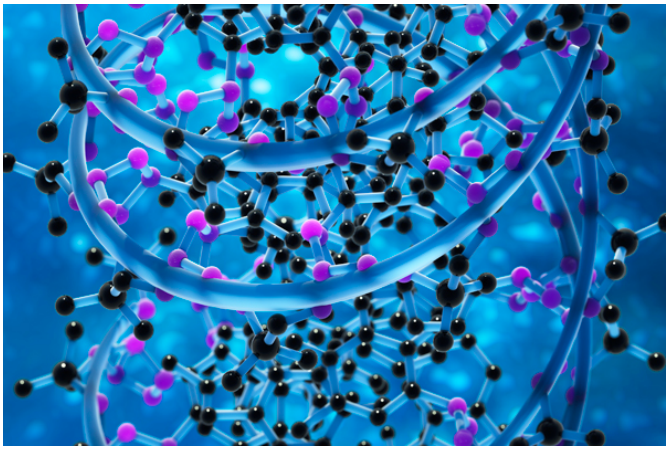
Prof. Dipankar Nandi,
Indian Institute of Science, Bangalore chaired the session

– SCIENTIFIC REPORT –

DEPARTMENT OF BIOPHYSICS

Bose Institute participated in the 24th National Science Exhibition", held during 28th to 31st October, 2021 at Science City Maidan maintaining all the Covid-19 protocols. This exhibition was organized by the Central Calcutta Science and Cultural Organisation for Youth on the occasion of 75 years of Indian Independence on the theme "A journey towards a Magnificent India in 75 years." The pavilion of Bose Institute displayed a variety of Scientific Posters as well as history of Bose Institute.

DEPARTMENT OF BIOPHYSICS



OVERVIEW

The Department of Biophysics was established in September 1983. Although a relatively young department and small in size, the department is very active in research primarily focused on Molecular Biophysics, Biophysical Chemistry and Structural Biology. The primary mission of the Department is to understand biological systems at a molecular level from a vantage point of physics, physical chemistry and computational chemistry, chemical and structural biology. This includes a detailed description in terms of molecular structure, conformation and dynamics and their interactions using both experimental and theoretical tools. In addition to generating fundamental knowledge in the field, the mission is to work in a collaborative fashion with other disciplines on fundamental as well as applied problems and solve them using cutting edge tools / methodologies.

LIST OF PERSONNEL

Faculty Members: Prof. Gautam Basu, Prof. Anirban Bhunia (Chairman), Dr. Subhrangsu Chatterjee, Dr. Debjani Roy, Dr. Smarajit Polley.

Research Scientists: Prof. Siddhartha Roy, J. C. Bose Fellow; Prof. Manju Roy, Visiting Scientist; Dr. Moitri Basu, DST Inspire Faculty.

Students : RA/JRF/SRF/Project Assistant : Anindya Dutta, Nilanjan Banerjee, Sudakshina Ganguly, Bhawna Pandey, Dr. Madhumita Chakraborty, Humaira Ilyas, Sk. Abdul Mohid, Pallabi Sengupta, Suman Panda, Chandradeep Basu, Dwijit Guha Sarkar, Nilanjana Maji, Dr. Trina Dutta, Dibakar Sarkar, Dipita Bhattacharyay, Pranita Roy, Ranit Pariary, Karishma Biswas, Shruti Mukherjee, Swarnali Kar, Prateeka Borar, Ananya Roy, Dr. Swati Bhowmick, Deeparna Sutradhar, Samrat Mitra, Debapriya Bose, Dr. Payel Bhatterjee, Laboni Roy, Ipsita Chakraborty, Dipanwita Roy, Dr. Raka Ghosh, Oishika Chatterjee Arkadeep Sarkar and Dr. Himal Kanti Ganguly.

Staff Members: Basudeb Marick, Barun Majumder, Tanmoy Debnath, Soumya Shankha Biswas, Swapan Joghsharma, Sudhir Turi, Nagnarayan Yadav.

PROF. ANIRBAN BHUNIA
Professor
Department of Biophysics

Group Members:
Dipanwita Roy, *SRF*
Karishma Biswas, *SRF*
Dipita Bhattacharyya, *SRF*
Sk. Abdul Mohid, *SRF*
Ranit Pariary, *SRF*
Dibakar Sarkar, *SRF*
Shruti Mukherjee, *SRF*

Research background and vision:

Biological membranes are an important functional interface for a plethora of physiological reactions, taking place within the cell. Thus 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. My laboratory involves several biophysical techniques, including cutting-edge solid- and solution-state NMR spectroscopic techniques to characterization the membrane-associated functioning of several biologically active peptides and proteins. This allows the atomistic understanding of the crucial structural motifs that can be targeted for therapeutic interventions.

Summary of research during April 1, 2021 – March 31, 2022:

- Structural characterization of small amyloid oligomers at an atomic resolution.
- Membrane induced amyloid pathogenicity.
- Molecular mechanism of fibrillation of Amyloidogenic peptide and design of inhibitors.
- Rational design of antimicrobial peptides to develop pathogen-resistant transgenic plants
- Regulation of Lipopolysaccharide (LPS) induced signalling cascade in sepsis or septic shock.

Major accomplishment (significant results):

1. Unravelling the molecular mechanism of Amyloid fibril formation.
2. In an attempt to develop novel antimicrobial peptides, a series of peptides were synthesized and evaluated their antimicrobial activities; a number leads have been identified with promising antimicrobial and antisepsis effects.
3. Molecular mechanism of fibrillation of Amyloidogenic peptide and designing of inhibitors for Aβ40/42, insulin, α-synuclein, Lysozyme, hIAPP etc.
4. Biochemical and molecular biological experiments will be performed to study the effect of the designed peptide on plant pathogen *Xanthomonas campestris*pv. Campestris, a Gram-

negative, rod shaped gamma-proteobacterium. Also, in due course, a transgenic, over-expressing the desired antimicrobial peptide would be developed using an Agrobacterium based binary vector system. The transgenic plants would be challenged with the relevant pathogen and their performance would be monitored along with the control.

5. Large efforts already have been devoted to clarifying the mode-of-action of antimicrobial peptides (AMPs), and to optimize their selectivity. In contrast, drug delivery aspects of AMPs have been much less investigated. Yet, drug delivery systems have potential to improve the performance of AMPs in a range of contexts. For example, proteolytic degradation, abundant in infected tissue, risks to dramatically reduce the effect of many AMPs administered on their own. Furthermore, systemically administered AMPs risk rapid clearance from bloodstream circulation due to binding to anionic serum proteins, in turn resulting in reduced bioavailability, as well as accumulation-related toxicity. There is also a need for approaches to facilitate cell internalization of AMPs for efficient antimicrobial effect on cell-internalized pathogens, of interest, e.g., in tuberculosis.

   Recently, we have started working on either nanoparticles or quantum dots for drug delivery to specific site by taking advantage of intracellular permeability of gold nanoparticles to mammalian cells and '**clustering effect**' upon attaching multiple copies of a short peptide sequence to the nanoparticles. Coupling the two concepts resulted in remarkable outcomes in both *in vitro* and *in vivo* experiments. We further elucidated the antimicrobial mechanism of peptide-conjugated nanoparticles by **live cell NMR spectroscopy** and confocal microscopy as well as determined the structure of the peptide assembly upon complexation with bacterial components.

6. Membrane-amyloid protein interaction study using solution- and solid-state NMR spectroscopy.

Future plan for 2022-23:

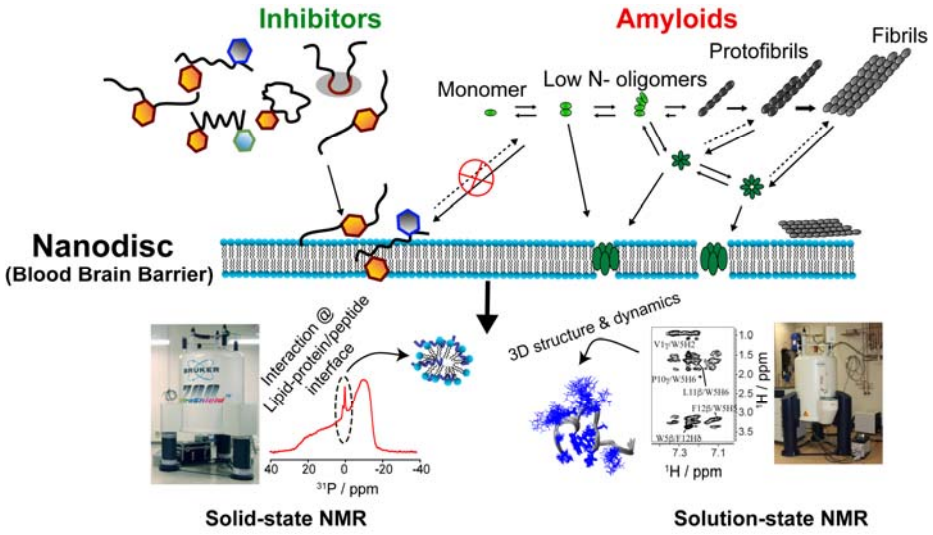
- **Characterizing β-sheet breaker hybrid peptidomimetics (BSBHps&cBSBHps).** The main aim of this work is to design, synthesis of novel β-sheet breaker hybrid peptidomimetics (BSBHps), which can either stabilize the monomeric Aβ40/42 or disrupt the mature fibrils to non-toxic species. Fluorescence experiments will be performed to evaluate the efficiency of inhibition of fibrillization and disruption of existing fibril of Aβ40/42. Further, the structural characterization of these compounds is planned to use solution state NMR such as STD, trNOESY and SOFAST-HSQC to define the binding modes against Aβ40/42 monomer, oligomer and mature fibrils.

- **Screening of small molecules against insulin fibrillation.**Insulin, a peptide hormone commonly used to treat diabetes, undergoes aggregation at the site of repeated injections in diabetic patients as well as during its industrial production and transport. The reduced bioavailability of insulin due to aggregation prevents the proper control of glucose levels in diabetic patients. Although insulin therapy was first introduced about 100 years ago, generating small molecules that can specifically and effectively inhibit insulin aggregation remains a challenge. Further, no synthetic small molecules have been found to disintegrate insulin amyloids to the best of our knowledge. Therefore, we shall be screening non-toxic and non-hemolytic small molecules to inhibit the insulin aggregation as well as disintegration of insulin fibrils to non-toxic ones. Furthermore, insulin biosimilars glargine and lispro that the currently widely used for diabetic treatment will also be used as a reference.

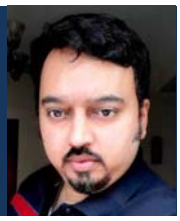
Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
03	13	01	02	01	–	04

Average publication impact factor: **5.4**



DR. SUBHRANGSU CHATTERJEE
Associate Professor
Department of Biophysics



Group Members:
Meghomukta Mukherjee, *SRF, Inspire Fellow*
Pallabi Sengupta, *CSIR-SRF*
Nilanjan Banerjee, *Instititute Fellow, SRF*
Suman Panda, *CSIR-SRF*
Anindya Dutta, *Institute Fellow, SRF*
Ananya Roy, *CSIR-SRF*
Debopriya Bose, *Institute Fellow, JRF*
Laboni Roy, *CSIR-JRF*

Collaborators:
Prof.Tanya Das, *Professor, Bose Institute*
Prof. Gaurishankar Sa, *Professor, Bose Institute*
Dr. Deba Prasad Mandal, *Associate Professor, WBSU*
Dr. Shamme Bhattacharjee, *Assistant Professor, WBSU*
Dr. Partha Chakrabarti, *Scientist E2, IICB*
Dr. Samit Chattopadhyay, *Ex-Director, IICB*
Dr. T. Govindraju, *Associate Professor, JNCASR*

Research background and vision:

My research project mainly focuses on the various G-Quadruplex structures with different sequence context. De novo design of ligands to arrest G rich quartet structures has become my major area of interest. Small molecules, short sugar modified DNA/RNA aptamers, antimicrobial peptides, natural products we screen to see their efficacy to bind telomeric DNA structures.

Summary of research during April 1, 2021 – March 31, 2022:

Targeting Oncogene Promoters and Ribosomal RNA Biogenesis by G-Quadruplex Binding Ligands Translate to Anticancer Activity.

G-Quadruplex (GQ) nucleic acids are promising therapeutic targets in anticancer research due to their structural robustness, polymorphism, and gene-regulatory functions. Here, we presented the structure–activity relationship of carbazole-based monocyanine ligands using region-specific functionalization with benzothiazole (TCA and TCZ), lepidine (LCA and LCZ), and quinaldine (QCA and QCZ) acceptor moieties and evaluated their binding profiles with different oncogenic GQs. Their differential turn-on fluorescence emission upon GQ binding confirmed the GQ-to-duplex selectivity of all carbazole ligands, while the isothermal titration calorimetry results showed selective interactions of TCZ and TCA to c-MYC and BCL-2 GQs, respectively. The aldehyde group in TCA favors stacking interactions with the tetrad of BCL-2 GQ, whereas TCZ provides selective groove interactions with c-MYC GQ. Dual-luciferase assay and chromatin immunoprecipitation (ChIP) showed that these molecules interfere with the recruitment of specific transcription factors at c-MYC and BCL-2 promoters and stabilize the promoter GQ structures to inhibit their constitutive transcription in cancer cells. Their intrinsic turn-on fluorescence response with longer lifetimes upon GQ binding allowed real-time visualization of GQ structures at subcellular compartments. Confocal microscopy revealed the uptake of these ligands in the nucleoli, resulting in nucleolar stress. ChIP studies further confirmed the inhibition of Nucleolin occupancy at multiple GQ-enriched regions of ribosomal DNA (rDNA) promoters, which arrested rRNA biogenesis. Therefore, carbazole ligands act as the “double-edged swords” to arrest c-MYC and BCL-2 overexpression as well as rRNA biogenesis, triggering synergistic inhibition of multiple oncogenic pathways and apoptosis in cancer cells.

Curcumin arrests G-quadruplex in the Nuclear Hyper-Sensitive III1 element of c-MYC Oncogene leading to apoptosis in metastatic breast cancer cells.

c-MYC is deregulated in triple negative breast cancer (TNBC) pointing to be a promising biomarker for breast cancer treatment. Precise level of MYC expression is important in the control of cellular growth and proliferation. Designing of c-MYC-targeted antidotes to restore its basal level of cellular expression holds an optimistic approach towards anti-cancer treatment. MYC transcription is dominantly controlled by Nuclear Hypersensitive Element III-1 (NHEIII1) upstream of the promoter region possessing G-Quadruplex silencer element (Pu-27). We have investigated the selective binding-interaction profile of a natural phytophenolic compound Curcumin with native MYC G-quadruplex by conducting an array of biophysical experiments and in silico based Molecular Docking and Molecular Dynamic (MDs) simulation studies. Curcumin possesses immense anti-cancerous properties. We have observed significantly increased stability of MYC-G Quadruplex and thermodynamic spontaneity of Curcumin-MYC GQ binding with negative ΔG value. Transcription of MYC is tightly regulated by a complex mechanism involving promoters, enhancers and multiple transcription factors. We have used Curcumin as a model drug to understand the innate mechanism of controlling deregulated MYC back to its basal expression level. We have checked MYC-expression at transcriptional and translational level and proceeded for Chromatin Immuno-Precipitation assay (ChIP) to study the occupancy level of SP1, Heterogeneous nuclear ribonucleoprotein K (hnRNPK), Nucleoside Diphosphate Kinase 2 (NM23-H2) and Nucleolin at NHEIII1 upon Curcumin treatment of MDA-MB-231 cells. We have concluded that Curcumin binding tends to drive the equilibrium towards stable G-quadruplex formation repressing MYC back to its threshold-level. On retrospection of the synergistic effect of upregulated c-MYC and BCL-2 in cancer, we have also reported a new pathway [MYC-E2F-1-BCL-2-axis] through which Curcumin trigger apoptosis in cancer cells.

Prion-derived tetrapeptide stabilizes thermolabile insulin via conformational trapping

Unfolding followed by fibrillation of insulin even in the presence of various excipients grappled with restricted clinical application. Thus, there is an unmet need for better thermostable, nontoxic molecules to preserve bioactive insulin under varying physiochemical perturbations. In search of cross-amyloid inhibitors, prion-derived tetrapeptide library screening reveals a consensus V(X)YR motif for potential inhibition of insulin fibrillation. A tetrapeptide VYYR, isosequential to the β2-strand of prion, effectively suppresses heat- and storage-induced insulin fibrillation and maintains insulin in a thermostable bioactive form conferring adequate glycemic control in mouse models of diabetes and impedes insulin amyloidoma formation. Besides elucidating the critical insulin-IS1 interaction (R4 of IS1 to the N24 insulin B-chain) by nuclear magnetic resonance spectroscopy, we further demonstrated non-canonical dimer-mediated conformational trapping mechanism for insulin stabilization. In this study, structural characterization and preclinical validation introduce a class of tetrapeptide toward developing thermostable therapeutically relevant insulin formulations.

Promoter G-quadruplex favours epigenetic reprogramming-induced atypical expression of ZEB1 in cancer cells

Aberrant expression of Zinc-finger E-box binding homeobox 1 (ZEB1), which remains repressed in normal cells, is frequently associated with cancer aggressiveness. However, transcriptional mechanism underlying such atypical ZEB1 expression in cancer is not yet well-understood. ZEB1 promoter G-quadruplexes were studied and modeled extensively using circular dichroism, fluorescence spectroscopy, ITC and DMS protection assay. Luciferase assay, qPCR, FAIRE, ChIP, western blotting, confocal microscopy was used to access the regulation of ZEB1 transcription. Our study unravels the occupancy of nucleolin to ZEB1 promoter as a crucial determinant which facilitates the binding of SP1 transcription factor to chromatin, by locally remodelling the region. SP1, subsequently, recruits P300 acetyl transferase leading to enriched acetyl-histone H3 at promoter and activates ZEB1 transcription. ZEB1 promoter analysis identifies presence of four putative G-quadruplex (G4) forming motifs within 700 bp of TSS; each quadruplex is characterized structurally in details with an array of biophysical techniques. Surprisingly, stabilization of G4 with cationic porphyrin TMPyP4 represses its transcription and eventually impedes cell invasiveness. TMPyP4 binding to a selected G4 motif (5' -534/-511-3' from TSS), where nucleolin/SP1/P300 co-occupies, prevents the association of nucleolin which consequently hinders SP1 binding, leading to chromatin compactness and transcriptional repression. Our findings demonstrate an epigenetic mechanism of ZEB1 reactivation where dynamic occupancy of transcription regulators encompassing a G4 motif is crucial and thus, small molecule induced G-quadruplex stabilization may act as a potential molecular switch to turn-off gene expression.

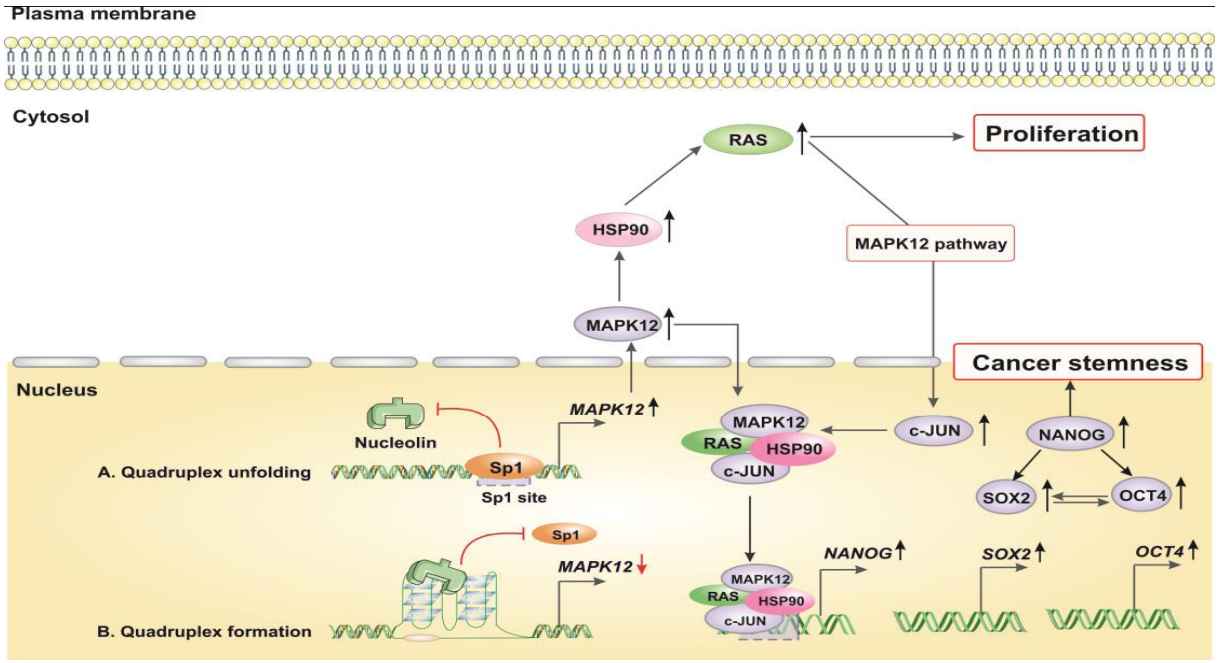
Major accomplishment (Significant Results):

Insu-lock : We, the researchers from Bose Institute and CSIR-Indian Institute of Chemical Biology, Kolkata have identified a tetrapeptide (consists of four amino acid units) which we named **Insu-lock** that prevents both heat and storage induced insulin fibrillation and thereby loss of effective quantum of insulin. Insulin was found to be stable up to 65 deg centigrade. We found that this molecule can maintain insulin in the active form without any loss for months, prevent amyloidoma formation, require no other toxic excipients and is compatible with various commercial insulin preparations. Our discovery would thus lead the path for developing novel insulin formulation that will not only be cheap but extremely useful in the hot tropical countries where maintenance of cold-chain has always been a bottleneck in delivering insulin to the patients particularly in the rural areas.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	12	–	–	–	–	04

Average publication impact factor: **4.83**


Plasma membrane
Cytosol
RAS
Proliferation
HSP90
MAPK12 pathway
MAPK12
Cancer stemness
Nucleus
MAPK12
Nucleolin
MAPK12
RAS
HSP90
c-JUN
c-JUN
NANOG
A. Quadruplex unfolding
Sp1
Sp1 site
SOX2
OCT4
Sp1
MAPK12
NANOG
SOX2
OCT4
MAPK12
RAS
HSP90
c-JUN
B. Quadruplex formation

DR. DEBJANI ROY
Assistant Professor
Department of Biophysics

Research background:

Over the past decades' considerable research has been made in modern medicine through science and technology. Therefore, there is a preponderance of global aging population. Alzheimer's disease (AD) and Parkinson's disease(PD) are the most common aging associated diseases. This poses a major reason of concern among older people worldwide. Several genetic disorders including chromosomal aberrations and gene mutations play vital roles in developing pathogenic mechanisms of AD and PD. Additionally epigenetic changes and environment are found to be associated with these diseases. Both AD and PD are caused by the intricate interactions between genetic and environmental factors.

We studied regulatory networks of PD where non-coding RNAs namely lncRNAs and miRsact as epigenetic regulators of PD. Single nucleotide polymorphisms and their associated miRs have been identified which may serve as biomarkers for identifying PD and AD at an earlier stage. We studied RNA-Seq data obtained from brain and blood samples of PD. Pathways common and unique to both samples were identified. For PD we proposed 9 repositioning drugs and their targets. For AD we proposed 14 repositioning epigenetic drugs and their targets. Regulations of non-coding RNAs of these drugs have also been studied.

The aim of this research work is to develop methods and identify new biomarkers for these aging associated diseases. The ultimate goal is to decipher the complex biological interactions of the normal human system and compare it with the disease state towards the development of precise and personalized medicine in the near future

Summary of research during April 1, 2021 – March 31, 2022:

Studied several pharmacological aspects of proposed repositioning drugs including drug scaffolds. It has been identified that anisole, piperidine, pyridine, and indole are the most prominent fingerprints through which proposed drugs have shared the maximum structural similarities with known and clinical trial Alzheimer's drugs.We predicted five new molecules with significant drug-likeness properties. Each new molecule contains the predicted repositioning /known drug scaffolds. These five novel molecules have the potential of being effective inhibitors of several Alzheimer-specific targets to develop new drugs for Alzheimer's Disease in the future.

We also studied repositioning of known drugs and micro RNAs of age associated diseases using systems biology approaches.

Major accomplishment (significant results):

We predicted five new molecules with significant drug-likeness properties. These five novel molecules have the potential of being effective inhibitors of several Alzheimer-specific targets to develop new drugs for Alzheimer's Disease in the future.

An Indian Patent has been granted in July 2021 based on the work entitled "systems level methods for epigenetic drug development for human diseases"

Inventor: Dr. Debjani Roy, Biophysics Department, Bose Institute. Patent Number: 371983

Future Plan for 2022-23:

Experimental:

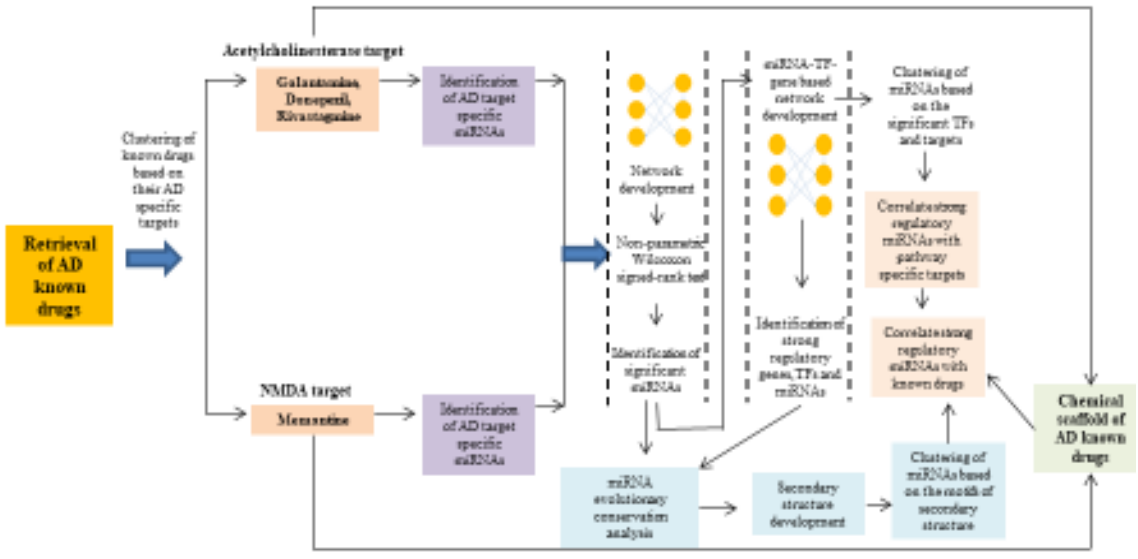
1. Study the inhibitory properties of predicted repositioning drugs/ novel drug like molecules under *in vitro* conditions and in cell culture assays.
2. Study drug-drug synergism.
3. Study the effects of natural compounds on the inhibitory activity of predicted repositioning drugs to reduce the side effects of these drugs.
4. Experimental validations of predicted regulators/regulatory processes of Neurodegenerative Diseases in Animal and Yeast Models.
5. Computational and experimental:
6. The development of a device that integrates one or several laboratory functions to achieve automation and high throughput screening.
7. Establish novel method as required for a particular experiment and fast track drug and microRNA clinical trials.

Computational:

Setting up of the IoT based network that is able to collect and exchange data in real time using the FPGA system for various clinical applications.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	–	–	–	–	–	–



DR. SMARAJIT POLLEY
Assistant Professor
Department of Biophysics

Group Members:

Dr. Trina Dutta, *DBT-RA*
Afreen Haque, *SRF*
Prateeka Borar, *SRF*
Samrat Mitra, *SRF*
Deeparna Sutradhar, *SRF*
Pranita Ray, *SRF*

Research background and vision:

The main focus of the laboratory is to understand cellular phenomenon at highest possible resolution. Protein kinases being the major interest. 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 signalling pathways. We primarily use biochemical, chemical and structural biology tools to understand the mechanistic details of a few key signalling pathways at highest resolution. Protein kinases and transcription factors are at the centre of attention in the laboratory. More than 500 protein kinases are encoded in the human genome. Protein kinases provide the regulatory framework for most signaling pathways in eukaryotic cells. They add phosphate groups to amino acid residues and create modified chemical entities that provide altered functionality to protein substrates. Stringent regulation of their activities is critical to proper functioning of cellular processes, which often make them interesting point of intervention in many pathological scenarios. Many eukaryotic kinases show signaling modularity entailing distinct outcomes, both beneficial and harmful in a context dependent manner. Indiscriminate inhibition of these activities often has deleterious effect. Signaling modularity is dictated by choice of substrates, cognate-binding partners, subcellular localization and post-translational modifications of the kinase itself. We investigate the mechanistic details of their activation and spatio-temporal regulations to fully realize the scope of modulating them in a manner beneficial for the organism. We work primarily on two model kinase systems: a) Inhibitor of kappaB Kinases (IKK), gateway to NF-kB activation and b) Dual Leucine Zipper Kinase 1 (DLK1), a major player in axonal regeneration.

Summary of research during April 1, 2021 – March 31, 2022:

Structural and Biochemical Basis of IKK complex formation and regulation:

NF-κB represents a family of dimeric transcription factors that play pivotal roles in a diverse array of cellular signalling. Upon stimulation by a number of cues, a kinase complex called the

inhibitor of kappaB Kinase (IKK) complex gets activated that marks Inhibitor of κB proteins for proteasome mediated degradation by phosphorylating them at specific positions. Prototypical IKK complex consists of three subunits, IKK1/α, IKK2/β and NF-κB Essential Modulator (NEMO/IKKγ). IKK1 and IKK2 are highly homologous catalytic subunits; whereas NEMO is the adapter/scaffolding subunit. Though structure of individual components are known, the no structural information is available for the IKK-complex. To this end, we have been able to purify all three components of the IKK-complex, viz. IKK1, IKK2 and NEMO in their native form from Sf9 cells using recombinant baculoviruses. Different complexes have been formed in large quantities amenable for structural studies. We have already tried to image them in CryoEM at the national facilities in NCBS and IISc, Bangalore. However, these complexes were shown to be non-ideal for imaging. They need further systematic optimization schemes, which we are set to do.

Novel autocatalytic mechanism of IKK and its implication in signaling:

We discovered that IKK2, a traditional Ser/Thr kinase, also possesses Tyr-kinase activity and explored the molecular mechanism of this autocatalytic Tyr-kinase activity. Using mass-spectrometric (MS) studieswe investigated possible auto- and trans- substrates. We have been able to identify multiple substrates that have not been reported earlier. We have also set up the workflow to identify hitherto unknown substrates of IKK2 using *analogue sensitive* kinase approach.

Nuclear function of IKK1:

IKK1 is a *bonafide*Ser/Thr kinase. It's functions are mostly known in the cytoplasm. However, some reports have shown that it migrates to nucleus and phosphorylates Ser10 on histone H3. We wanted to understand the structural basis of its interaction with the nucleosome in order to perform this phosphorylation.

We found out that recombinant Cy-5 labeled mononucleosomes interacted with IKK1 in an EMSA assay.

Structural and Biochemical Basis of DLK activation and function:

MAP Kinase (MAPK) signaling pathways have been implicated in many cellular signaling events. A cascade of three kinases constitutes the core of these pathways: MAP3Ks activate MAPK kinases (MAPKK or MAP2K) by phosphorylation, which in turn similarly activates the effector MAPK. An example of such MAP3K is the DLKs belonging to the Mixed Lineage Kinase (MLK) family. Activation of DLK leads to differential responses in neurons those lead to development and regeneration of neural circuitry. In *C. elegans*, a shorter isoform of DLK1 was found to inhibit the kinase activity by sequestering the full-length active kinase. In essence, both homo and heteromeric interactions (primarily with JIPs) play important roles in regulating the function of these kinases. To this end, we have been able to recombinantly express and purify all the components of the pathway, either from *E. coli* or from Sf9 cells. These components are, DLK1(MAPKKK or MAP3K), MKK4 (MAPKK or MAP2K), PMK3 (MAPK), downstream kinase MAK2 and the scaffolding protein JIP1. Both the long and short isoforms, DLK1L and DLK1S, respectively have been expressed. We have not yet been able to purify the DLK1L to homogeneity as it is highly susceptible to degradation. We are currently optimizing conditions to form combinatorial complexes with or without JIP1. These complexes will be subjected to structural analyses primarily using CryoEM at the national facilities.

Theme 2: Understanding the Structural basis of cancer promoting function of p53 GoF (Gain of Function) mutants.

The TP53 gene is the most frequently mutated gene in cancer. The p53 protein is termed as the guardian of the genome which is a pro-apoptotic, tumor suppressor protein. In normal cells the p53 is maintained at a very low level which is continually degraded by the proteasome. Upon genotoxic stress p53 gets stabilized and leads to apoptosis. However, mutant p53s lack this regulation and function. Moreover, some of these mutants helps in tumor progression, and they are called the Gain of Function mutants. One of the proposed mechanisms by which they achieve this new function is by recruiting some other transcription factors to novel locations on the genome. In order to gain better insight to this problem, we took structural and biophysical approaches to study these complexes of GoF p53 with other transcription factors like Ets2.

We have been able to express and purify WT and a few GoF-p53 mutant proteins. We have also been able to express and purify Ets2 protein. Currently we are optimizing ways to form stable complexes between Ets2 and GoF-p53s.

We were also able to reconstitute recombinant mononucleosome using purified histones and Widom 601 DNA sequence.

We have also reconstituted a Cy-5 labeled version of the recombinant mononucleosome.

We have found out that Ets2 interacts with naked DNA as well as mononucleosomes in EMSA assays.

We plan to optimize this complex formation and purification of this complex to subject it to structural studies using Cryo-EM at National Facilities around the country.

Theme 3: Enzymatic remediation of environmental pollution

The industrial revolution has led to a significant expansion of the chemical repertoire on earth. These compounds can persist for years in the environment, often causing toxicity to many forms of life. Pollutants likealkanes present in petroleum, hydrocarbons and organic contaminants from industrial effluents like polyaromatic hydrocarbons (PAH's), polychlorinated phenols (PCP's), pesticides, phenols, bleach plant effluents, azo dyes, nitro compounds etc. are extremely toxic to the environment.

Enzymes have several beneficial characteristics. They are catalysts for all transformation reactions with either narrow (chemo-, region- and stereo-selectivity) or broad specificity and, therefore, can be applied to a large range of different compounds in mixture, as well. Keeping this in mind, the present research aims at studying class I oxidoreductase enzymes, Pentachlorophenol mono-oxygenase (PcpB) and Azobenzene reductase (AzoRs) which play significant roles in alleviating certain type of toxic pollutants like synthetic dyes and polychlorinated phenols from the ecosystem. We have cloned, overexpressed and purified multiple AzoR proteins from *Pseudomonas fluorescens* and a pentachlorophenol monooxygenase (PcpB). We have been able to obtain crystals for AzoR3A and PcpB. Initial diffraction experiments yield data up to ~3.5 A° for PcpB. Further optimization is ongoing for both crystals in order to obtain higher resolution data.

Major accomplishment (significant results):

- IKK1 and IKK2, well known Ser/Thr kinases, also possess Tyr kinase activity.
- They phosphorylate peptides on Tyr residues *in vitro*
- IKK1 forms complex with recombinant mononucleosome.
- Ets2 binds to naked DNA as well as recombinant mononucleosomes.

Future plan for 2022-23:

- To optimize Cryo-EM data collection conditions for IKK-complexes, and determine the structure if suitable data is obtained.
- To optimize Cryo-EM data collection conditions for IKK1:monucleosome complexes, and determine the structure if suitable data is obtained.
- To find out the domains on GoF-p53 and Ets2 that mediate interaction between these proteins.
- To identify domain(s) responsible on Ets2 to bind to DNA and nucleosome.
- To optimize conditions for forming complexes between GoF-p53 and Ets2.
- Directed evolution of azoreductases (if manpower is provided)
- Cloning, expression and purification of NIK constructs (if manpower is provided)

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	04	–	–	02	–	–

Average Publications Impact Factor: **3.4035**

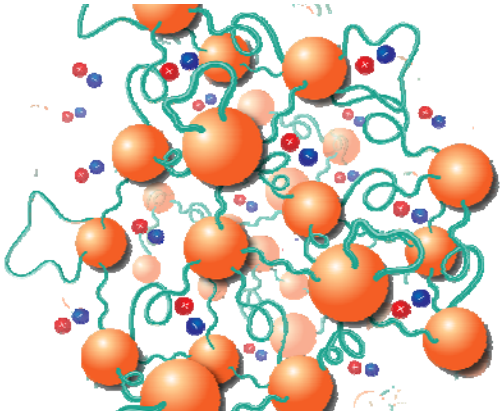
– SCIENTIFIC REPORT –

DEPARTMENT OF CHEMISTRY

The High Energy Physics group of the Department of Physics, Bose Institute organised **"IV ALICE-India School on Quark-Gluon Plasma"** during 08th to 20th November, 2021 through Virtual mode, as a part of celebration of 75th year of Independence "AZADI KA AMRIT MAHOTSAV".

The school aimed at providing the basic knowledge and techniques necessary for carrying out research in the experimental High Energy Physics (EHEP). It included hands-on sessions and special lectures delivered by distinguished speakers from Institutes/Universities in India and abroad.

DEPARTMENT OF CHEMISTRY



OVERVIEW

The Department of Chemistry was established in 1917, at the time of inception of the Institute. A major part of Shambhu Nath Dey's seminal work on the discovery of Cholera toxin was performed in this department for which he was nominated for the Nobel Prize. Over the course of time the department has adopted interdisciplinary research using the application of chemical principles to explore biological phenomena.

Present research activities of the department are

- Host-pathogen interaction: *Mycobacterium tuberculosis* and *Helicobactor Pylori*
- Stress response and signaling in *Mycobacterium tuberculosis*
- Recombinant approach to prokaryotic transcription
- Mathematical modeling of signaling pathway.

LIST OF PERSONNEL

Faculty Members: Prof. Suman Kumar Banik, Prof. Jayanta Mukhopadhyay.

Senior Scientists: Prof. Joyoti Basu, J. C. Bose National Fellow; Prof. Manikuntala Kundu, CSIR Emeritus Scientist.

Students : JRF/SRF/Project Assistant : Suruchi Lata, Amar Chandra Mahatha, Madhurima Chatterjee, Shreya Bagchi, Debayan Majumder, Tuhin Subhra Roy, Ritu Jaiswal, Sourajit Saha, Aniruddha Tewary, Thurbu Tshering Lepcha, Pankaj Jankiram Birari, Arkajyoti Datta, Soumya Mal, Soumya Mukherjee, Md. Sorique Aziz Momin, Nilanjana Hazra. ***RA :*** Arun Kumar Sharma.

Staff Members: Debarati Kanjilal, Gaurab Kumar Roy, Mrityunjoy Kundu, Asoke Kr. Maity.

PROF. SUMAN KUMAR BANIK
Professor
Department of Chemistry

Participants :
Tuhin Subhra Roy, *SRF*
Md Sorique Aziz Momin, *SRF*

Collaborators :
Prof. Pinaki Chaudhury, *Calcutta University*
Mintu Nandi, *SRF, Calcutta University*

Research background and vision:

A living system survives in a continuously changing environment. In order to respond to the changes made in the surroundings, each living species has developed specialized gene regulatory networks (GRNs). One of the major functions of a GRN is to efficiently transduce the incoming signal. The inherent noisy interactions in the biochemical system make signal transmission stochastic and can be understood using the formalism of non-equilibrium processes.

Summary of research during April 1, 2021 – March 31, 2022:

- Interplay of activation and repression in feed-forward loop.

Major accomplishment:

- Interplay of activation-repression in coherent feed-forward loop motif.
- Abundance criteria of feed-forward loop motif in terms of signal-to-noise ratio.

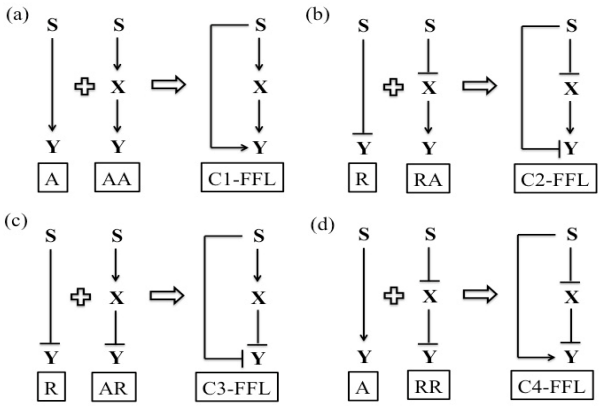
Future plan for 2022-23:

Information theoretic study of complex gene regulatory networks.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	01	–	–	–	–	–

Average publication impact factor: **1.91**

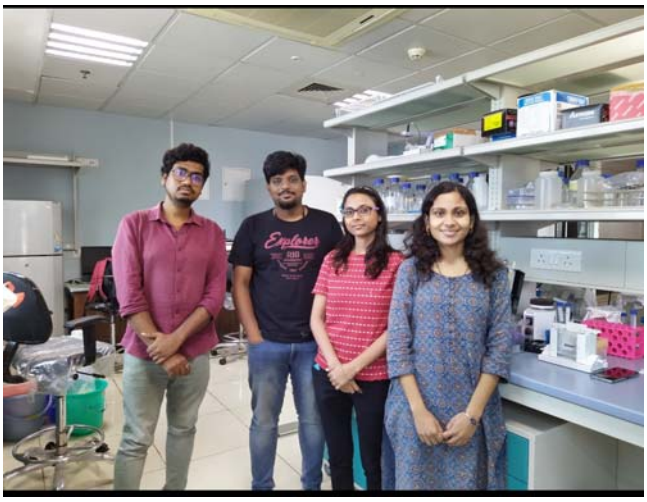


Construction of different coherent feed-forward loop (CFFL) motifs using one-step cascade (OSC) and two-step cascade (TSC). Different combinations of activation and repression in OSC and TSC results into different CFFLs. A and R in OSC stands for activation and repression, respectively. AA, AR, RA and RR in TSC designates activation-activation, activation-repression, repression-activation, and repression-repression, respectively. In the diagram, → and ⊣ stands for activation and repression, respectively.

PROF. JAYANTA MUKHOPADHYAY
Professor
Department of Chemistry

Participants:

Dr. Soumya Mukherjee, *DBT-NPDF*
Arkojyoti Dutta, *Institute Fellow-SRF*
Ritu Jaiswal, *CSIR-JRF*
Sourajit Saha, *CSIR-JRF*
AniruddhaTewari, *CSIR-JRF*
Madhumita Chatterjee, *DST Inspire Fellow*
Nilanjana Hazra, *Institute Fellow, JRF*



Research background and vision:

Our lab aims to understand the fundamental mechanism of transcription and gene regulation in bacteria by characterizing the interactions amongRNAP, sigma factors, and regulators required for various gene expressions in prokaryote, e.g. *Escherichia coli*, *Bacillus subtilis* and *Mycobacterium tuberculosis*. We use integrated biophysical, biochemical and genetic approaches, along with a recombinant in vitrotranscription system to address the following specificaims:

- Mechanism of gene regulation by various transcriptional factors and sigma factors in prokaryote
- Identify and characterize inhibitors of M. tuberculosis gene expression.
- Identify new target for anti-tuberculosis agents.

Summary of research during April 1, 2021 – March 31, 2022:

Evaluating the role and mechanism of function of delta factor of Bacillus subtilis.

Most bacterial RNA polymerases (RNAP) contain five conserved subunits viz. 2α, β, β' and ω. However, in many gram-positive bacteria, especially in fermicutes, RNAP is associated with an additional factor, called δ. Over three decades since its identification, it had been thought that δ functioned as a subunit of RNAP to enhance the level of transcripts by recycling RNAP. However, we have recently shown that δ functions as a transcriptional regulator. The protein binds to the A rich sequence near the promoter DNA and depending upon the location of its binding the protein could act both as a transcriptional activator or repressor. In our current work, we observed that the affinity of δ factor to DNA significantly increases when RNAP is present at the promoter. When RNAP leaves the promoter during transcription elongation, the affinity of δ to the promoter again reduced. We further showed that the interactions of α-CTD of RNAP

with δ factor is responsible for this enhanced DNA binding affinity. Chromatin Immunoprecipitation assay and quantitative Real Time PCR experiments, we were able to show that δ protein has maximum occupancy at the promoter when we compared the in vivo binding of δ at different location of the gene.

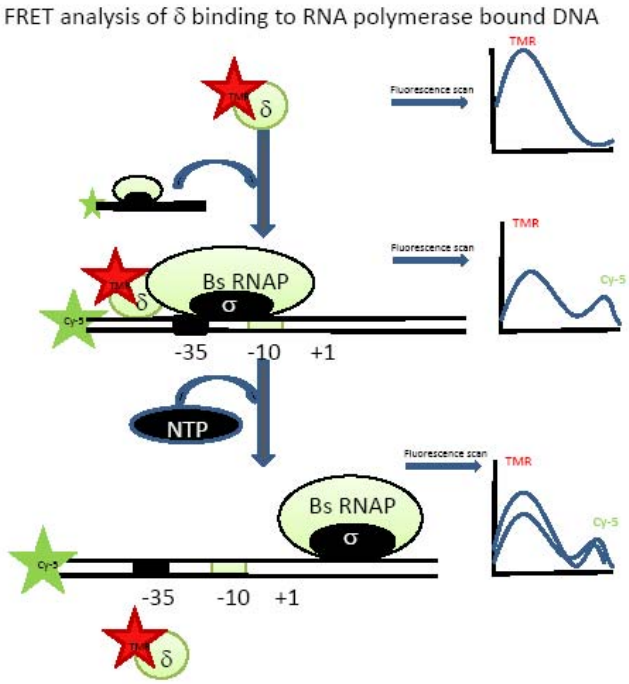
Major accomplishment:

- We have isolated and identified an anti-bacterial compound from Cassia fistula Bark that inhibits transcription. The compound is active against MDR-RNA polymerase.
- We have revealed the functional role of DevR- an important transcription factor of *M. tuberculosis.*

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	02	–	01	01	–	–

Average publication impact factor: **4.097**



The presence of RNA polymerase enhances the affinity of δ to upstream promoter region. When RNA polymerase leaves the promoter during transcription, the affinity of δ to DNA is significantly reduced

– SCIENTIFIC REPORT –

ENVIRONMENTAL SCIENCES SECTION

Dr. Abhijit Chatterjee, Associate Professor, Environmental Sciences Section, BI delivered Expert Talk on “Long Term trend of aerosols and air quality over Kolkata: Impact of local emissions and long range transport”. The entire program was presided over by Dr. Kalyan Rudra, the Chairman, WBPCB. MoU was exchanged between Bose Institute, WBPCB and KMC for National Clean Air Program for Kolkata. The program was also attended in person by students from Bose Institute and Officers and officials from WBPCB.

ENVIRONMENTAL SCIENCES

OVERVIEW

Environmental sciences section (ESS) was established in 1992. The ESS is working focusing on the local and regional air quality, air pollutants, chemical and physical atmospheric changes, and the regional climate change emphasizing on the eastern parts of Himalayas. Regular basis ground-based observation and monitoring are going on over different atmospheric environments at different strategic locations like high altitude Himalayan station, Darjeeling; typical urban metropolis, Kolkata; semi-urban atmosphere at Shyamnagar (north-24 pgs) and rural atmosphere over Falta near the coast of Bay of Bengal (south 24 pgs). ESS is also engaged in studying long-term variabilities in the atmospheric levels of several gaseous and particulate air pollutants along and across the Indo-Gangetic Plains collaborating with other institution/universities/organizations. ESS is also engaged in several national network program like "National carbonaceous Aerosol Program" of MoEFCC, "National Network Programme on Climate Change & Aerosol" of DST, "Biosphere-atmosphere exchange of Greenhouse gases (Metflux) of MoES, and a national mission of Govt. of India called "National Clean Air Mission" by MoEFCC. Because of the well expertise, knowledge and experience of the ESS in the field of atmospheric science, Bose Institute has been selected as the Nodal Institute and the Institute of Repute (IoR) in West Bengal for the National Clean Air Mission.ESS organizes several on-board ship experiments over the Bay of Bengal, Arabian Sea, Indian Ocean, and Southern Ocean for investigation of marine aerosols. ESS participated 35th Indian Expedition to Antarctica to explore the characteristics of aerosols over the South Pole.

LIST OF PERSONNEL

Faculty Members: Prof. Sanjay K. Ghosh (Chairman), Dr. Abhijit Chatterjee and Dr. Sanat K. Das.

Students: RA/SRF/JRF/Project Associate/Project Assistant: Abhinandan Ghosh, Monami Dutta, Sauryadeep Mukherjee, Sabyasachi Majee, Dr. Debajyoti Ray, Dr Chirantan Sarkar, Shahina R. Shaikh, Piyal Halder.

Staff Member: Dr. Anandamay Adak.

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Environment Sciences Section

Group Members:
Abhinandan Ghosh, *SRF*
Monami Dutta, *SRF*
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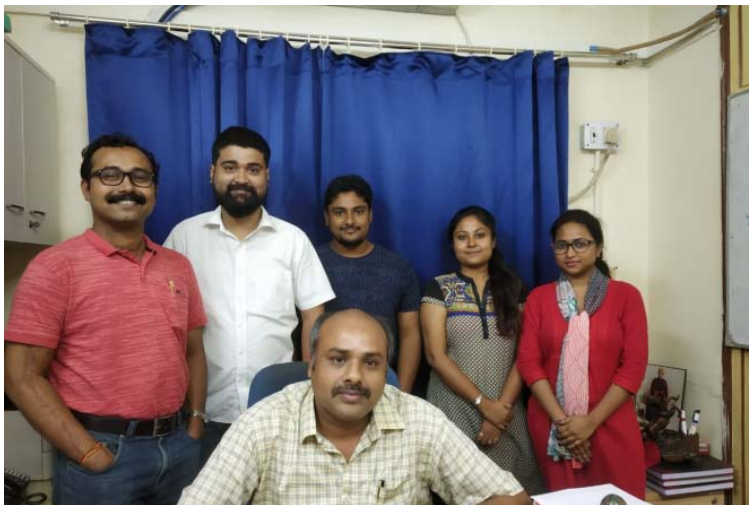


Collaborators:
Dr. Tuhin Kumar Mandal, *Principal Scientist, NPL, New Delhi*
Dr. Sudhir Kumar Sharma, *Senior Scientist, NPL, New Delhi*
Dr. Supriyo Chakraborty, *Scientist-F, IITM, Pune*
Prof. Chandra Venkataraman, *IIT, Bombay*
Dr. Chaithanya D Jain, *Sci./Engineer 'SD', NARL, Gadanki*
Dr. Neeraj Rastogi, *PRL, Ahmedabad*
Prof James Schauer, *University of Wisconsin-Madison, USA*

Research background and vision:

Background : Broadly, I work on the "Air Pollution and Climate Change". Specifically, the studies are focused on the chemical and physical characteristics of atmospheric aerosols and trace gases like CO, O3, NOx, SO2; identification and quantitative estimation of their natural and anthropogenic sources; interaction of aerosols with the solar radiation; role of aerosols in cloud droplet formation; effect of aerosols and gases on rainwater chemistry and biogeochemical cycles of an ecosystem; biosphere-atmosphere exchange of Greenhouse gases and whether an ecosystem acts as the net source or sink of the Greenhouse gases. The studies are being carried out focusing on some strategic locations with extreme climatic importance like high altitude Himalayan atmosphere, Sundarban mangrove ecosystem, tropical coastal atmospheres, tropical urban and semi-urban/rural atmospheres.

Vision: The long-term trend of several air pollutants, major sources, emission inventories and their interaction with the climate in India, their future projection and designing mitigation strategy.

Summary of research during April 1, 2021 – March 31, 2022:

The summary of research conducted during the above mentioned period has been given below through various studies conducted addressing some specific objectives.

Relative dominance of fossil fuel and biomass burning on India's air quality in absence of anthropogenic activities during Covid-19 lockdown

The study was conducted with the purpose to understand the spatial heterogeneity and the inter-state variability of the relative contributions of the long-range transport, fossil fuel and biomass

burning on the atmospheric aerosol pollution across India. Satellite and reanalysis datasets (MODIS and MERRA-2) were used to study the total aerosol and its differential components over each of the Indian states under the limited anthropogenic emission condition (April 2020) and compared with the normal condition (April, 2015-2019). We observed that the changes in aerosol pollution with the changes in sources from normal to limited anthropogenic activities were not homogeneous across the country. Based on such heterogeneity in "aerosol source-aerosol pollution" relationship, we divided the entire country in four different groups. The states under Group 1(most of Indo-Gangetic Plain, north-eastern and parts of western and southern India) are found to be mostly influenced by the local/regional anthropogenic sources. The sources other than the biomass burning are the most influential for the aerosol pollution over Group 2 states (Punjab, West Bengal, Rajasthan, Madhya Pradesh, Karnataka and Tripura). Both the biomass burning and long range transport are the major factors for Group 3 state, Telangana. Rest of the states (Group 4) exhibit the relative dominance of the regional and trans-boundary transport over local anthropogenic emissions. Relative influences of fossil fuel and biomass burning over each other and how it changed from the normal to limited activities have also been quantified for each of the states of different groups. The results from the study would be an input of immense importance for the policy makers building state-wise strategies in air pollution control in India.

Atmospheric Aerosols over high altitude Himalayan and an urban metropolis in eastern India: Effect of size and chemistry

A study has been conducted focusing on the chemical and optical characterization of water soluble inorganic and organic components of aerosols at different sizes, over a high altitude Himalayan station, Darjeeling (27.1° N and 88.15° E, 2200 m amsl) and a tropical urban metropolis, Kolkata (22.5° N, 88.3° E, ~6 m amsl). It was observed that local meteorology and long range transport of pollution plumes have played the pivotal role in governing the temporal variation of the mass distribution and concentration of aerosols and its various components over both the sites. The aerosol mass-size distributions were found to be bimodal in nature with the relative dominance of accumulation mode (0.1-1.0 µm) over coarse mode (1.8-10 µm) over both the stations, indicating dominance of the anthropogenic emissions. Among the size classes, accumulation mode aerosols alone contributed 55-75 % over Darjeeling and 40-60% over Kolkata to PM_{10}. The coarse mode aerosols were mainly consisted of primary inorganic species over Kolkata and water soluble organic carbons (WSOC) over Darjeeling whereas the fine mode aerosols (accumulation: 0.1-1.0 µm) were primarily composed of the secondary inorganic aerosols for both the stations. Irrespective of the seasons and stations, SO_4^{2-} and NH_4^+ exhibited peaks in the mass-size distribution at 1.0-0.1 µm whereas that of NO_3^- varied with the seasons. The photochemical oxidation and the aqueous phase oxidation of SO_2 (g) were the pathways for SO_4^{2-} formation over Darjeeling whereas the later dominated over Kolkata. Concentration weighted trajectory (CWT) model has revealed that the secondary inorganic aerosols and WSOC were local/regional in origin over Kolkata megacity whereas Darjeeling was influenced by mixed sources. The accumulation mode aerosols were found to be the highest light absorbing over both the stations irrespective of the seasons. Over Darjeeling, the absorption coefficient (b_{abs_365}) and the mass absorption efficiency (MAE) of WSOC were maximum for local biomass burning aerosols than the transported plumes whereas those over Kolkata were maximum for transported biomass burning plumes from Eastern Ghats.

Carbonaceous aerosols over eastern Himalaya: Role of transport pathways

In this study, we examined the seasonal transport pathways of carbonaceous species [Organic Carbon (OC), Elemental Carbon (EC), Water-Soluble Organic Carbon (WSOC), Primary Organic Carbon (POC), Secondary Organic Carbon (SOC), and Total Carbonaceous Aerosols (TCAs)] of $PM_{2.5}$ and PM_{10} over a semi-urban high-altitude site of Darjeeling (27.041ºN,

88.266ºE, 2200 m above mean sea level (amsl); an eastern Himalayan region, India. The annual average concentrations of $PM_{2.5}$ and PM_{10} were 37 ± 12 μg m^{-3} and 55 ± 18 μg m^{-3}, respectively that was within but quite close to the threshold limit of National Ambient Air Quality Standards (NAAQS) (annual 60 μg m^{-3} for PM_{10}; and 40 μg m^{-3} for $PM_{2.5}$). The seasonal average concentration of OC in $PM_{2.5}$ was highest in pre-monsoon (4.2 ± 1.7 μg m^{-3}) > post-monsoon (4.0 ± 1.6 μg m^{-3}) > winter (3.3 ± 1.5 μg m^{-3}) > monsoon (2.2 ± 0.9 μg m^{-3}) whereas OC in PM_{10}, in the order of highest in post-monsoon (5.9 ± 2.4 μg m^{-3}) > winter (5.4 ± 2.0 μg m^{-3}) > pre-monsoon (5.2 ± 2.1 μg m^{-3}) > monsoon (3.6 ± 0.9 μg m^{-3}). Similar seasonal variation in case of EC in both $PM_{2.5}$ (winter 1.8 ± 0.8 μg m^{-3}; pre-monsoon 2.2 ± 0.9 μg m^{-3}; monsoon 1.2 ± 0.4 μg m^{-3}; post-monsoon 2.2 ± 1.1 μg m^{-3}) and PM_{10} (winter 2.7 ± 1.0 μg m^{-3}; pre-monsoon 3.0 ± 1.1 μg m^{-3}; monsoon 1.2 ± 0.4 μg m^{-3}; post-monsoon 1.9 ± 1.2 μg m^{-3}) were observed during the study period. Based on different altitudes (100, 500, 1000 m), the seasonal backward trajectory and its concentration-weighted trajectory (CWT) analysis reveal the local, Indo-Gangetic Plain (IGP), the Thar desert, semi-arid, central highlands, Nepal, and the Bay of Bengal (BoB) as the common pollutant transporting regions to the observational site of Darjeeling. Also, its cluster analysis at 500 m above ground level (AGL) indicates that air mass originates mainly from 3 sides [western region, Thar desert (17.6%); north-western region, Nepal (45.1%); southern region, Bangladesh (37.3%)] during the study. Due to high tourist influx in pre-monsoon (peak tourist season), the maximum contribution of carbonaceous aerosols was mainly from the vehicular sources, coal combustion, transboundary pollutants, biomass burning in the IGP region, and the formation of secondary organic aerosols (SOA). Besides, active Terra and Aqua MODIS fire and thermal anomalies (≥ 80 per cent) indicated the maximum prevalence of fire spots during pre-monsoon across India (except the Thar desert) followed by post-monsoon (due to crop-residue burning) in Punjab and Haryana.

Poor air quality over Kolkata metropolis in India: A long-term study

A 15 years long-term (2004-2018) study was conducted to investigate the temporal and inter-annual variability, trend and sources of major gaseous (NO_2 and SO_2) and particulate (PM2.5) air pollutants over a tropical metro city, Kolkata in eastern India. The study was conducted in two phases; Phase-I (2004-2009) and Phase-II (2012-2018). PM2.5 shows a gradual rise in aerosol loading from 2004 to 2018 (5 μg m^{-3} yr^{-1}). SO_2 (NO_2) built up at the rate of 2.2 (~ 4) μg m^{-3} yr^{-1} during 2004-2011 (2004-2012) and then declined at the rate of 3.2 (~ 7) μg m^{-3} yr^{-1}. The seasonal features of all the pollutants were similar; winter> postmonsoon > premonsoon > monsoon. Source apportionment of PM2.5 showed noticeable shift of the highest contributing source; vehicular emissions in Phase-I to solid fuel burning in Phase-II. The banning of old vehicles, up-gradation of fuel, introduction of BS-III and BS-IV could reduce the vehicular emission contribution in Phase-II. In addition, the reduction in coal consumption in power sectors, low sulphur fuel in diesel vehicles etc in Kolkata could be the reason for the decrease in SO_2 and NO_2. Concentration weighted trajectory (CWT) analysis identified major source regions like central and western IGP during winter and postmonsoon, arid/semi-arid regions of western India and biomass burning over Eastern Ghat during premonsoon. It was observed that the light rain with longer duration scavenged more aerosols (55-60%) than the shorter duration heavy rain (20-22 %). Overall, winter and postmonsoon were the worst for PM2.5 and NO_2 pollution over Kolkata. However the city remained clean in terms of SO_2 pollution. Long-term variability in air quality index (AQI) showed moderate to poor air quality in winter and postmonsoon. The air quality during premonsoon has been approaching towards poor air quality in Phase-II. Monsoon has been found to be cleanest season with the air quality of good to satisfactory level.

India's aerosol pollution: Long-term trend, current scenario and future projection

The present study provides a national scenario of aerosol pollution with the long-term (2005-2019) trend, source apportionment and future scenario (2023) for each of the Indian states. We

used MODIS AOD and FRP, differential AODs from MERRA-2 and trace gases (NO_2, SO_2) data from OMI. Almost all the states of IGP fall under the red zone ("highly vulnerable"; AOD > 0.5) whereas central, western, and few south-Indian states fall under the orange zone ("vulnerable"; 0.4 < AOD > 0.5). The most alarming feature is that most of the southern Indian states exhibit a shift from blue/green (less vulnerable/safe; AOD < 0.4) to vulnerable zones in 2023 as observed using auto-regressive integrated moving average (ARIMA) model. Principal component analysis (PCA) revealed that the coal-fired thermal power plant (TPP), vehicular, solid fuel/waste and biomass burning are the major sources of aerosols for the vulnerable states at present and in the future. We estimated and proposed the TPP capacity (GW) that needs to be reduced to bring down the AOD to move the vulnerable zones to less vulnerable and safe zones. The present study would complement and strengthen the ongoing national missions to combat air pollution in India.

Major accomplishment (significant results)

- Hydrophobic black carbon aerosols can act as better cloud condensation nuclei than hydrophilic sea-salt aerosols when get aged in the atmosphere.
- The absorption coefficient and the mass absorption efficiency of ultrafine aerosols are maximum when they emitted from local biomass burning activities.
- In the absence of fossil fuel emissions, biogenic VOCs emitted from eastern Himalayan conifer forest play pivotal role in aerosol formation when VOCs get oxidized by enhanced ozone.
- Several states in India were found to change the scenario in terms of the relative dominance of fossil fuel and biomass burning.
- A long-term (15-years) study over Kolkata metropolis exhibited that solid fuel burning dominated over the fossil fuel emission in ultrafine aerosol pollution over the years.

Future plan for 2022-23:

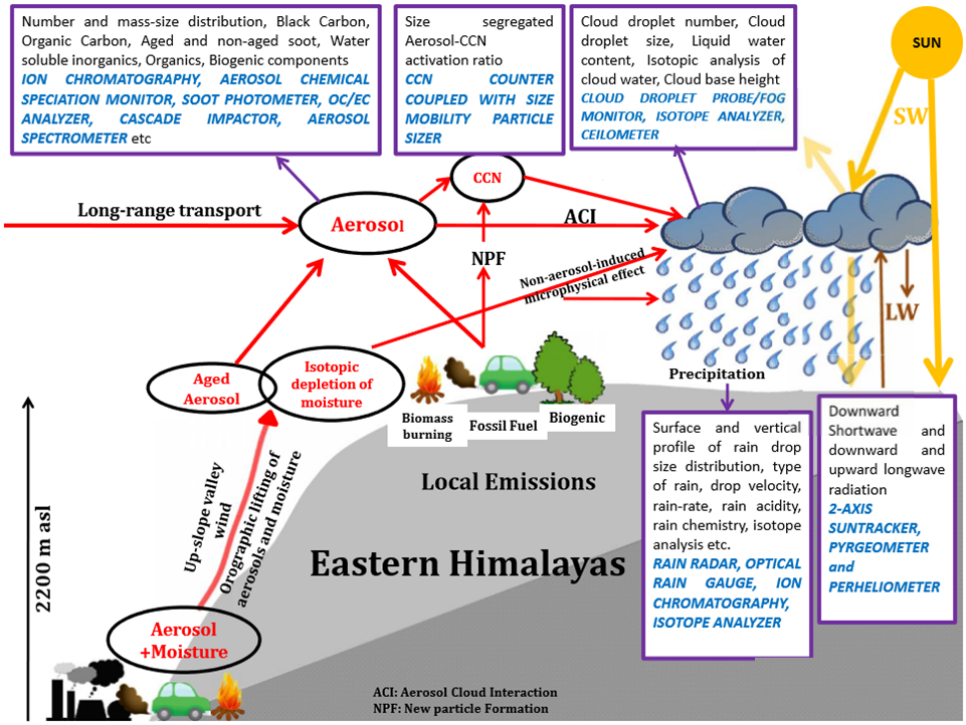
- We are planning to establish a High Altitude Himalayan Cloud Research Center at Darjeeling. Our plan is to conduct long-term and comprehensive as well as cohort studies on the chemical and microphysical properties of aerosols and aerosols-induced changes in cloud microphysics and regional climate over eastern Himalaya.
- We have planned to study the geomorphological changes and the changes in land-use land-cover over eastern Himalaya over the years and how it affects regional air pollution scenario.
- As a part of National Clean Air Program, we are planning to conduct a long-term study on the identification of hotspots and the major contributing sources of air pollution in and around Kolkata, which would be helpful for the urban local bodies to take actions.
- We are planning to conduct a long-term study over India on the air pollutants induced microphysical changes of cloud properties based on satellite observation.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	07	–	03	–	–	02

Average publication impact factor: **4.23**

The proposed plan on Aerosols-Cloud Interaction over eastern Himalaya can be illustrated as shown below:



DR. SANAT KUMAR DAS
Associate Professor
Environmental Sciences Section

Objectives:

The main objective of the present research is to detect wind driven air-borne, cloud-borne and rain-borne bioaerosols and identify the possible source regions. Specifically, the objectives are given below.

i. What are the air-, cloud- and rain-borne bioaerosols present over the eastern Himalayas, eastern & coastal India, and marine regions?

ii. From where are they coming to main land of India and which mode of transportation among air, cloud, rain is most suitable for the transportation?

iii. How do bioaerosols help to form clouds and get the non-hygroscopic aerosols like dust and Black Carbon (BC) into the clouds?

iv. How much do dust and BC aerosols involve in radiative warming up the cloud and promoting cloud burn-off process?

Objectives addressed and work done:

The work related to proposed objective (I-III) have been partially (60% of total) completed.

a. Determination of microbial diversity within aerosols that are abundant in Eastern India

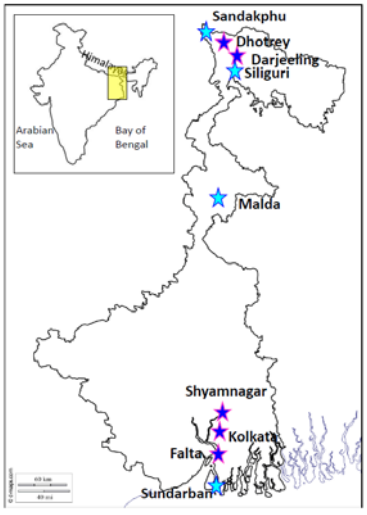


Figure 2: Map showing the measurement locations of the various permanent site (blue) and campaign sites (Sky blue) over Himalayas and Eastern India (highlighted portion inset).

An integrated campaign covering wide region of Eastern India in winter starting from the Himalayas to the coastal region of Bay of Bengal was conducted during 4^{th}-20^{th}Jan, 2020 collecting air-borne samples at Darjeeling (Hill-top), Siliguri (Foot-hill), Kolkata (Urban), Malda (Urban), Sundarban Mangrove forest. Geographicaly these five sampling sites are categorized as Trans Himalayan area – Darjeeling, Foothill area – Siliguri, Urban area – Malda, Kolkata, Coastalmangrove forest area – Sundarban.

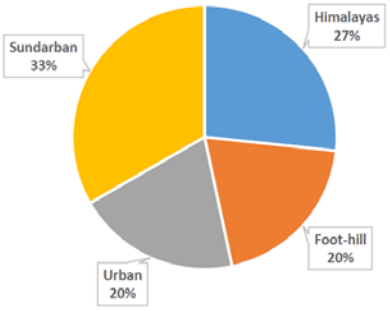


Figure 1: Sampling period in winter Season collected at different types of environmental conditionsfrom the Himalayas to Coastal Mangrove forest to achieve objective 1 over Eastern India.

b. *Extraction of total community DNA*

c. *Amplification of V3 regions of all bacterial 16S rRNA genes present in total community DNA*

d. *Total bacterial cell counts in each batch of air sample*

e. *Assessment of microbial alpha diversity to identify the types of microbiomes using Ion S5 Next-Generation DNA Sequencing Machine (Thermo Fisher Scientific, USA) and back-trajectory model to identify the continental source regions*

Future plan for 2022-23:

Plan of works for 2022-2023 is as follows:

A) Observations and Sample Collections at

Urban and Surroundings for identification of 'local' urban bioaerosols (shown in Fig.2)

a. Kolkata (Urban) b. Shyamnagar (Upwind) c. Falta (Downwind)

I. *Himalayas sampling for detecting hill-top transported 'foreign' and 'local' bioaerosols*

a. Darjeeling (Polluted Hill-top) b. Sandukphu (Clean Hill-top) c. Dhotrey (Himalayan Forest)

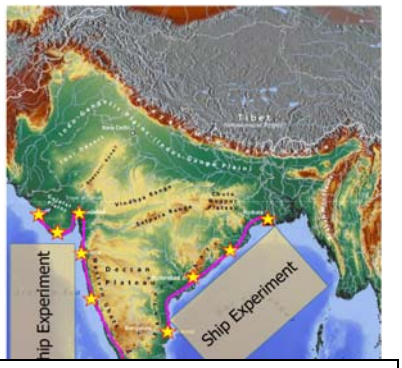


Figure 3: *Next observational sites at east and west coast region, synchronized with ship movement*

II. *Sundarban Mangrove Forest to investigate the outflow of pollutant from Indo-Gangetic Palin to the Bay of Bengal and aerosol radiative effects by continental anthropogenic aerosols retrieved from observations (shown in Fig. 3) postponed for 2022-23 due to COVID-19 pandemic situation*

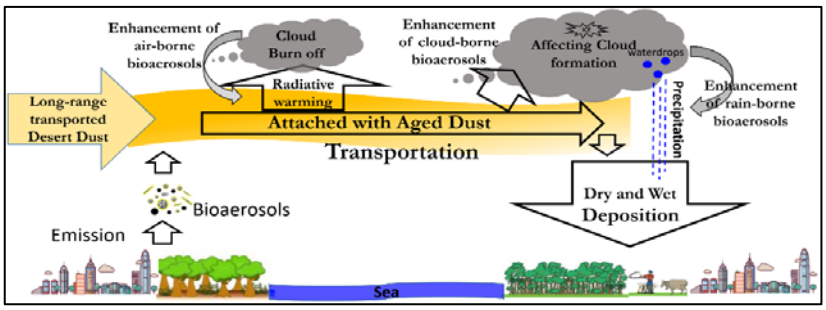
III. *East-West Coastal Observations Synchronized with Ship-borne measurements to identify the different types of bioaerosols entering to Indian Subcontinent postponed for 2022-23 because of COVID-19 pandemic situation*

IV. *Marine regions over the Bay of Bengal and Indian Ocean on Oct, 2020 and Jan, 2021 to identify marine bioaerosols confirming the transported 'foreign' bioaerosols over mainland of India, scheduled three ship platform for observations with RV-Sagar Tara and Anveshika*

B) Laboratory Sample Analysis for detecting microbiomes at Dr. Wriddhiman Ghosh's lab

C) Ground-based and satellite-based data analysis and model simulation using radiative transfer and back-trajectories model to estimate radiative warming and identify continental source region

Time (2021-2022) / Work Type	MAM (Pre-monsoon)	JJA (Monsoon)	SON (Post-monsoon)	DJF (Winter)
Manpower Requirements				
Sampling collection spatiotemporal variation Himalayas, urban, rural				
Clean Hill-top sampling (Sandukphu)				
Ship-borne and East-West Coast measurements				
Data analysis				



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 air-borne bioaerosols and formation of clouds by elevated bioaerosols on the enhancement of cloud-borne & rain-borne bioaerosolsare shown here.

Possible entry regions of bioaerosols and carrier aerosols in Indian subcontinent

– SCIENTIFIC REPORT –

DEPARTMENT OF MICROBIOLOGY

As a part of Azadi Ka Amrit Mahotsav, Bose Institute observed 137th Birthday of Prof. Debendra Mohan Bose on November 26, 2021. Prof. Amitava Raychaudhuri, Emeritus Professor, Department of Physics, University of Calcutta, Kolkata, graced the occasion as Guest of Honour and delivered the D. M. Bose Memorial Lecture 2021 on the topic "Musings on Mass". Prof. Soumitra SenGupta, Amal Kumar Raychaudhuri Chair Professor, School of Physical Sciences, Dean (Faculty affairs and Staff matters), Indian Association for the Cultivation of Science (IACS), Kolkata presided over the programme.

DEPARTMENT OF MICROBIOLOGY

OVERVIEW

The Department of Microbiology was founded in 1942, not only as one of the first of its kind in India but in this subcontinent too, being a part of the century old Bose Institute. During early years, this department was very actively engaged in the area of antibiotic research. Later in the second half of last century, the main focus was industrial Microbiology, primarily on fermentation technology, mutational research and microbial bioleaching of mineral ores. However, with time, this department engaged both in applied and basic research and had addressed various problems in the area of infection biology, biocatalysis, drug design and detoxification apart from plant-microbe and mineral-microbe interactions. Currently this department is devoted to understand various aspects of microbiological processes in planetary health, environmental restoration and pathogenesis.

- Management of *Mycobacterium tuberculosis* with the perception of the molecular biology and metabolism of the TB pathogen, using its phages and plasmids as model systems, tools and probes. Strategic combating approaches include 'Phage inspired antibiotics for mycobacteria' and CRISPR-Cas9-based editing of genes for the down regulation enzymes inhibiting the growth of mycobacteria.
- Genomic and proteomic approaches to understand bacterial metabolism of health hazard aromatic pollutants, regulation of gene expression and *in silico* analyses of biomolecular evolution. Development of biosensors and bioprospecting of novel compounds from plant and microbe, besides studies on gut and environmental metagenome and understanding of host-pathogen relationships are the key strategic schemes of research.
- Studies on the molecular biology of sulfur-chemolithotrophic prokaryotes and their evolutionary dynamics to reveal opportunities and constraints of *in situ* metabolisms, and geochemical manifestations of the microorganisms of the Carbon-Sulfur-cycle within microbiomes of extreme environments that have active interfaces with the Earth’s geological processes.

LIST OF PERSONNEL

Faculty Members: Prof. Sujoy Kr. Das Gupta, Prof. Tapan Dutta (Chairman), Dr. Wriddhiman Ghosh.

Students : JRF/SRF: Shrestha Ghosh, Sabyasachi Bhattacharya, Apurba Sarkar, Subhrangshu Mandal, Moidu Jameela Rameez, Moushumi Bhattacharyya, Poulami Ghosh, Madhu Manti Patra, Saikat Deb, Megha Chakraborty, Rahul Shaw, Anik Barman, Mriganka Munshi Karmakar, Nibendu Mondal, Suman Basu, Rinita Dhar, Jagannath Sarkar, Sumit Chatterjee, Subhajit Dutta. ***RA :*** Dr. Avijit Das, ***Women Scientist :*** Dr. Madhumita Roy, Dr. Shreya Sengupta.

Staff Members: Prabir Kumar Haldar, Debashis Sarkar, Rabin Paul, Narayan Patali.

PROF. TAPAN K. DUTTA

Professor
Department of Microbiology

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Mriganka Munshi Karmakar, *SRF*
Megha Chakraborty, *SRF*
Saikat Deb, *SRF*
Mousumi Bhattacharyya, *SRF*
Dr. Avijit Das, *RA*
Dr. Debarun Acharya, *RA*
Dr. Madhumita Roy, *RA (DST-WOSA)*

Collaborators:
Dr. Kannan Pakshirajan, Professor, IIT-Guwahati
Dr. Tapas K. Sengupta, Professor, IISER-Kolkata
Dr. Subrata K. Das, Scientist F, ILS, Bhubaneswar
Dr. Darren Reynolds, Professor, University of West England, Bristol, UK
Dr. Robin Thorn, Associate Professor, University of West England, Bristol, UK

Research background and vision:

The booming chemical and biotechnological activities, serving the greedy needs of human, have been contributing massive environmental pollution, imparting major health problems in humans and also perturbing the ecosystems. Microbial bioremediation is a sustainable tool with significant prospective, such as expression of genes of interest which have unique and robust catabolic potentials in the degradation of wide range of pollutants under eco-friendly conditions. The pool of information regarding microbial remediation processes, with respect to catabolic pathways, gene regulation, enzyme evolution and biosensor-based monitoring of pollutants, can provide a wide window in evaluating key areas on environmental management. Additionally, it is important to understand the indigenous microbiota in different host, which are no longer passive bystanders, but do participate in a wide range of complex interactions with their host. Also, the burgeoning field to understand host pathogen relationships and therapeutic microbiology from large-scale genomic and proteomic data aid to better understanding of pathogenesis in order to hinder the health hazards of host.

Summary of research during April 1, 2021 – March 31, 2022:

To unveil the catabolic diversity and metabolic versatility of bacterial strains capable of degrading Endocrine Disrupting Chemicals (EDC), various strains belonging different genera were isolated by employing enrichment culture technique. An on-going study on di-(2-ethylhexyl) phthalate (DEHP) degrading strain Mycolicibacterium sp. MBM, revealed esterase mediated hydrolysis of DEHP, releasing probable metabolites phthalic acid and side-chain alcohol 2-ethylhexanol (2-EH), which were further assimilated to TCA cycle. Based on genomic and transcriptomic analysis along with biochemical assays, various catabolic genes/gene clusters were funneled down and few unique novel phthalate esterase(s) were upregulated and the metabolism of 2-EH was found to be initiated by NAD+ independent dehydrogenase gene(s).

Upregulation of genes involved in the degradation of phthalate diesters were validated by proteomic and transcriptomic analyses confirming desired specific traits for biosensor development. One bioreporter strain was developed by chromosomal insertion of reporter gene (egfp) using strategically constructed reporter plasmids capable of detecting Di (2-ethylhexyl) phthalate at nanomolar levels (Figure 1). Simultaneously, a few potential bacteria capable of degrading alkylphenols, specifically, nonyl phenol (NP) and octyl phenol (OP) were isolated and whole genome sequencing was done. The biochemical and genomic analysis of the NP and OP degrading isolates unveiled the monooxygenase mediated pathway(s). The transcriptome analysis is on-going for further validation.

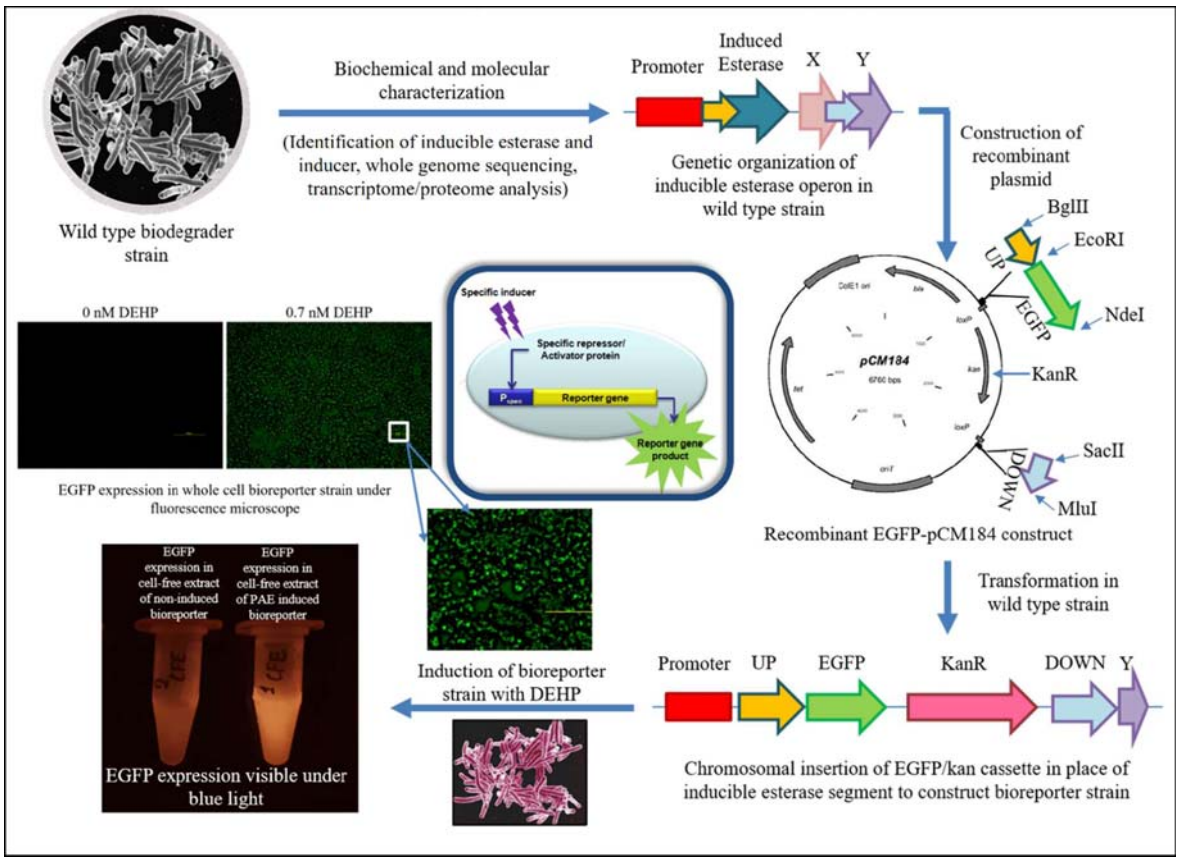

Figure 1: Construction of whole-cell bacterial bioreporter strain for endocrine disrupting phthalate diester detection

In pursuing other aspect of research, mangrove associate Suaeda monoica (Figure 2) was selected for study of novel bioactive compounds present in root, shoot and leaf of the plant (Figure 3). In addition, both culture-dependent and culture-independent approached were undertaken to reveal microbial profiles and their relationship within plant rhizosphere soil, nonrhizosphere soil, apart from that present in plant root, shoot and leaf. Genome mining of selected strains is underway to elucidate the gene clusters involved in secondary metabolite production, where one of the isolates, Bacillus velezensis strain Endo_51, showed the presence of two RiPP clusters encoding Lanthipeptide class II and lactococcin 972 family of bacteriocin and four NRPS gene clusters encoding lipopeptide antibiotic surfactin, bacillibactin siderophore and antimicrobial peptides, bacilysine and bacitracine. The bacterium also possessed seven different types of PKS gene clusters. Among them one cluster was found similar to that for Bacillaene polyketide antibiotic, produced by B. amyloliquefaciens FZB42 and pksX in B. subtilis 168. In the metagenome data, many secondary metabolite producing gene clusters, RiPP, NRPS and PKS were found that encoded for the synthesis of tropane, piperidine, pyrimidine, alkaloid, steroid hormone, streptomycin, penicillin, cephalosporin etc.

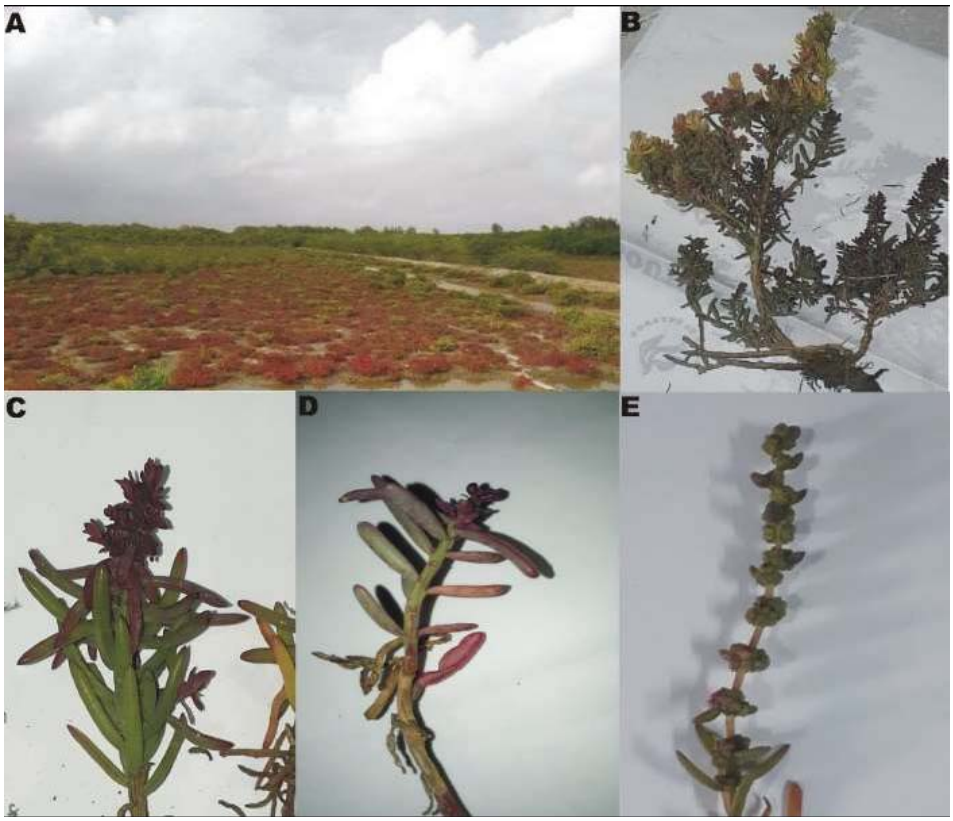

Figure 2: Images of Suaeda monoica. (A) Sample collection site, (B) isolated plant, (C, D) Enlarged view of leaves and stems with emerging inflorescence, (E) Matured inflorescence.

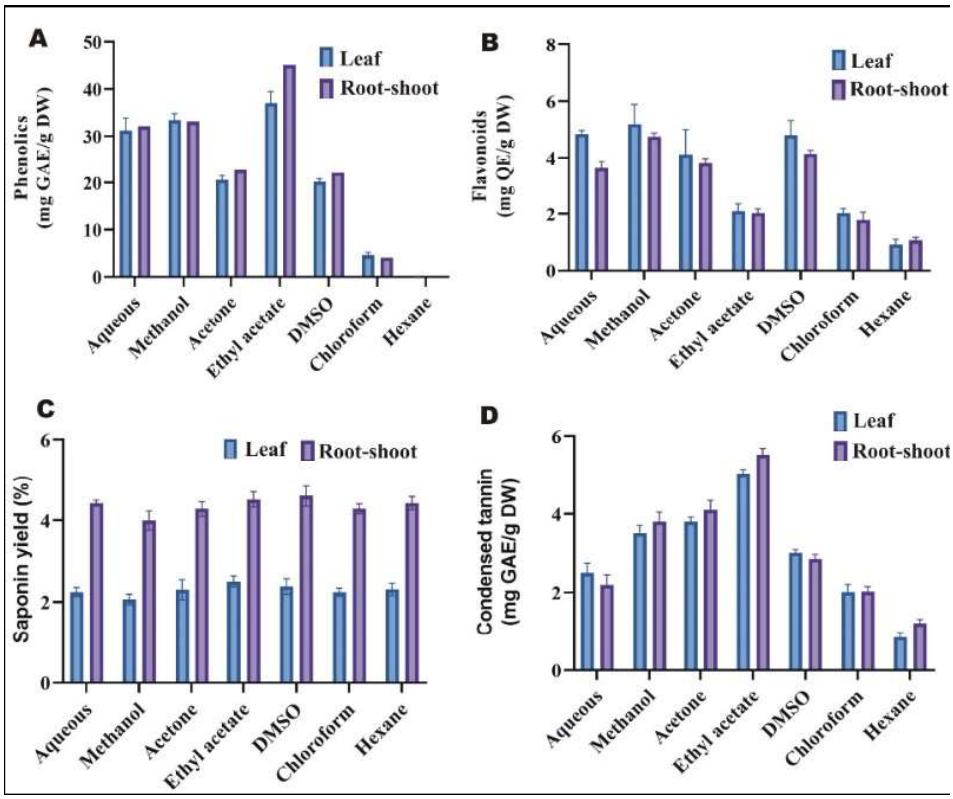

Figure 3: Quantification of phenolics (A), flavonoids (B), saponins (C) and condensed tannins (D) in the leaf and root-shoot extracts of Suaeda monoica. Two-way ANOVA showed significant differences at p values < 0. 0001 by Turkey's multiple range test.

While in another study, a soil isolate Pseudomonas aeruginosa was exploited to evaluate its antimicrobial properties. Presence of antimicrobial peptide was screened from culture supernatant and purified using a series of chromatographic and molecular size-based membrane filtration techniques. The identity of the molecule, found to be less than 1 kDa in size, has been characterized by MALDI-TOF MS analysis and a novel penta-peptide was identified using ESI-MS analysis, which was further verified by correlating with the protein sequence from whole genome sequence of the isolated strain. The identified and synthesized peptide is more hydrophobic in nature, with higher GRAVY score, and a broad-spectrum antimicrobial activity. Also, the cloning and expression of the antimicrobial peptide is under investigation by using SUMO fusion protein and purification procedure was done by Ni-NTA column chromatography techniques.

In another endeavour, Next-generation Sequencing (NGS) analysis was performed to reveal culturable and non-culturable microbial diversity of Hilsa (Tenualosa ilisha, an anadromous fish). While, functional annotation of the NGS data was performed using PICRUSt bioinformatic tool. Apart from microbial diversity, omega-3-fatty acids producing gene named DesA was selected for cloning and purification from whole metagenome data. Exploration of metagenome data using various bioinformatics tools will facilitate functional characterization of various important enzymes and/or biosynthetic pathways of omega-3-fatty acids and flavors that are among the major future objectives.

In addition, a study on the host-pathogen interaction from molecular perspective using high-throughput protein-protein interaction network (PPI) data were conducted. Here, we accumulated PPI data from the literature published till date to construct a high-throughput (PPI) network of human and human coronaviruses to understand the evolution of SARS-CoV2 inside human host by comparing its attributes with other CoVs. A comprehensive analysis revealed that unlike other host-pathogen interactions that are mostly mediated by hub and bottleneck proteins, the SARS-CoV2 mainly interact with human proteins having high betweenness centrality (bottlenecks) but not hubs, when compared to other coronaviruses. Moreover, the low affinity interactions mediated by intrinsically disordered residues of human proteins play important role in human-SARS-CoV2 protein-protein interactions. We further aim to explore the interactions for a better understanding of the evolution of the SARS-CoV2 as it is still adapting to the human host.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	05	–	–	01	–	–

Average publication impact factor: **6.2**

DR. WRIDDHIMAN GHOSH
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Collaborators:
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University of North Bengal, India

Research background and vision:

Our Geomicrobiology Group undertakes fundamental research on the evolutionarily ancient metabolism called chemolithotrophy (use of inorganic salts by microorganisms as sole sources of energy and electrons), which is thought to have originated in the hot and reducing environments of the early Earth. Besides the quest for novel molecular mechanisms of sulfur-chemolithotrophy, our laboratory is engaged in revealing the *in situ* metabolisms, ecosystem constraints and opportunities, and geochemical manifestations, of the Carbon-Sulfur-cycle microorganisms within microbiomes having major interfaces with the Earth's geological processes. In doing so, we also explore the physicochemical windows of opportunity that sustain life at the entropic and bioenergetic extremities of the Earth's biosphere. Our activities are centered on the following biophysically-extreme habitats:

- the geochemically-special (pH-neutral, silica-poor, but boron-, sulfide-, sulfate- and thiosulfate-rich) hot spring systems of the Trans-Himalayan region (Eastern Ladakh, India);
- the Trans-Himalayan lake systems, which occur on either side of the Indus Suture Zone (the collision boundary between the Asian and Indian continental plates involved in Himalayan orogeny), and remain frozen for approximately one third of a year; and
- certain oxygen-stressed territories of the marine realm, such as the perennial and seasonal oxygen minimum zones (OMZs) of the Arabian Sea

Summary of research during April 1, 2021 – March 31, 2022:

Association of the typically thermophilic or hyperthermophilic bacteria and archaea with hydrothermal habitats is axiomatic. Accordingly, our knowledge on microbial adaptation to high temperature is based largely on hot spring isolates that grow *in vitro* either obligatelyat ≥80°C or facultativelybetween 30°C and 80°C. Mesophilic microbial groups (taxa having no member reported for laboratory growth at >45°C), on the other hand, though unexpected in high-temperature environments, often get stochastically introduced to hydrothermalsystems, where they are detected mostly via metagenomics, and sometimes as pure culture isolates. In this

scenario, it was imperative for the global understanding of life's high-temperature adaptation, to explore the biology of the phylogenetic relatives of mesophilic bacteria which happen to be there in hot spring habitats. We investigated high-temperature growth and survival in relation to the physiology, cell biology, and genomics of a novel, facultativelychemolithoautotrophic strain of the alphaproteobacterial genus *Paracoccus* (named SMMA_5) that was isolated from the vent-water of a sulfur-borax spring called Lotus Pond, located in the Puga geothermal area of eastern Ladakh, at an altitude of 4436 m, where water boils at ~85°C. Remarkably, whereas no member of *Paracoccus* grows at >45°C *in vitro*, the temperature of the habitat of SMMA_5 ranges between 78°C and 85°C.

Our previousexplorations of geomicrobiology carried out for the sulfur-boron-rich hot springs of Puga Valley in eastern Ladakh had revealed peculiar, mesophiles-dominated microbiomes within this mineralogically special, Trans-Himalayan hydrothermal system. The unique geochemistry of the Puga hot springs - which includes the discharge of boiling or near-boiling water having circumneutral pH, accompanied by low levels of sulfide, silicon and total dissolved solids (TDS), but high concentrations of sodium, boron, elemental sulfur and sulfate - had been hypothesized as the key facilitator of the high *in-situ* diversity of microorganisms. Furthermore, the characteristic geohydrology of the Puga hot spring area was identified as the key driver of microbial flux through the hot spring system. These ecosystems apparently hold paradigm-changing implications for our understanding of life's adaptation to heat, the nature of ancient metabolism, and the geobiological frameworks of early ecosystems on Earth.So it was imperative, as well as timely, to reveal the microbiomes of other Trans-Himalayan hot spring systems and consider the community architectures in the context of the systems' geology and chemistry. In this year's study centered on the Chumathang and Panamikhot spring systems located within the Indus and Nubra valleys of eastern and northern Ladakh respectively, we explored the vent-waters' chemical and microbial compositions, and evaluated the geochemical dependencies of the microbiome architectures in the context of equivalent information available for the previously studied hotsprings of the Puga geothermal area. Our analyses revealed distinctive as well as unifying geomicrobiological features (physicochemical factors promoting and/or constraining the microbiota) for the hydrothermal systems located in the distinct Trans-Himalayan territories.

Our recent discovery of metabolically active aerobic microbial communities across the anoxic (sulfidic) sediment-horizons of the Arabian Sea oxygen minimum zone ushered new understanding of organic matter remineralization in this ecologically sensitive territory of the global ocean. In order to further appreciate the implications of these cryptic microbial communities in the carbon cycle of anoxic marine sediments we presently carried out the isolation of native bacterial strains capable of breaking down and growing on complex carbon compounds. Our findings revealed hitherto unknown biogeochemical pathways of organic matter remineralization in the OMZ sediments.

With regard to the source of cryptic O_2that may facilitate the survival and activity of the aerobic bacterial communities across the anoxic (sulfidic) sediments of Arabian Sea OMZ, we investigated the *in situ* ecology of the Crenarchaeota species *Nitrosopumilus maritimus*, strains of which have been recently appreciated by other laboratoriesfor the production and accumulation of O_2, via reduction of nitrous oxide during ammonia oxidation, once ambient O_2 is depleted. Metagenomeswere analyzedto revealthe population distribution of *Nitrosopumilus* species, while pure culture strains were isolated on ammonium chloride as the sole energy source, with an aim at future co-culture experiments to check whether these organisms could indeed supply biogenic O_2 to sustain the obligately aerobic OMZ-sediment isolates, within an otherwise anaerobic environment.

Major accomplishment (significant results):

(i) Progressive reverse fractionation of sulfur stable-isotopes (enrichment of the heavier isotope ^{34}S) was discovered to be a signature of thiosulfate oxidation by "*Proteobacteria*".

(ii) Metagenome analysis for the sulfide-containing anoxic sedimentsof the Arabian Sea OMZs revealed the widespread abundance of *Nitrosopumilus* species, including *Nitrosopumilusmaritimus*, strains of which have been appreciated by Kraft et al.(2022)for the production and accumulationof O_2, via reduction of nitrous oxide during ammoniaoxidation, once ambient O_2 is depleted. Three pure culture isolates of *Nitrosopumilus* were also isolated by us with an aim at testing them *in vitro* as the potential sources of cryptic O_2 for the active aerobic communities that we had discovered previously in the anoxic OMZ sediments (Bhattacharya et al., 2020).

(iii) Physicochemical determinants of microbiome architecture across continental shelves/slopes were unknown. We discovered that the nature, abundance, and fate of the organic matter delivered to the sea floor shaped microbiomes across a continental margin under direct and indirect influence of sedimentation rate and water-column O_2 level respectively.

(iv) We discovered that bacterial mesophiles dominated the microbiomes in Trans-Himalayan hot springs, and delineated the geochemical and biophysical bases of the high habitability of these ecosystems.

(v) Endurance of high heat, up to the extent of growth under special conditions, was discovered in a hot spring dwelling relative of the mesophilic*Paracoccus*. Thermal conditioning, extreme oligotrophy, metabolic deceleration, presence of inorganic/organic solutes, and genomic specializations were revealed as the key drivers of this conditional (acquired) thermophilicity. Feasibility of such phenomena across the taxonomic spectrum can be paradigm-changing for the established scopes of microbial adaptation to physicochemical extremes.

Future plan for 2022-23:

(i) Our research has revealed the endurance of high heat by a hydrothermal vent isolate SMMA_5, which is phylogenetically closest to the mesophilicalphaproteobacteria classified under the genus *Paracoccus*. The logically consequent task would be to explore the feasibility of this kind of conditional or secondarily acquired thermophilicity in other mesophilic taxa. If such phenomena are indeed found to be universal then it would revolutionize the existing paradigm of thermal barriers for life and usher new vistas of opportunity in microbial process biotechnology.

(ii) As thermal conditioning and metabolic deceleration were identified as the key drivers of high temperature adaptation by hot spring mesophiles, global transcriptome analysis would be conducted to evaluate the potential role of epigenetic memory and control of metabolisms towards successful thermal stress management.

(iii) A holistic research program would be carried out to reveal the sedimentary and water-column microbiomes, and delineate the biogeochemical (carbon-sulfur-iron-nitrogen) cycles, of Himalayan/Trans-Himalayan lake systems to understand the constraints and opportunities of ecosystem function *in situ*. The entire gamut of knowledge obtained in relation to biogeochemical complexity for the individual ecosystems explored would be applied to design ecosystem-inspired bioreactors for organic waste degradation in cold/frigid territories of India.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
01	04	03	–	–	–	–

Average publication impact factor: **3**

– SCIENTIFIC REPORT –

DIVISION OF MOLECULAR MEDICINE

"A FILM ON THE GLORIOUS HISTORY OF BOSE INSTITUTE"- Historical perspectives and current activities, Vigyan Prasar is running a series made on various institutes of DST, on the occasion of the Golden Jubilee Year Celebration of the DST. These films are launched (Every Monday and Wednesday) and are available to watch on India's 24x7 national science channel on the internet, called India Science (www.indiascience.in). The remarkable voyage of Bose Institute was featured on July 7, 2020 at 6:00 pm.

DIVISION OF MOLECULAR MEDICINE

OVERVIEW

The primary mission of this division is to understand the molecular architecture of different cellular functions related to vital life processes, and also to unravel the complexities of a disease processes such as neurodegenerative disorders, cancer, gastrointestinal pathogenesis, metabolic disorders, malaria, filariasis etc. To achieve this, multidirectional chemical biology approaches have been initiated by the faculties of this division to understand the fundamental aspects and mechanism of tumor immunosuppression as well as glycobiology of tumor, protein misfolding-induced neuro-degenerative disorders both at the cellular and molecular levels. Approaches have been undertaken to identify natural products and natural product inspired synthetic bioorganic molecules towards the development of novel therapeutics. In addition, identification of new anti-malarial drug target, structure–function analysis of PfAlba, a family of *P. falciparum* DNA binding protein and evaluation of the role of mitochondrial pathology in stress-related gastric mucosal disorder and injury-induced by NSAIDS is also being carried out. The prime objective of the division is to generate knowledge through cutting edge basic research and their translational applications towards the development of therapeutics and disease diagnosis

LIST OF PERSONNEL

Faculty Members: Prof. Uday Bandyopadhyay, Prof. Gaurisankar Sa, Prof. Mahadeb Pal, Prof. Anup K Misra, Prof. Kaushik Biswas, Prof. Atin K Mandal, Dr. Kuladip Jana.

Students : JRF/SRF/RA : Dr. Aharna Guin, Dr. Soumita Mukherjee, Dr. Silpita Paul, Dr. Sarita Sarkar, Dr. Nivedita Roy, Dr. Deblina Guha, Dr. Papri Basak, Dr. Dipanwita Mukherjee, Chinmoy Banerjee, Shiladitya Nag, Arin Gucchait, Tapasi Manna, Monalisa Kundu, Pradip Shit, Satyajit Halder, Abhijit Rana, Baijayanti Ghosh, Sayantan Bose, Sendge Anil Khusal Rao, Anirban Manna, Somesh Roy, Abhishek K. Das, Subhadip Pati, Susweta Mahalonobis, Sharmistha Chatterjee, Elora Khamrui, Sourio Chakraborty, Apratim Dutta, Subhankhi Dhar, Mousumi Kundu, Samhita De, Noyel Ghosh, Naibedya Dutta, Sumon Mukherjee, Saikat Dutta, Dhiman Saha, Ankita Mandal, Udit Basak, Abhishek Sarkar, Subha Roy, Sounak Banerjee, Madhuparna Chakraborty, Gourab Shome, Upama Chowdhury, Chirantan Majumdar, Hossainur Rahaman Sareng.

Staff Members: Uttam Kr Ghosh, Arindam Basu, Debasish Majumder, Nilanjana Bhattacharya, Sanghamitra Das, Sourav Samanta, Kalyan Das, Amartya Sen, Sankar Prasad Bari, Purnendu Manna.

PROF. ANUP KUMAR MISRA
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Monalisa Kundu, *CSIR-SRF*
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Abhijit Rana, *CSIR-JRF*

Research background and vision:

Synthesis of complex oligosaccharides of bacterial origin for their utilization in the carbohydrate base vaccine development. Development of synthetic methodologies for the preparation of glycomimetics.

Summary of research during April 01, 2021 – March 31, 2022:

As a part of the project proposal, chemical synthesis of the oligosaccharide repeating units corresponding to the *O*-antigens of *Salmonella enterica* strains have been undertaken. A series of differentially protected monosaccharide intermediates have been prepared from the commercially available reducing sugars following the reported reaction methodologies. Having the suitably protected monosaccharides at hand, attempts were made to couple them using stereoselective glycosylations. A tetrasaccharide and a pentasaccharide have already been synthesized. Besides the synthesis of pentasaccharide, a number of novel reaction methodologies have also been developed, which include (a) Influence of remote functional groups towards the formation of 1,2-*cis* glycosides: special emphasis on β-mannosylation; (b) use of glycosyl selenoacetates as versatile building blocks for the preparation of stereoselective selenoglycosides and selenium linked disaccharides; (c) Selective acetolysis of primary benzyl groups in carbohydrate derivatives under mild reaction condition; (d) preparation of selenium incorporated carbohydrate derivatives, pseudosugars. From the research outcome, **six** papers have been published in the peer reviewed international journals till date.

Major accomplishment (significant results):

(a) Synthesis of two oligosaccharides containing rare sugars.

(b) A series selenium incorporated carbohydrate derivatives.

Objectives addressed and work done:

As a part of the project proposal, chemical synthesis of the oligosaccharide repeating units corresponding to the *O*-antigens of *Salmonella enterica* strains have been undertaken. A series of differentially protected monosaccharide intermediates have been prepared from the commercially available reducing sugars following the reported reaction methodologies. A tetrasaccharide and a pentasaccharide fragments have already been synthesized. Besides the synthesis of pentasaccharide, a number of novel reaction methodologies have also been developed, which include (a) Influence of remote functional groups towards the formation of 1,2-*cis* glycosides: special emphasis on β-mannosylation; (b) use of glycosyl selenoacetates as versatile building blocks for the preparation of stereoselective selenoglycosides and selenium linked disaccharides; (c) Selective acetolysis of primary benzyl groups in carbohydrate derivatives under mild reaction condition; (d) preparation of selenium incorporated carbohydrate derivatives, pseudosugars.

Future plan for 2022-23:

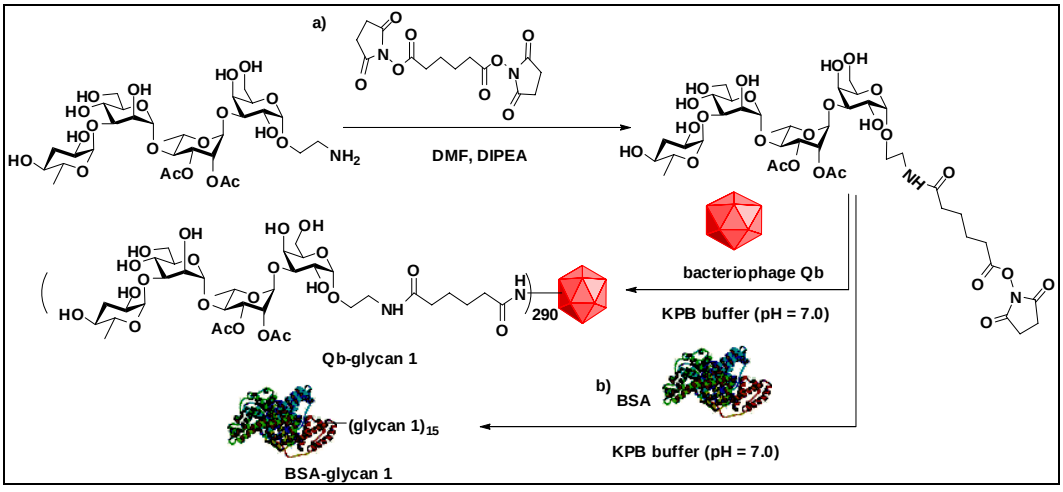
(a) Chemical synthesis of complex oligosaccharides and their utilization in the preparation of glycoconjugates.

(b) Carbohydrate derived small molecules of biological interest.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	06	–	–	01	–	–

Average publication impact factor: **3.5**



PROF. ATIN KUMAR MANDAL

Professor
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Pramit Bhattacharjee, *SRF*
Somesh Roy, *SRF*
Madhuparna Chakraborty, *SRF*
Dhiman Saha, *JRF*
Soumita Mukherjee, *DBT-RA*
Gourav Some, *CSIR-JRF*

Collaborators:
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Dr. Dhandapany Perundurai, *InStem, Bangalore*
Dr. Mohit Prasad, *IISER, Kolkata*

Research background and vision:

Protein quality control (PQC) maintains cellular protein homeostasis at physiological or stress condition. Chaperones and degradation machinery play in concert in maintaining balanced proteome which is critical for cell survival. Whereas chaperones bind to non-native polypeptides to prevent aggregation and facilitate the folding of proteins, the degradation system– the ubiquitin-proteasome and autophagy clears abnormal or damaged proteins. However, the efficiency of the PQC system is often perturbed by environmental, cellular or genetic factors which generate metastable conformation of protein having gain-of-function or aggregation prone protein conformation. Generation of these metastable protein conformations are the causal reason for various diseases including cancer, diabetes, hypertrophy and late-onset neurological diseases. My lab is focused to understand the mechanism of cellular PQC and how the PQC is altered for mutant having gain-of-function or aggregation prone proteins.

Summary of research during April 1, 2021 – March 31, 2022:

Work Done during 2021-2022

- **Identifying the role of Praja1 ubiquitin ligase in regulating the homeostasis of PolyQ proteins associated with neurodegenerative disorders**

We have identified the functional role of Praja1 (PJA1), an ubiquitin ligase highly expressed in brain tissue in clearing polyQ proteins, Ataxin-3 and Huntingtin associated with Spinocerebelar Ataxia-3 (SCA3) and Huntington's disease.

1. PJA1 ligase ubiquitinates normal and expanded polyQ proteins
2. PJA1 promotes degradation of PolyQ proteins via proteasome and autophagy,
3. PJA1 reduces polyQ toxicity in yeast and *Drosophila*.
4. PJA1 interacts with molecular DNAJ chaperones DNAJB2 and DNAJB6
5. Ubiquitin K48A, K63A and their double mutant have been generated to analyse specificity of PJA1 mediated ubiquitination.

- **Role of chaperones and ubiquitin ligases in regulation of CRAF kinase**

We elucidated the role of HOP (Hsp70/Hsp90 organizing protein), co-chaperone of Hsp90, in maintaining CRAF kinase activity.

a. HOP remains in complex with CRAF and maintains CRAF activity.

b. The rigid TPR2A-2B-DP2 domain of HOPrecruits Hsp90 to CRAF

c. HOP binding

d. to CRAF was enhanced during activation of MAPK signaling which recruits Hsp90 and actin for translocation of CRAF.

e. Down-regulation of HOP reduces activity of mutant CRAF kinase associated with 'Rasopathy' in yeast, mammalian cell and transgenic *Drosophila* model.

f. Generation of HOP knock-out HEK293T cells by CRISPR

g. Generation of CRAF knock out HEK293T cells by CRISPR

- **Characterizing the interaction between Phosphodiesterase 8 (PDE8A) and 14-3-3 with CRAF: Gaining insights into CRAF regulation**

cAMP-specific phospdiesterases downregulate protein kinase A (PKA) signalling. Among these PDE8A is a high affinity cAMP-specific phosphodiesterase. Interestingly, PDE8A interacts with CRAF kinase and attenuate its PKA mediated inhibitory Ser259 phosphorylation. On contrary, scaffold protein 14-3-3 inhibits CRAF activity by binding to phosphorylated Ser259. Thus, PDE8A antagonizes 14-3-3 function for activation of CRAF kinase, thereby activating MAPK pathway which may implicate in cross-talk between PKA and MAPK signaling in cellular milieu. But how PDE8A triggers the switch and regulates PKA and MAPK signalling is largely unknown. We have found

a. Interaction between PDE8A and 14-3-3ξ protein by Co-IP in mammalian cells and alsoin yeast system.

b. PDE8A -14-3-3ξinteraction is enhanced during activation ofPKA.

c. 14-3-3ξ binds to the phosphoS359 residue of PDE8A

d. Both 14-3-3 dimer and monomer interact with PDE8A.

Major accomplishment (significant results)

- CRISPR-CAS9 mediated generation of knock out cells is established
- Identification of interaction between phosphodiesterase 8A (PDE8A) with 14-3-3ξ
- Received DSTBT-GoWBgrant "Characterizing the interaction between Phosphodiesterase 8 (PDE8A) and 14-3-3 with CRAF: Gaining insights into CRAF regulation". [978 (Sanc.)/STBT-11012(12)/23/2020-BT SEC],PI, March 17, 2020-2023; Rs. 21,40,000.00

Future plan for 2022-23:

- **Identifying the role of Praja1 ubiquitin ligase in regulating the homeostasis of PolyQ proteins associated with neurodegenerative disorders**

We will primarily address to understand the mechanism of PJA1 mediated protein degradation and establish the frame work for proteome and interactome analysis.

i. Assistance of molecular chaperones (Hsp70/DNAJ) in PJA1 mediated ubiquitination and degradation of ataxin-3 protein.
   A. Identification of interaction between Hsp70 or DNAJ with PJA1
   B. Generation of DNAJB2 and DNAJB6 knock out cells
   C. Studying PJA1 mediated ubiquitination of ataxin-3 upon modulation of Hsp70 or DNAJB level

ii. The substrate specificity of the PJA1 whether it act on various substrates such as **α-synuclein, aβ, Tau, SOD1, FUS** in addition to PolyQ proteins (Ataxin-1, Ataxin-3, and Huntingtin). Identifying its substrates will provide an overview of proteostasis network maintained by PJA1 ligase.

iii. PJA1 knock out cell will be generated to understand its function, specificity of action and analysis of proteome maintained by PJA1. We will design the CRISPR sgRNA for PJA1 and clone it into the vector pSpCas9(BB)-2A-Puro (PX459). The construct will be transfected in mouse neuroblastoma cell and expression of endogenous PJA1 will be checked in polyclonal pool. We will then screen for monoclonal knockout PJA1 cell from this pool and use it for proteome analysis.

iv. PJA1 stable cell line will be generated in Tet-ON lentiviral system. PJA1 will be cloned into pLenti-tet vector with FLAG-tag in neuronal cell line under the control of tet ON/OFF system which can be induced by the addition of tetracycline. This stably expressed PJA1 will be used to purify PJA1 protein with FLAG-M2 bead for further analysis by mass spectroscopy.

- **Role of chaperones and ubiquitin ligases in quality control of CRAF kinase**

  i. Establishing the role of Hsp40 chaperone in proteostasis of CRAF kinase
     a. Interaction of DNAJ (DNAJA and DNAJB) with CRAF by Co-IP
     b. Generation of DNAJA1, DNAJA2 and double knock out HEK293T cells
     c. Check CRAF maturation, activity, stabilityin DNAJA knock out cells
     d. Interaction of CRAF with Hsp70 and Hsp90 in DNAJ knock out cells

  ii. Identification of ubiquitin ligase in degradation of mutant CRAF kinase associated with cardiac hypertrophy.
     a. Generation of sgRNA directed ubiquitin ligases (Cul5, CHIP, HECKTD3 etc) knock out HEK293T cells using CRISPR
     b. Cycloheximide chase of CRAF in knock out cells
     c. Ubiquitination of mutant CRAF in knockout cells
     d. Association of CRAF mutants with chaperones

- **Characterizing the interaction between Phosphodiesterase 8 (PDE8A) and 14-3-3 with CRAF: Gaining insights into CRAF regulation**

  i. Optimization of 14-3-3ξdownregulation by siRNA, shRNA or sgRNA
  ii. Check PDE8A stability and activity upon downregulation of 14-3-3ξ
  iii. Identify the domain of CRAF required for interaction with PDE8A

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	03	–	–	02	–	–

Average publication impact factor: **4.4433**

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Understanding the role and identifying the mechanism underlying ganglioside GM2-mediated Epithelial-Mesenchymal Transition (EMT) and Metastasis

Research background and vision:

Glycosphingolipids, in particular gangliosides are found to be over-expressed in several cancers. Research from our laboratory over the last few years have identified ganglioside GM2, over-expressed in many cancers, to be involved in the process of tumorigenesis. Through our research, we want to find out "How" GM2 mediates vital cellular process associated with pro-tumorigenic effects, and also, "Why" is GM2 over-expressed in cancers ? In the current proposal, we attempt to find out how GM2 mediates epithelial-mesenchymal transition (EMT) through possible involvement of a critical tumor suppressor pathway, HIPPO.

Summary of research during April 1, 2021 – March 31, 2022:

Previous studies show that gangliosides over-expressed and actively shed from cell membrane promotes cancer cell migration, invasion and immune cell dysfunction. Recent publications from our laboratory provide enough evidence that ganglioside GM2 (over-expressed in glioblastoma, renal cell carcinoma, lung adenocarcinoma) enhances tumor cell migration, invasion as well as anchorage independent growth (AIG) leading us to consider the idea that GM2 may influence EMT. Preliminary data from our laboratory shows several genes modulated by Hippo-signaling, more specifically regulated by the YAP/TAZ-TEAD transcriptional complex to be significantly altered either in GM2-synthase knockout cells (with negligible or significantly low GM2 expression) or exogenous GM2 treatment, suggesting that GM2 mediated EMT and tumorigenesis may involve Hippo signaling. However, the role and molecular mechanism played by GM2 in cancer cell metastasis remains elusive. Hence, the current proposal will be aimed towards defining the role of ganglioside(s), specifically GM2 in modulating Hippo signaling and elucidate the precise molecular mechanism through which GM2 mediates EMT by involving the Hippo signaling pathway. To this end, in the preceding year, a global transcriptomic analysis 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. During the current period, we focused our research towards finding out whether GM2-mediated deactivation of HIPPO and consequent activation of YAP/TAZ occurs F-actin dependently or independently. Here we show that GM2 caused time-dependent F-actin formation, while F-actin/G-actin ratio decreases in Renca-v$^{GM2\text{-}syn\ KO}$ 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. Furthermore, chemical inhibition, siRNA mediated knockdown of YAP-TAZ blocks GM2 mediated modulation of target gene expression. Finally, we show that siRNA mediated silencing of YAP/TAZ target gene expression, blocks GM2-mediated migration of tumor cells, thereby confirming that GM2-mediated migration of tumor cells is YAP/TAZ-dependent.

Objectives:

i. Delineating the signaling components involved in ganglioside GM2-mediated de-activation of Hippo and downstream activation of YAP/TAZ signaling.

ii. To identify unique gene sets modulated by GM2 and whose promoters/enhancers are bound to YAP/TAZ.

iii. To define the functional role of ganglioside GM2 mediated regulation of Hippo-YAP/TAZ signaling in tumorigenesis.

iv. Identification of the receptors involved in ganglioside GM2-mediated HIPPO-YAP/TAZ signaling.

Objectives addressed and work done:

Objective 1 *- Delineating the signaling components involved in ganglioside GM2-mediated de-activation of Hippo and downstream activation of YAP/TAZ signaling.*

Objective 3 *- To define the functional role of ganglioside GM2 mediated regulation of Hippo-YAP/TAZ signaling in tumorigenesis.*

Plan of work for 2022-2023:

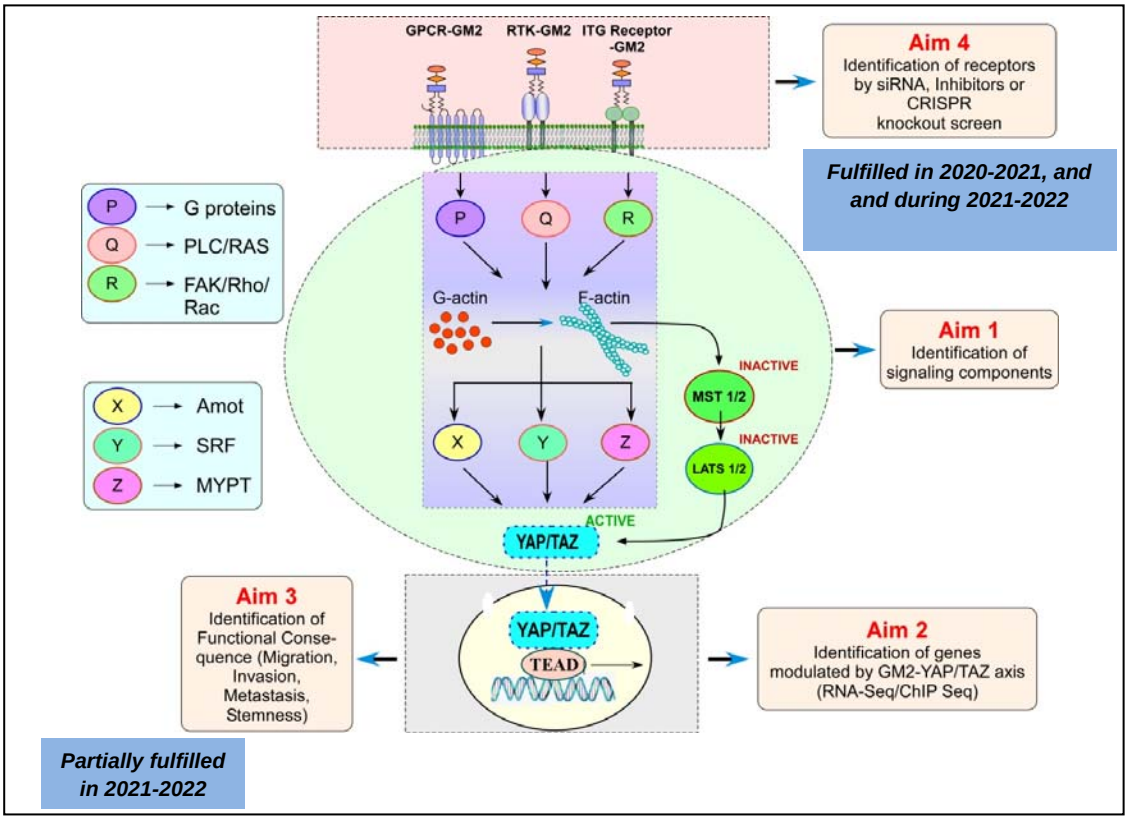
Objective 2: *To identify unique gene sets modulated by GM2 and whose promoters/enhancers are bound to YAP/TAZ.*

Objective 4: *Identification of the receptors involved in ganglioside GM2-mediated HIPPO-YAP/TAZ signaling.*

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	01	–	02	02	–	–

Average publication impact factor: **4.23**



– SCIENTIFIC REPORT –

DEPARTMENT OF PHYSICS

Bose Institute is responsible for coordinating the Indian contribution towards the construction of "Facility for Anti Proton Ion Research" at Darmstadt, Germany and subsequent participation of Indian Institutes/Universities in the experiments. To that end, Department of Science & Technology, Government of India has sanctioned Rs. 615 crores to Bose Institute, for the duration 2021-26.

Twenty two Ultra high Vacuum chambers produced by the Vacuum Technique Private Ltd Bangalore were flagged off to the Facility for Antiproton and Research (FAIR) at Darmstadt, Germany by Prof. Uday Bandyopadhyay, Director, Bose Institute, Kolkata on 10th November 2021 in a brief ceremony at VT complex Bangalore. Dr. K N Vyas, Chairman Atomic Energy Comission & Secretary, Department of Atomic Energy, Government of India, in a brief message sent on the occasion expressed his happiness for reaching this important milestone.

DEPARTMENT OF PHYSICS


OVERVIEW

Department of Physics has been an integral part of the Institute from the very beginning and evolved along with the Institute. Though founder himself was involved mainly in his biological experiments, the Physics Department was involved in both theoretical as well experimental studies of different aspects, such as, propagation of radio waves in the ionosphere, propagation of supersonic wave in different media, study of nuclear disintegration, radioactivity and Cosmic Rays. Presently the research in the department is focused mainly in five areas namely, (a) Complex Systems and Statistical Physics (b) Nanoscience and advanced materials (c) Quantum Information and Foundation (d) Nuclear Physics and (e) High Energy and Astroparticle Physics.

LIST OF PERSONNEL

Faculty Members : Prof. Sanjay Kr. Ghosh; Prof. Somshubhro Bandyopadhyay (Chairman), Prof. Rajarshi Ray, Prof. Dhruba Gupta, Prof. Supriya Das, Prof. Achintya Singha, Prof. Soumen Roy, Dr. Saikat Biswas, Dr. Sidharth Kr. Prasad.

Senior Scientists : Prof. Sibaji Raha, DAE-Raja Ramanna Fellow; Prof. Sushanta Dattagupta, INSA Senior Scientist; Prof. Dipankar Home, NASI Senior Scientist, Prof. Barun Kr. Chatterjee, CSIR Emeritus, Dr. Dhrubajyoti Roy.

Students : RA/SRF/JRF/Project Associate: Dr. Rupa Sarkar, Dr. Chirantan Sarkar, Dr. Swati Kumari, Pitam Sen, Sumana Bhattacharya, Deeptak Biswas, Prasenjit Deb, Soumitra Maity, Pracheta Singha, Pooja Bhattacharjee, Trishna Bhattacharyya, Shreya Roy, Arkaprabha Ghosal, Pratik Ghosal, Sayak Chatterjee, Prottoy Das, Abhi Modak, Debjani Banerjee, Arindam Sen, Md. Asif Bhat, Kabita Kundalia, Sk. Mustak Ali, Md. Sariful Sheikh, Sreyan Raha, Sahanaj Aktar Banu, Chumki Nayak, Sumana Gop, Tushar Kanti Bhowmik, Ranjan Sutradhar, Himadri Sekhar Tripathi, Ram Awdhesh Kumar, Deep Nath, Suvadeep Masanta, Subhankar Maity, Moumin Rudra, Sanjay Mukherjee, Sayanika Bandyopadhyay, Srijit Goswami, Sumana Singh, Ritankar Mitra.

Staff Members : Dr. Subhasis Banerjee, Shyam Sundar Mallick, Manas Datta, Subrata Das, Sujit Kr. Basu, Kaushik Maiti, Kanak Baran Hazra, Raj Kumar Mourya, Amar Nath Hela.

PROF. SANJAY KUMAR GHOSH
Professor
Department of Physics

Group Members:
Deeptak Biswas, *SRF*

Trishna Bhattacharyya, *SRF*

Comprehensive study of urban heat island condition (UHI), its response during heat wave conditions and interdependence on local climatic variability over Kolkata urban agglomeration using surface and satellite observations and numerical simulations using WRF coupled with Urban Canopy Model (UCP)

Research Background and Vision:

Discovery of quarks as an underlying substructure of hadrons (baryons and mesons) in the mid 60's has opened up new directions of research in particle physics. Quarks are strongly interacting objects, Quantum Chromodynamics (QCD) being the theory of strong interaction. The interesting characteristics of quark is that their interaction strength increases with the separation between them while becoming very small, leading to free quarks, at smaller separations. This in turn implies that at very high temperature and/or densities the quarks will no longer be confined inside hadrons and one may envisaged a phase transition from hadronic to quark matter.

In nature such a phase transition must have occurred in early universe, few microsecond after big bang, when the universe was hot. On the other hand such a scenario may also occur inside the Neutron stars where baryon density is extremely high, temperature being low. Presently at LHC, CERN, heavy ion collision experiments are exploring this early universe scenario. The high-density scenario will be explored in Facility for antiproton-ion research at GSI, Germany.

Theoretical studies also suggest that quark matter may also exist in the form of small lumps of low baryon number, usually called as strangelets. Theoretical studies also suggest, that these objects may reach the earth's surface and can be detected in cosmic ray detectors.

Understanding of the observed high energy Cosmic Rays is an active area of research. We are presently trying to understand their possible sources of production and acceleration using the available data.

We are involved in the research to have better understanding of vertical profile of the atmosphere and their variabilities using physical aspects of atmosphere, namely electric field and electromagnetic scattering.

Primary Objectives:

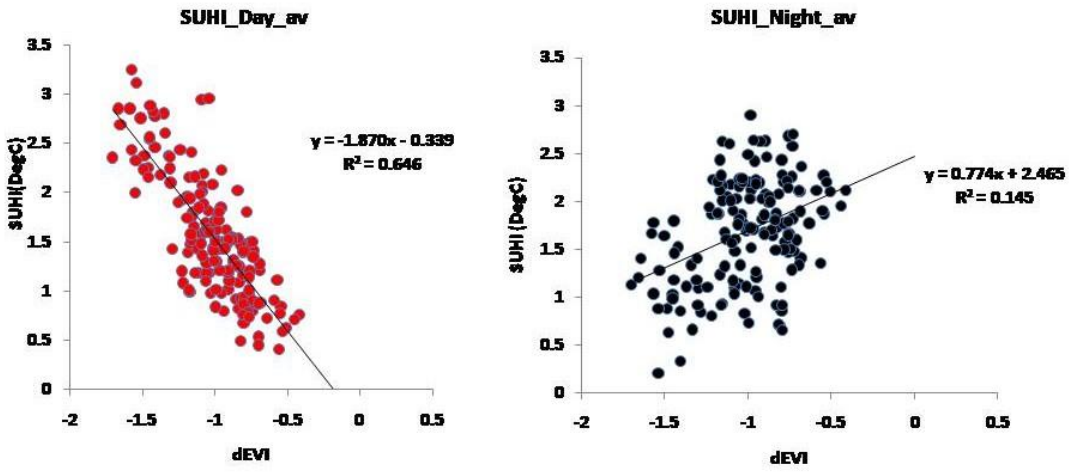
- Understanding the characteristics of strongly interacting system at high temperature and/or density using phenomenological models
- Understanding the possible mechanisms and sources of high energy cosmic rays and their interactions
- Understanding of physical aspect of atmospheric, such as atmospheric electric field, microphysical aspects of aerosol and cloud and their interaction using ground based and satellite observations.

Summary of Research Work during April 1, 2021 – March 31, 2022:

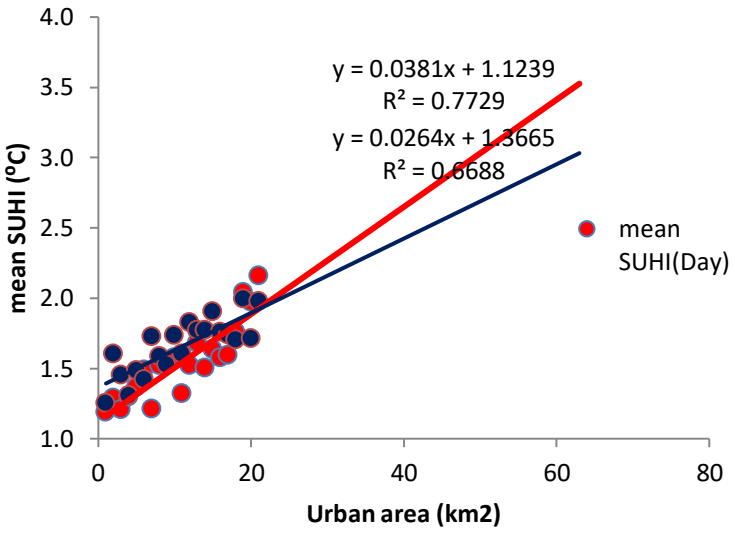
- We are presently trying to understand the possible mechanism of 1-100 TeV gamma rays observed from Cygnus Cocoon as these cannot be explained by single electron population. Moreover, there may be an apparent relationship between the neutrino event Ice-Cube-201120A detected by Ice-Cube neutrino observatory and the ultra-high energy gamma rays from Cygnus Cocoon. A hybrid model including both leptonic and hadronic processes may be able to explain this observed gamma ray spectrum along with the observed neutrino event from Cygnus Cocoon.
- A study is being performed to understand the Aerosol and cloud layer variability and their interaction over Darjeeling. Here we have studied the profiles of aerosol and cloud layers vis-vis temperature inversion. In addition, the stability conditions have been explored using Burnt Viasalam frequency. We have also studied the fluctuation in the observed boundary layer and compared with the high split results. LIDAR observations along with the observations from micro rain radar gives us an insight on the life cycle of the cloud.
- Detailed study on the effect of urban morphology like building height, road space and green space on the local urban heat island intensity is being carried out using high resolution satellite observation. WRF coupled with UCM simulation is being designed to accurately predict the near-surface temperature and other meteorological parameters to investigate the actual governing parameters behind the UHI.

Major Achievements in the April 1, 2021 – March 31, 2022:

- Preliminary findings indicates that Cygnus Cocoon may be working as a source as well accelerator for high energy cosmic ray
- Vertical profiling of atmosphere indicates the presence of marine and black carbon aerosol in mixing state in core shell combination.
- Study indicates the influence of planetary Rossby waves and orography induced gravity waves.
- The 20 years analysis of surface heat island intensity (SUHI) over city metropolitan shows that the heat island intensity for both the cities is always positive like other megacities in eastern India. A significant positive trend was observed for both day and night time SUHI. The daytime SUHI is increasing at a rate of 0.03^0C/year whereas night-time SUHI is creasing at a higher rate of 0.04^0C/year.



Correlation between ΔEVI and SUHI for day and night time for the entire study period.



Correlation between urban area and annual mean SUHI for day and night time for the entire study period.

Future plans for 2022-23:

- A systematic analysis of observed high energy gamma rays up to PeV energies to understand their origin and possible source of their acceleration to such high energies.
- Understanding of surface heat island around Kolkata and Howrah using ground-based data and simulation with weather forecasting and research model.
- Understanding of atmospheric aerosols – size, shape and single scattering albedo through optical scattering.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	03	–	–	01	–	–

Average Impact Factor: **1.7**

PROF. SOMSHUBHRO BANDYOPADHYAY
Professor & Chairman
Department of Physics

Group members:
Dr. Prasenjit Deb, *CSIR-RA*
Arkaprabha Ghosal, *SRF*

Collaborators:
Debarshi Das, *Bose Institute*
Saronath Halder, *IISER Berhampur*
Saptarshi Roy, *HRI*

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, quantum nonlocality, and quantum gravity.

In recent times, we have been focusing on the following areas:

- Quantum entanglement
- Quantum nonlocality
- Quantum gravity

Summary of research during April 1, 2021 – March 31, 2022:

Genuine activation of nonlocality: From locally available to locally hidden information

Quantum nonlocality has different manifestations that, in general, are revealed by local measurements of the parts of a composite system. In this paper, we study nonlocality arising from a set of orthogonal states that cannot be perfectly distinguished by local operations and classical communication (LOCC). Such a set is deemed nonlocal, for a joint measurement on the whole system is necessary for perfect discrimination of the states with certainty. On the other

hand, a set of orthogonal states that can be perfectly distinguished by LOCC is believed to be devoid of nonlocal properties. Here, we show that there exist orthogonal sets that are locally distinguishable but without local redundancy (i.e., they become nonorthogonal on discarding one or more subsystems) whose nonlocality can be activated by local measurements. In particular, a state chosen from such a set can be locally converted, with certainty, into another state, the identity of which can now only be ascertained by global measurement and no longer by LOCC. In other words, a locally distinguishable set without local redundancy may be locally converted into a locally indistinguishable set with certainty. We also suggest an application, namely, local hiding of information, that allows us to locally hide locally available information without losing any part. Once hidden, the information in its entirety can only be retrieved using entanglement.

Entanglement cost of discriminating noisy Bell states by local operations and classical communication

Entangled states can help in quantum state discrimination by local operations and classical communication (LOCC). For example, a Bell state is necessary (and sufficient) to perfectly discriminate a set of either three or four Bell states by LOCC. In this paper, we consider the task of LOCC discrimination of the states of noisy Bell ensembles, where a given ensemble consists of the states obtained by mixing the Bell states with an arbitrary two-qubit state with nonzero probabilities. It is proved that a Bell state is required for optimal discrimination by LOCC, even though the ensembles do not contain, in general, any maximally entangled state, and in specific instances, any entangled state.

Quantum communication using a quantum switch of quantum switches

The quantum switch describes a quantum operation in which the order of application of two or more quantum channels is controlled by the state of a quantum system. The state of the control system can be suitably chosen to create a quantum superposition of the causal orders of the quantum channels, which can now perform communication tasks that are impossible within the framework of the standard quantum Shannon theory. In this paper, we consider the scenario of one-shot heralded qubit communication and ask whether there exist protocols using a given quantum switch or switches that nonetheless could outperform the given ones. We answer this question in the affirmative. Specifically, we define a higher-order quantum switch composed of two quantum switches, where the order of the quantum switches is controlled by another quantum system. We then show that the quantum switches placed in a quantum superposition of their alternative causal orders can transmit a qubit, without any error, with a probability strictly higher than that achievable with the individual switches. We discuss three examples demonstrating this communication advantage over both kinds of quantum switches: those that are already useful as a resource and those that are useless. However, we also show that there are situations where no communication advantage can be had over the individual switches.

Major accomplishments:

- We showed that locally available quantum information distributed between several physically separated observers can be locally locked without losing any information. Once locked, this information can be accessed only using entanglement as a resource. This demonstrated, for the first time, activation of quantum nonlocality in the scenario of local discrimination of quantum states.

- We proved that the entanglement cost of distinguishing several families of two-qubit states is one-ebit, even though none of them contains maximally entangled states. This proves that maximal entanglement may be required in accessing quantum information even if such information is not encoded in maximally entangled states.

- We proved that the quantum switch constructed from quantum switches could outperform them even if the individual switches are useful or even useless for quantum communication..

Future plan for 2022-23:

To study the following:

1. Nonlocal properties of composite quantum systems
2. Quantum gravity induced many-body entanglement**.**

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	02	–	01	–	–	–

Average publication impact factor: **3+**

PROF. RAJARSHI RAY
Professor
Department of Physics

Group Members:

Sumana Bhattacharyya, *SRF-CSIR*
Pracheta Singha, *SRF-INSPIRE*
Pratik Ghoshal, *SRF*
Abhishek Atreya (NPDF)

Research background and vision:

The fundamental strong force binds the quarks and gluons within femtometer distances due to the elastic-like confinement of the intrinsic charges of strong force, known as 'colour' charges. At very high temperatures ~10^12 K and / or at very high matter densities ~ 10^17 Kg/m^3, the strong interactions become Coulombic, and colour charges flow over macroscopic distances. Such matter is known as Quark Gluon Plasma. Physically such high temperatures could exist in the early universe, and such high densities may be existing in the core of super-massive stars like the neutron stars.

Experimentally the various possible phases of strong interactions are being explored at various high energy particle laboratories around the world. Theoretically the first principle approach of strong interactions is given by Quantum Chromodynamics. In the Coulombic region of interaction strength one can perform analytic perturbative analysis. But much of the interesting phases of strong interactions are in the non-perturbative regime. The first principle lattice formulation of Quantum Chromodynamics is extremely involved and time consuming. Therefore various model systems that mimics some relevant physics of the system and are yet light on the required resources are routinely employed to get physical insight into the problem.

Summary of research during April 1, 2021 – March 31, 2022:

Our aim was to study the general thermodynamic properties for strong interactions from theoretical models, as well as contrasting the theoretical results with experimental data.

- Studied the effects of gluon quasiparticles in Polyakov Loop effective models by contrasting them with certain available first principle results.
- Studied the effects of hadron sizes and velocities using the Hadron Resonance Gas (HRG) model for the study and characterization of strongly interacting systems formed in the ultra-relativistic heavy-ion collision experiments.

Objectives:

a) Build a simple but reliable model for understanding the equilibrium properties of strongly interacting matter at various temperature and matter densities.

b) Use these models for the study and characterization of strongly interacting systems formed in the ultra-relativistic hadronic and heavy-ion collision experiments, as well as for the evolution of the early universe and super-massive stars.

Major accomplishment:

1) Systematic uncertainties due to choice of hadron ratios used to obtain possible equilibrium conditions in heavy-ion collision experiments using chi-squared analysis have been analyzed quantitatively.

2) A novel scheme for obtaining possible equilibrium conditions of the hadrons yielded in heavy-ion collision experiments have been established.

3) Systematic uncertainties due to various other hadron properties in determining the possible equilibrium conditions in heavy-ion collision experiments have been analyzed.

Future plan for 2022-23:

- Studying the properties of radiation from black holes
- Studying the properties of gluon quasiparticles using model dynamics

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	01	–	–	–	–	–

Average publication impact factor: **1.683**

PROF. DHRUBA GUPTA
Professor
Department of Physics

Group Members:
Dr. Rupa Sarkar,
DST Women Scientist
Sk. Mustak Ali, *SRF*
Kabita Kundalia, *SRF*
Subhankar Maity, *SRF-UGC*
Sahanaj Aktar Banu,
SRF-INSPIRE
Ritankar Mitra, *JRF-INSPIRE*
Sumana Singh,
Senior Technical Associate
Manas Datta

Research background and vision:

In recent times, the advancement of nuclear physics has allowed us to study very neutron and proton rich exotic nuclei (rare isotopes). We can study nuclear structure, reactions and astrophysics using beams of rare isotopes in state-of-the-art accelerators around the world. Several new facilities as well as upgrades are also coming up in many countries including India. Recently, we carried out an experiment at the HIE-ISOLDE rare isotope beam facility of CERN. Such sophisticated experiments with the exotic isotopes are expected to lead to a detailed understanding of nuclei and the origin of the elements in the universe.

Summary of research during April 1, 2021 – March 31, 2022:

The cosmological lithium problem is one of the most important unresolved problems in nuclear astrophysics at present. The problem delineates a pronounced anomaly in observational abundance of ^{7}Li and that predicted by the Big Bang Nucleosynthesis theory. To study the ^{7}Li problem, we carried out an experiment at HIE-ISOLDE, CERN using a 5 MeV/u ^{7}Be beam on a CD_2 target. We observed resonance excitations in the ^{7}Be + d channel up to ~ 20 MeV for the first time. Substantial data analysis have been completed and two papers (Phys. Rev. Lett.; Phys. Lett. B) are under review. Excitation energy spectrum of ^{8}Be* from triple coincidence of protons and two alpha-particles have been obtained. We found that by including the contribution of the 16.63 MeV excited state of ^{8}Be, the maximum value of the total S-factor inside the Gamow window comes out to be 167 MeV-b as compared to earlier estimate of 100 MeV-b. However, this still does not account for the lithium discrepancy. Elastic, inelastic and α-cluster transfer reaction for ^{7}Be + ^{12}C have also been studied, involving doublet states of ^{16}O, which have a profound impact on astrophysics. Coupled-channel calculations are being carried out to estimate the effect of inelastic and breakup reactions on the elastic channel. Monte Carlo simulations and relevant DWBA calculations to study Coulomb breakup of ^{9}Li and ^{14}O have also being carried out for submission of new experimental proposals.

Objectives addressed and work done:

a) To address the cosmological ^{7}Li problem, we have carried out substantial data analysis from our experiment at HIE-ISOLDE, CERN studying ^{7}Be(d,p)^{8}Be* reaction at

Ecm = 7.8 MeV, populating excitations up to 22 MeV in ^{8}Be for the first time. The results show that by including the contribution of the 16.63 MeV state, the maximum value of the total S-factor inside the Gamow window comes out to be 167 MeV-b as compared to earlier estimate of 100 MeV-b. However, this still does not account for the lithium discrepancy. We have also analyzed the elastic and inelastic scattering of ^{7}Be + ^{12}C and extracted relevant optical model potential parameters required for the study of α-cluster transfer reactions, having a profound impact on astrophysics. Two papers (Phys. Rev. Lett.; Phys. Lett. B) are under review.

b) To study the ^{8}Li(n, γ)^{9}Li reaction through Coulomb breakup of ^{9}Li, Geant4 simulations in the NPTool framework and related DWBA calculations were carried out to propose an experiment.

c) In the context of the hot CNO cycle we plan to study the Coulomb breakup of ^{14}O at 17 MeV/A with ^{208}Pb target using a highly granular Si detector array and a spectrometer. The preliminary Geant4 simulations are underway.

d) In the context of the lithium problem, using supersymmetric quantum mechanics, we could detect the 16.84 MeV (5/2+) resonance state of ^{9}B. One paper (JPG) has been communicated.

Major accomplishment (significant results):

- First measurement of excitations in ^{7}Be(d,p)^{8}Be* up to 22 MeV. Contribution of high lying states up to 16.63 MeV in ^{8}Be does not solve the cosmological Li problem.
- First measurement of inelastic scattering angular distribution of ^{7}Be + ^{12}C at 35 MeV and the study of effect of breakup and inelastic channel coupling on elastic scattering.
- Study of ^{12}C(α, ɣ)^{16}O reaction via indirect method of α-cluster transfer reaction, using ^{7}Be radioactive beam, to populate relevant states of ^{16}O in the context of nuclear astrophysics.

Future plan for 2022-2023:

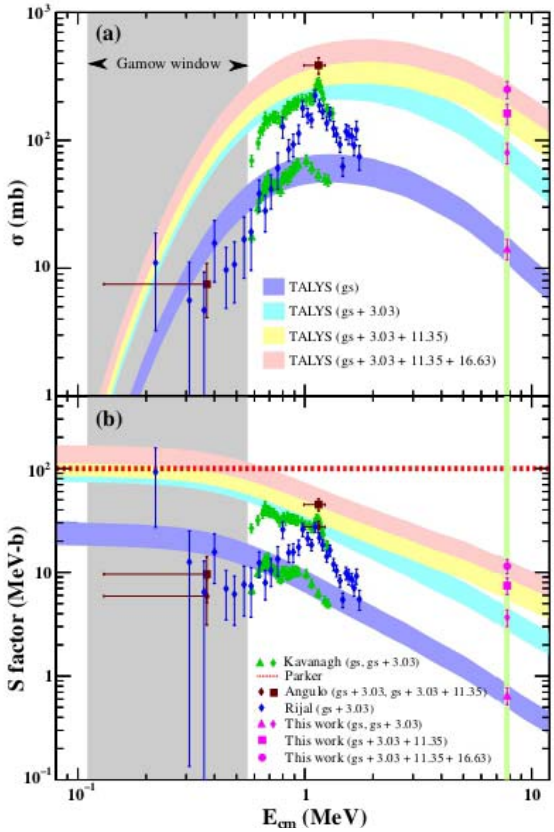
- The ^{7}Be(d,^{3}He)^{6}Li reaction in the context of the lithium problem will be studied.
- Analysis of the transfer reactions from ^{7}Be + ^{12}C at 35 MeV, in the context of stellar nucleosynthesis will be carried out.
- Detailed experimental planning and simulations would be continued to finalize experimental proposals on the Coulomb breakup of ^{9}Li and ^{14}O.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	05	–	02	–	–	–

Average publication impact factor: **6**

An image /cartoon capturing the essence of work achieved:



The figure shows the excitation function for ^{7}Be(d,p)^{8}Be* and the S-factor representation of the excitation function.

PROF. SUPRIYA DAS
Professor
Department of Physics

Group Members:

Md. Asif Bhat, *SRF*
Shreya Roy, *SRF*

Research background and vision:

Study of matter at extreme condition:

For a long time now scientists all over the world are trying to know about the state of the matter that existed just after the big bang that is believed to have created this universe. The only way to study and characterize this state of the matter is to create it in the laboratory. To achieve this goal a number of high energy accelerators are engaged to collide heavy ions moving in relativistic speed. In these collision a temperature similar to that existed during the time of the big bang is obtained. Theoretical understanding tells us that at this temperature the hadrons melt liberating the quarks and gluons, which forms a soup of deconfined state of matter. However, the temperature soon decreases and the quarks and gluons get confined again to form normal nuclear matter. But the particles formed carry certain signatures, which reveal the features of the matter from which they are generated.

Another extreme condition exists inside the core of neutron stars where the density is very high (~10^{14} times the density of the Sun). It is again believed that the matter at such densities is a soup of deconfined quark and gluons rather than normal nuclear matter. Facilities are being built to create the matter at such high densities inside laboratory to characterize that.

Cosmic rays are high-energy charged particles (~90% of them are protons) that enter into our atmosphere from different sources. They can be detected in direct method by putting detectors in balloons or satellites. But these particles produce hadronic /electromagnetic showers while travelling through the atmosphere and employing ground-based detectors are another way of detecting them.

Summary of research during April 1, 2021 – March 31, 2022:

a. **Estimation of energy deposition by high energetic particles from EAS in plastic scintillation detector material:**

In this work GEANT detector simulation package has been utilized to study the energy deposition in plastic scintillation detector modules of the size of 1m x 1m x 1 cm by high energetic particles. The source species and energy have been chosen from results of CORSIKA toolkit that simulates the products of cosmic ray Extended Air Shower (EAS) at an altitude of ~2200m asl. The goal of this work is to standardise the detector elements planned to be used in the air shower array at Darjeeling campus of Bose Institute.

The results from this study show that in most cases where the incident primary particles are high energy neutrons and protons, the scintillation light is produced by protons, recoiling carbons, electrons and positrons. The energy depositions for these protons is in the range of sub keV to

few hundreds of MeV. In case of carbon the same is in few hundred keV to few tens of MeV whereas the electrons/positrons produced inside the detector material deposit energy in the range of few tens of MeV.

A draft reporting the results from this work is under preparation.

Collaborators: Susnata Seth, Shreya Roy, Saikat Biswas and Sanjay K. Ghosh

b. Stability and time resolution of straw tube detectors:

Straw tubes are thin walled single wire proportional counters generally used as tracking detectors for their very low material budget. In this work the performance of a straw tube prototype in terms of gain and energy resolution under long term exposure with high rate of radiation was studied.

The results from this work show a reduction in gain of 9.6% per C/cm of charge after a total accumulation of 0.6 C/cm. It was also observed that with an increased flow of gas inside the detector helps to restore the gain. However, after operation for very long time the gain degraded beyond recovery showing symptoms of what is called 'ageing'. Another important conclusion from this experiment is that the straw tube detectors are safe to operate either at low rate with low gas flow rates or at high rate but with increased gas flow rate.

The details of the findings of this work was reported in Pramana – J. Phys. (2021) 95:50

Collaborators: Shreya Roy, Subham Jaiswal, Sayak Chatterjee, Arindam Sen, Saikat Biswas, Sanjay K. Ghosh, Sibaji Raha; External Collaborators: V. M. Lysan, G. D. Kekelidze, V.V. Myalkovsky (LHEP-JINR Dubna, Russia).

c. Development of charged particle identification framework for CBM experiment:

The framework for charged particle identification (PID) in the Compressed Baryonic Matter (CBM) is being developed. This is a crucial component not only for obtaining several important observables such as the spectra, multiplicity etc. for identified particles but also for any further analysis such as flow, fluctuation, correlation etc. involving them. For this work we are using the information such as time of flight for the charged particles from the TOF detector. After plotting a 2D distribution (m^2 vs. momentum) for all charged particles we are studying a graphical cut to distinguish different charged particles and the performance of such a cut as a function of momentum. The performance of this method was tested using two different MC generators showing comparable results. Improvement of this PID method after inclusion of the dE/dx information from Silicon Tracking Station (STS) is under way.

The results from this work have been presented in CBM PWG-Hadron group meetings and CBM Collaboration meetings.

Collaborators: Arindam Sen; External collaborator: Sumit Kundu (IIT Indore)

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	36	–	03	02	–	–

Average publication impact factor: **3.0**

PROF. ACHINTYA SINGHA
Professor
Department of Physics

Group Members :
Dr. Subhasis Roy, *under DST TARE project*
Shib Shankar Singha, *Guest Researcher*
Tara Shankar Bhattacharya, *Guest Researcher*
Sreyan Raha, *SRF*
Himadri Sekhar Tripathi, *SRF*
Chumki Nayak, *SRF*
Suvadip Masanta, *SRF*

Research background and vision:

In recent years, the study of nanomaterials has stimulated a new enthusiasm in the field of science and technological applications. In fundamental physics, nanomaterials act as a laboratory to study the fascinating phenomenon in sub-micron regime. We employ a variety of spectroscopic techniques such as micro-Raman spectroscopy, micro-photoluminescence spectroscopy and absorption spectroscopy to investigate the fundamental properties of single to an ensemble of nanostructured materials and their hybrids and how they respond to various externally controlled perturbations e.g. temperatures, pressures, light, and electric field. We also work on studying the applicability of low dimensional materials as photo-detector, energy storage devices and biosensors.

Summary of research during April 1, 2021 – March 31, 2022:

In last one year, our lab focuses on the study of vibrational and optical properties of 1D and 2D semiconductor nanostructures mainly using Raman and photoluminescence spectroscopy. We explored complete lattice dynamics of polymorph ST12 germanium nanowire through Raman spectroscopy and are able to assign all the experimentally observed modes from first-principles calculations using density functional theory. The origin of various Raman modes of direct band gap $Ge_{1-x}S_x$ alloy nanowire is investigated bypolarization,laser power and temperature dependent Raman study. Our study also involves probing anomalous phonon behaviour of SnSenanoribbon at various thermodynamic conditions. Lastly, we demonstrate tuning optical property and multi-colour emission from the Mn-doped $MoSe_2$ 2D sheet through photoluminescence spectroscopy. We also explored their electrochemical and photoresponse properties.

Major accomplishment (significant results):

The manipulation of light absorption and its conversion into free carriers are key issues for novel optoelectronic devices, advanced biosensing, photocatalysis and photovoltaics. Here, we achieve amplification of light collection in the atomically thin MoSSe 2D semiconductor exploiting enhanced light scattering and field amplification from Au nanoantennas coupled to the 2D semiconductor (Manuscript under preparation).

A. Lattice dynamics in ST12 phase germanium nanowires by Raman spectroscopy

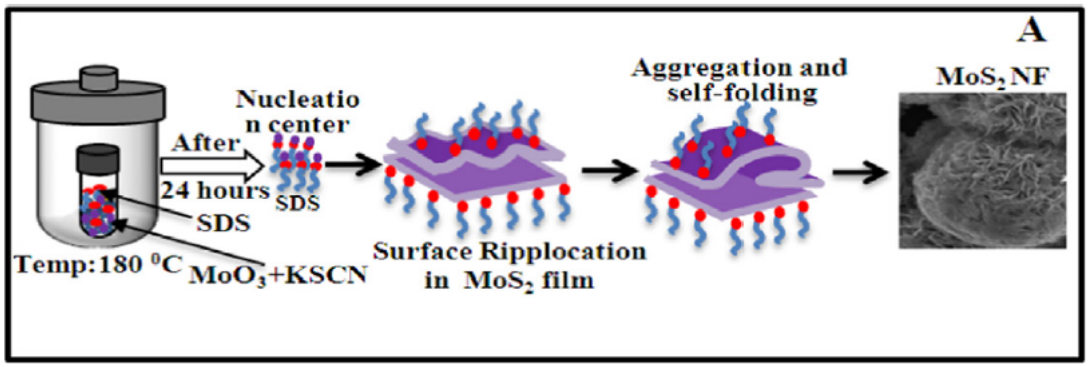
We fabricated stable ST12 phase Ge nanowires for the first time and investigated their lattice dynamics using polarization and temperature dependent Raman study. This is the first report where the experimentally measured Raman spectrum of ST12-Geis in agreement with the DFT calculations. Furthermore, from the temperature dependent Raman study, we have estimated first-order temperature coefficients and isobaric Grüneisen parameter of each mode **[*Appl. Phys. Lett.* 119, 232105 (2021)].**

B. Raman study of direct band gap $Ge_{1-x}Sn_x$ alloy nanowires

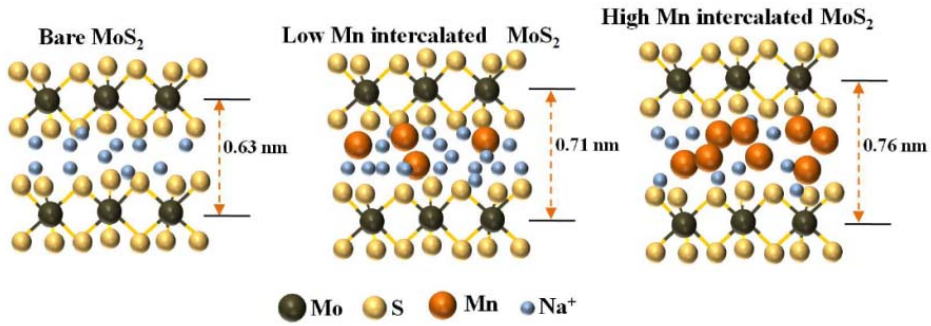
Alloying group IV semiconductors offer an effective way to engineer their electronic properties and lattice dynamics. The incorporation of Sn in Ge permits a transition from an indirect to a direct semiconductor. Here, by combining polarization, laser power-dependent, temperature-dependent micro-Raman spectroscopy and fully analytic anharmonic valence force field (VFF) potential based theoretical analysis, we have explored the full lattice dynamics of $Ge_{1-x}Sn_x$ (x= 0.01, 0.06 and 0.08) alloy nanowires. Our study provides new insights relevant to the applications of $Ge_{1-x}Sn_x$, an emerging material system **[*Nanoscale* (2022), accepted, communicated to *Phys. Rev. Mat.* (Referee report received)].**

C. Mn doped $MoSe_2$: an efficient material for wide range emission, charge storage and photodetection

We have synthesized Mn doped $MoSe_2$ using an easy chemical method and are able to tune the emission range from blue-green to red by changing Mn concentration. We also demonstrate that the Mn doped $MoSe_2$ is an efficient material for charge storage and photodetection.



Schematic presentation of MoS_2 NFs preparation using hydrothermal method



Schematic of restacked bare and Mn intercalated MoS_2 NF

Future plan for 2022-23:

- Flexible solid-state supercapacitors based on Mn doped 2D transition metal dichalcogenides
- High responsive, broadband, ultrafast photodetector based on Janus 2D materials (MoSSe and WSSe) and their hybrids with graphene.
- Helicity dependentphotodetectorbased on 2D transition metal dichalcogenides

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	07	–	04	–	–	–

Average publication impact factor: **4.201**

PROF. SOUMEN ROY
Professor
Department of Physics

Group Members:
Deep Nath, *SRF*
Sumana Gop, *SRF*
Swati Sharma, *JRF*

Research background and vision:

Diverse natural, engineered and economic systems are composed of many constituents and subconstituents interacting non-trivially amongst themselves and perhaps even with the environment. Examples of such systems can be found in the physical as well as the living world. Networks often successfully capture the architecture of the underlying complexity in these systems.

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. Most of our published work is based on empirical or experimental data.

Summary of research during April 1, 2021 – March 31, 2022:

Networks with a scale-free degree distribution are widely thought to promote co- operation in various games. By studying the well-known prisoner's dilemma game, we show that this need not necessarily be true. For the very same degree distribution and indeed identical degree sequence, we present a variety of possible behaviour. We reassess the perceived importance of hubs in a network towards the maintenance of cooperation. We also reevaluate the dependence of cooperation on network clustering and assortativity. This work has been published in Europhysics Letters.

The detection and management of diseases become quite complicated when pathogens contain asymptomatic phenotypes amongst their ranks, as evident during the recent COVID-19 pandemic. Spreading of diseases has been studied extensively under the paradigm of susceptible–infected–recovered–deceased (SIRD) dynamics. Various game-theoretic approaches have also addressed disease spread, many of which consider S, I, R, and D as strategies rather than as states. Remarkably, most studies from the above approaches do not account for the distinction between the symptomatic or asymptomatic aspect of the disease. It is well-known that precautionary measures like washing hands, wearing masks and social distancing significantly

mitigate the spread of many contagious diseases. We consider the adoption of such precautions as strategies and treat S, I, R, and D as states. We also attempt to capture the differences in epidemic spreading arising from symptomatic and asymptomatic diseases on various network topologies. Through extensive computer simulations, we examine that the cost of maintaining precautionary measures as well as the extent of mass testing in a population affects the final fraction of socially responsible individuals. We observe that the lack of mass testing could potentially lead to a pandemic in case of asymptomatic diseases. Network topology also seems to play an important role. We further observe that the final fraction of proactive individuals depends on the initial fraction of both infected as well as proactive individuals. Additionally, edge density can significantly influence the overall outcome. Our findings are in broad agreement with the lessons learnt from the ongoing COVID-19 pandemic. This invited contribution was published in a special issue on Complex Systems at J. IISc.

Major accomplishment (significant results):

a) We have recently shown [EPL, 2021] that a widely believed central tenet in game theory on networks, that cooperation occurs on scale-free graphs, may not always be true.

b) We introduce topology dependent game payoffs [EPJB, 2021]. We demonstrate that even with such a weak dependence, the fundamental game dynamics and indeed the very nature of the game may be altered.

c) Various game-theoretic epidemiological approaches have considered S, I, R, and D as strategies rather than as states. By treating precautions as strategies and S, I, R, and D as states, we explore the spread of diseases on different network topologies.

Future plan for 2022-23:

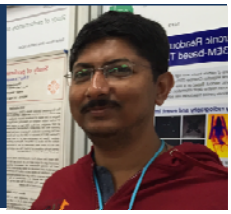
- Attainment of an integrative understanding of microbial interactions using mathematical (both analytical as well as computational) and experimental techniques.
- Apply information-theoretic methods to study proteins. In the longer run, we would also like to seek experimental validation of our results.
- Evaluation of the importance of the topology of a network towards the determination of entropy of the network.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	03	–	–	01	–	02

Average publication impact factor: **1.73**

DR. SAIKAT BISWAS
Associate Professor
Department of Physics



Group Members:
Sayak Chatterjee, *SRF*
Arindam Sen, *SRF*
Shivshant Chauhan, *(Int. MSc-PhD)*
Subrata Das

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 goal is to study the physics of Quark-Gluon Plasma (QGP) at low baryonic density and high temperature in the ALICE experiment, whereas to study the QGP physics 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 in the High Energy Physics detector laboratory at Bose Institute. 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).

Summary of research during April 1, 2021 – March 31, 2022:

Characterization GEM detectors for ALICE and CBM experiments (Study of Charge-up effect):

The Gas Electron Multiplier (GEM) detectors are widely used in many HEP experiments as tracking devices because of their good spatial resolution and rate handling capability.

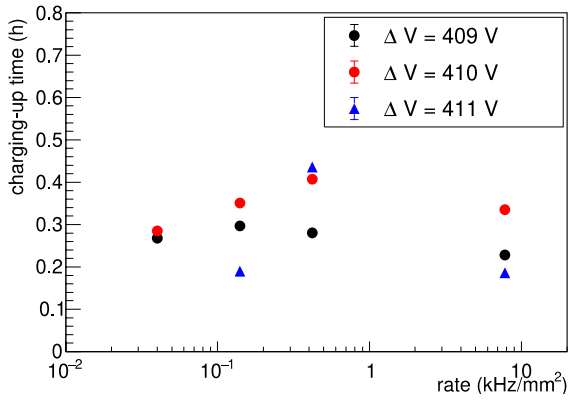
The presence of the dielectric medium inside the active volume of the GEM detector changes its behaviour when exposed to external radiation. This mechanism is commonly referred to as the charging-up effect. The effect of the charging-up phenomenon and the initial polarization effect of

the dielectric on the gain of the chamber are investigated for a single mask triple GEM chamber with Ar/CO_2 gas mixture using Fe^{55} X-ray source at different gains and irradiation rates. The effect of initial polarisation of the dielectric is also investigated for four different irradiation rates and with three different voltage settings. The charging-up time is found to be between 0.2–0.4 h for a gain of ~ 10^4.

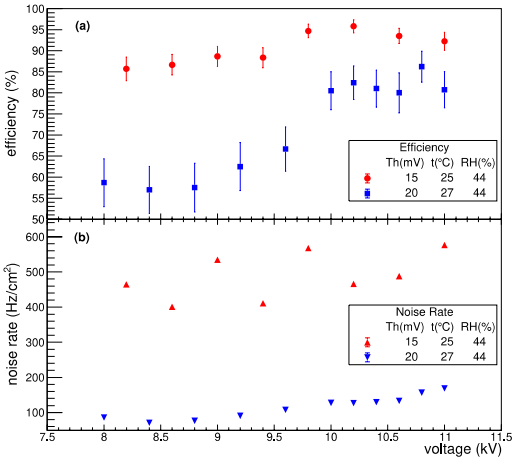
R&D of RPC for CBM experiment:

The aim of this research is to build RPC using indigenous materials for CBM. Several RPC modules are fabricated using commercially available bakelite plates. A setup for the bulk resistivity measurement is made operational. The surface resistivity of the graphite layer is also measured by a jig made in the lab.

As a proof of principle, we introduced a new technology of oil coating in RPC with bakelite electrodes. The cosmic test showed that this technology does work. However, the cosmic test does not answer on the main questions about the long-term stability and the particle rate capabilities. The long-term stability test, measurement of timing properties and the effect of the temperature and relative humidity on the performance of the chamber are planned to be studied in future. To answer the question of particle rate capabilities, it is required to perform the test with an accelerator, which is also in the future plan.



Charging-up time as a function of rate for a single mask triple GEM detector at different voltage settings



(a) The efficiency as a function of the applied voltage for the RPC, (b) Noise rate as a function of the applied voltage.

Stability study of Straw-Tube Detector for High-Energy Physics experiments:

Straw tube detectors are single wire proportional counters that are widely used as tracking devices. We have carried out R&D activity with a straw tube detector prototype. The aim of this work is to study the stability of the performance in terms of gain and energy resolution of these types of detectors under high rate of radiation. The gain and energy resolution of the detector are studied along with its variation with ambient temperature and pressure. X-rays from a radioactive source (Fe^{55}) are used to irradiate the detector and to monitor the energy spectra simultaneously for calculating the gain. The method followed here is unique as the ageing measurements are performed without using an accelerated particle beam or any radiation generator. The performance of a straw tube detector is studied in a laboratory for more than 800 h at a stretch using a single sealed radioactive X-ray source with high intensity. Variation of gain and energy resolution of the straw tube detector under X-ray irradiation in Ar/CO_2 gas mixture (volume ratio 80/20) is studied. It is observed that the gain of an aged straw depends on the gas flow rate. The time required for the gain of a straw tube detector under ageing tests to recover on increasing the gas flow rate is estimated.

Study of cosmic ray:

Cosmic ray muon flux is measured by the coincidence technique using plastic scintillation detectors in the High Energy Physics Detector Laboratory at Bose Institute, Kolkata. Due to the COVID-19 outbreak and nationwide complete lockdown, the laboratory was closed from the end of March 2020 till the end of May 2020. After lockdown, although the city is not in its normal state, we still were able to take data on some days.

We found significant declination in the concentrations of the pollutants due to the lockdown, and we tried to look for any correlation with the measured muon flux within the stipulated time window. The result shows a correlation as with decreasing concentrations of the air pollutants we observed an increasing trend of the normalized muon flux. However, there are a few limitations of our measurement. First, the detector coverage area was very small, resulting in low statistics. Second, the statistics of muon flux data before lockdown is small. It will be very interesting if any other research laboratory having a large facility of cosmic ray flux measurement can try to study such correlation.

Major accomplishment (significant results):

- Charging up effect of a single mask triple GEM detector is studied. The charging-up time is found to be between 0.2–0.4 h for a gain of ~ 10^4.
- As a proof of principle, we introduced a new technology of oil coating in RPC with bakelite electrodes. The cosmic test showed that this technology does work.
- Stability and ageing study of Straw-Tube detector is performed for High-Energy Physics experiments.
- The cosmic ray muon flux is measured using plastic scintillation detector and correlation with the concentration of air pollutant is studied.

Future plan for 2022-23:

The main goal of the proposed research plan is the characterization of RPC detectors for high-rate environment of the CBM experiment. The future plan is discussed below.

- Study on the composition of the fill gas and optimization of the gas mixture for the linseed oil coated RPC according to the global environmental policy.
- Long term stability and aging study of the detectors for operation in a harsh environment for a long period.
- Study on the improvement of time resolution and efficiency of RPC at a low gas gain so that we can use the RPC for high-rate handling.
- To increase rate handling capacity, the only way is to use low resistive electrodes and to use the chamber at a low gas gain in the avalanche mode. So, the study on the mode of operation is also necessary.
- Study of crosstalk and optimization of strip width will also be performed.
- Study of uniformity of performance over the surface.
- Extensive study of the properties of the materials used to make electrodes of RPC and its surface treatment to improve the rate handling capability of the detector.
- Comparison of bulk resistivity measurement with and without guard ring.
- Study of performance and the rate handling capability in an accelerator facility.
- Other than the above-mentioned future plan in the research and development of RPC, I would like to continue the following projects
- Research and development of Gas Electron Multiplier 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

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	09	–	03	01	–	03

Average publication impact factor: **1.7**

DR. SIDHARTH KUMAR PRASAD
Associate Professor
Department of Physics

Group Members:

Abhi Modak, *SRF*
Prottoy Das, *SRF*
Debjani Banerjee, *SRF*

Collaborations:

A Large Ion Collider Experiment (ALICE) at CERN, Geneva

Compressed Baryonic Matter (CBM) experiment at GSI, Germany

Research background and vision:

The main goal of my research is the study and characterization of quantum chromodynamics (QCD) matter under extreme conditions of temperature and/or pressure using heavy ion collisions. In the collision of two ions moving at relativistic speeds a system with partonic degrees of freedom known as Quark Gluon Plasma is formed. A similar system is believed to have existed in the few microseconds old universe. Characterization of QGP is very important as it provides an insight to the early universe situation when the matter was in its fundamental state. Physics analyses of the experimental data to extract QGP properties, detector development and instrumentation to perform the experimental measurements, and model-based Monte Carlo simulation studies are the primary objectives of my research.

Summary of research during April 1, 2021– March 31, 2022:

The main research works I have taken up during the aforesaid period are following:

(a) Understanding the photon production mechanism in proton-Lead collisions at forward rapidity in ALICE at LHC energy:

Multiplicity and rapidity dependence of particle production are some of the most fundamental measurements for shedding light on the physics processes involved in the collisions. They provide important constraints on various theoretical models based on different initial conditions and particle production mechanisms. Moreover, such measurements in pPb collisions provide an important baseline to interpret and understand Lead-Lead (PbPb) results. We are measuring multiplicity and pseudorapidity distributions of inclusive photons and their centrality dependence for non-single diffractive events (NSD) in pPb collisions at centre-of-mass energy 5.02 TeV using the data obtained by an indigenously built Photon Multiplicity Detector (PMD) of ALICE. In the current year we completed the analysis, the results are discussed and a paper proposal is presented and got approved by the ALICE experiment. We are working towards the completion of final paper draft including all the obtained results.

(b) Understanding the dynamics of particle production in small systems in high energy collisions using jets:

Proton-proton collisions have drawn immense attention at LHC energy due to the fact that multiplicities achieved in these collisions are quite large and there are several experimental and theoretical observations indicating the possible formation of QGP in these collisions. However some of the observables such as jet quenching have not shown indication of such effects.

We are analysing LHC data using ALICE experiment for pp and p-Pb collisions at 13 and 5.02 TeV respectively to investigate and understand the origin of such effects experimentally. In this year we already obtained the preliminary results from our analysis of jet properties in proton-proton collisions at 13 TeV and proton-Lead collisions at 5.02 TeV.

We are also studying in great details the possible modifications of jet properties at high multiplicities in pp collisionsat 13 TeV due to effects such as modifications in initial conditions, which are not related to medium formation. We are performing simulation based on PYTHIA8 Monash Tune with various parameter settings in PYTHIA8.In preliminary study we found that due to increased gluonic contributions and multi partonic interactions, at higher multiplicities the inclusive jets become softer and broader.

Major accomplishment (significant results):

(a) Understanding the photon production mechanism in proton-Lead collisions at forward rapidity in ALICE at LHC energy:This is the first measurement of centrality dependent inclusive photon production in p-Pb collisions at 5.02 TeV at forward rapidity in ALICE experiment.

(b) Understanding the dynamics of particle production in small systems in high energy collisions using jets:In ALICE experiment, this is the first attempt to measure the centrality dependent transverse jet shapes in pp collisions at 13 TeV and in p-Pb collisions at 5.02 TeV.

Proposed objectives:

(a) To investigate and study the particle production mechanism in small collision systems (p-p and p-A) at LHC energies by the measurements of hard probes and distributions of multiplicity, transverse momentum and energy of the produced particles in these collisions using various Monte Carlo (MC) models to understand the underlying physics mechanisms and their connections with the final particle production.

(b) A toy model will be developed to explain various aspects of experimental findings and to disentangle some of the aspects of initial vs. final state effects in collision of small systems.

Objectives addressed and work done:

(a) Framework for Monte Carlo event generation using PYTHIA8 for pp collisions is developed

(b) Analysis framework for extracting mean multiplicity, transverse momentum and observables related to hard probes is developed

(c) Small sample of events are produced, processed and the preliminary distributions of observables are obtained

Objectives unaddressed and plan of work for 2022-2023:

(a) Framework development for pPb event generation using MC models

(b) Large sample of events generation and analysis for both pp and pPb collisions

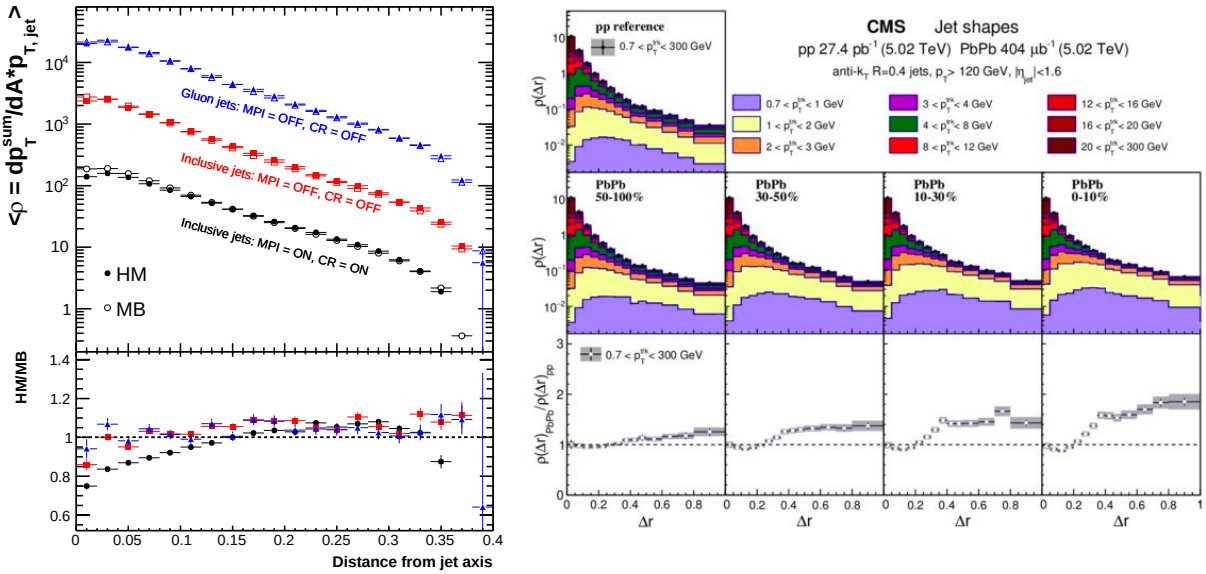
Future plan for 2022-23:

Extraction of important Physics output from LHC data:I will continue analyzing the ALICE data for extracting the important physics to address the open questionsfocusing on hard probes and photon production in small systems. This work will be supported by the extramural project "Indian Participation in the ALICE Experiment at CERN"

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	02	–	09	02	–	01

Average publication impact factor: **3.6**



(Left) Radial transverse momentum density (ρ (r)) distribution about the jet axis of charged jets reconstructed using anti-kT algorithm with R = 0.4 for High multiplicity (HM) and Minimum Bias (MB) pp events at 13 TeV obtained using PYTHIA8 (Right) Similar distribution from CMS experiment in PbPb collisions compared to pp collisions.

– SCIENTIFIC REPORT –

DIVISION OF PLANT BIOLOGY

The Vigilance Awareness Week was observed during October 26 – November 1, 2021. As a part of this programme, the Integrity Pledge taking ceremony was organized by Bose Institute on October 26, 2021.

DIVISION OF PLANT BIOLOGY

OVERVIEW

The present Division of Plant Biology, conceived by Sir J.C. Bose as the Department of Botany, works towards fulfilling his dream of understanding the plants' responses through an interdisciplinary approach. This research helps to understand the intricate life processes of plants for sufficing the basic and essential needs of the human population. In this era of population outbursts and shrinkage of agricultural land, developing high-yielding plants with increased yield and combating environmental stress is a daunting task for the present plant scientists. The plant system offers a unique opportunity to explore properties like to tipotency - the plant equivalent feature of stem cells, stress resilience, and biodiversity. The mission of the scientists of this division directs towards achieving fundamental knowledge in the fields of plant stress biology, development biology, plant-pathogen interaction, and genomics-assisted molecular breeding. The goal remains to understand the plant system to the extent for the benefit of the human race and preserve the balance of nature.

LIST OF PERSONNEL

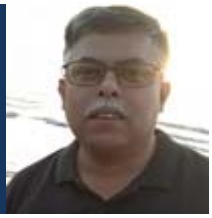
Faculty Members:, Prof. Shubho Chaudhuri (Chairman), Prof. Gaurab Gangopadhyay, Prof. Pallob Kundu, Dr. Anupama Ghosh.

Research Scientist: Prof. A. N. Lahiri Majunder, INSA Senior Scientist; Prof. Sampa Das, INSA Senior Scientist.

Students : RA : RA : Dr.Sathi Paul, Dr.Alka Kumari, Dr.Sambit Datta, ***Women Scientist*** : Dr.Papri Nag, Dr. Lekha Bandopadhyay, Dr. Akansha Jain. ***SRF/JRF :*** Rahul Dutta, Dibya Mukherjee, Udita Acharya, Aishee De, Surbhi Shriti, Subhasish Mukherjee, Shreya Chowdhury, Rohit Das, Jinia Chakrabarty, Shrabani Basak, Pratiti Dasgupta, Rwitie Mallik, Anisha Roy, Aroni Mitra, Ruby Biswas, Sonal Sachdev, Sayan Mal, Himadri Das, Ananya Mukherjee, Sayani De, Raghuvir Singh, Debabrata Dutta, Moumita, Bhowmik, Moumita Biswas Sarkar, Vivek Awon, Diptasree Kumar, Soumili Pal. Mushtaq Ahmad Najar.

Staff Members: Arup Kumar Dey, Ashim Kumar Nath, Dr. Chaitali Roy, Jadab Kumar Ghosh, Kaberi Ghosh, Jayasish Ghosh, Nadiram Kayal, Birendra Kumar Bari, Siddhartha Roy, Moumita Mondal Basu Roy.

PROF. SHUBHO CHAUDHURI
Professor
Division of Plant Biology



Group Members:
Rwitie Mallik, *SRF*
Pratiti Dasgupta, *SRF*
Jinia Chakrabarty, *SRF*
Sonal Sachdev, *SRF*
Ruby Biswas, *JRF*
Dr. Sambit Datta, *RA, DBT-NWO*

Research background and vision:

Plants being sessile organisms constantly modify their physiological and developmental processes in response to various environmental cues for stress adaptation. The stress signal promotes the transcription of plethora ofstress responsive genes by inducing changes in chromatin structureto generate 'open' or 'closed' chromatin configuration inside the cell. The accessibility of highly complex chromatin structure to initiatetranscription is achieved through post-translation modification of histones (epigenetic mark) or through active chromatin remodelling guided by ATP dependent chromatin remodeleror histone chaperones. The focus of my lab is to study themechanism of chromatin remodelling in plants to understand the transcription regulation during plant development and stress response.

The small architectural proteins belonging to High Mobility Group superfamily is involvedin changing the topology of DNA to provide appropriate structure for the binding of nuclearproteins, especially transcription machinery. The presence of high diversity in HMG-box group of protein in plants suggest that these proteins were involved in many developmental and environment induced transcription for proper specio-temporal expression of genes. Presently we are characterizing the role of plant specific ARID-HMG groupof proteins in pollen development process.

Stress-induced epigenetic changes in the chromatin can lead to transient response or sustained response where the new chromatin state can be maintained inside the plants as stress memory. It is assumed that theseepigenetic stress memoriescan provide a "primed state" for faster and stronger response against subsequent environmental conditions. The research in my lab focuses on exploring different epigenetic changes that occur in the genome during abiotic stress response.

Summary of research during April 1, 2021 – March 31, 2022:

Role of RiceTrithorax factor ULTRAPETALA 1 (OsULT1) in regulating transcription during abiotic stress response

Ultrapetala 1 (ULT1), a sand domain containing protein function as plant trithorax factor. Expression of OsULT1 increases during environmental stress condition specially at salinity

stress response. Genome-wide analysis shows significantly higher occupancy of OsULT1 in loci involved in abiotic stress responese;Reduction-oxidation; Protein-phosphorylation; Methyltransferase; Metabolism and Ion Transport. Further analysis shows that the binding of OsULT1 overlaps with the AP2/ERF transcription factor binding site, that are involved in stress responsive gene expression. Parallelly, we have generated OsULT1 overexpression line in IR64 backgroud. These lines show enhanced salt-induced genesexpression and better protection against salinity induced ROS production.

Comparative changes in Histone H3K27 modification and gene expression during cold stressresponse in rice

Low temperature is a major abiotic stress for rice plants and known to adversely affect the growth and development of rice plants. In this project we have studied the genome-wide changes in the epigenetic marks of histone H3Lysine 27 and its affect ingene expression. The acetylation of Lys27 of Histone H3 (H3K27ac) is known to be an activating mark, facilitating transcription, as opposed to the trimethylation of the same residue (H3K27me3), which leads to repression of transcription. Integration of the chromatin immunoprecipitation data, with transcriptome, indicated that upregulation of stress-responsive TFs, photosynthesis-TCA-related, water-deficit genes, redox and JA signalling components, was associated with differential changes of H3K27ac and H3K27me3 level. Furthermore, cold-induced upregulation of histone acetyltransferases and down regulation of DNA methyltransferases with enrichment of H3K27ac and H3K27me3 respectively, was noted. Moreover, motif analysis of H3K27ac and H3K27me3 enriched regions are associated with putative stress responsive transcription factors binding sites, GAGA element and histone H3K27demethylase. Our results suggest a positive correlation between the changes in H3K27 modifications and stress-responsive gene activation in *indica* rice.

Investigating the role of nuclear architectural protein ARID/HMG in pollen development

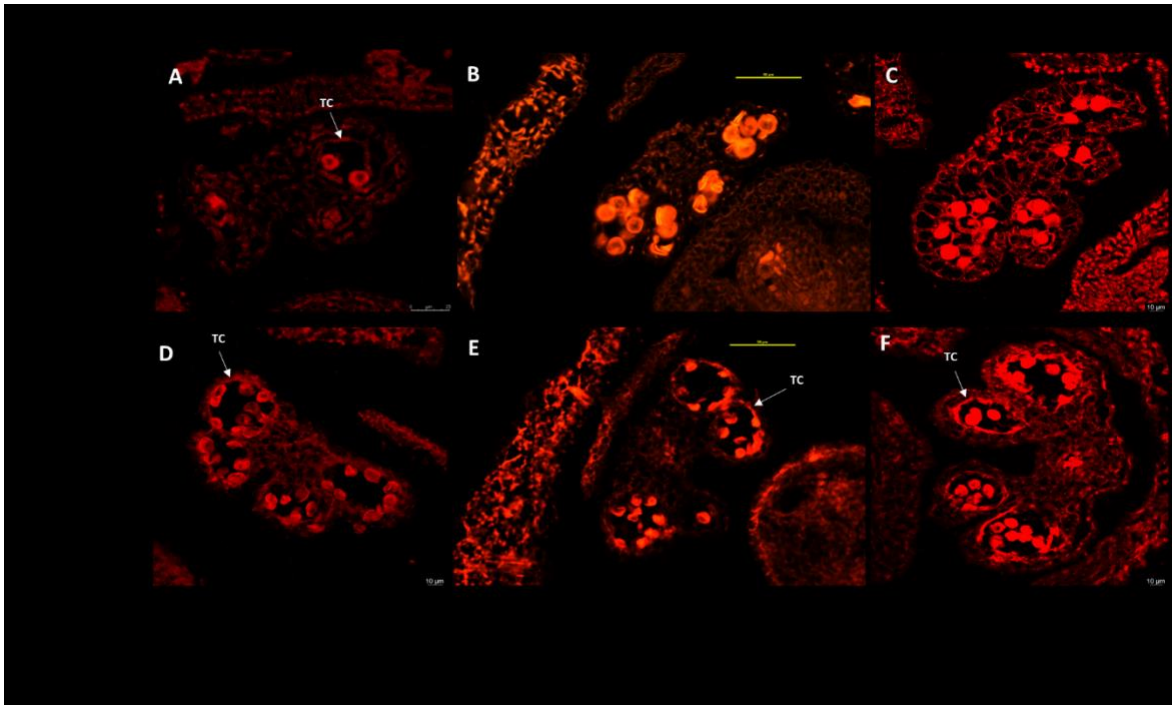
The plant specific architectural protein ARID/HMG prefer to bind different DNA topological forms and can bent and induce supercoiling. Knockout mutant of ARID/HMG protein AtHMG15 (Arabidopsis HMG15) shows mutant pollen morphology and retarded pollen tube germination. Most of the pollen grains from mutant plants were spherical in shape compared to ellipsoidal shape of wild type pollen. The outermost exine wall of wild type pollen has a typical reticulate pattern of ornamentation, which is completely defective in case of the mutant pollen grains. The wildtype typically consists of vertical sutures called the pollen apertures which are either absent or underdeveloped in the mutant pollen.Comparative analysis of transcriptome between wild-type and athmgb15 flowers revealed that all the Jasmonic Acid biosynthesis related genes and few important JA response and signalling genes were down-regulated. Also, few genes corresponding to the Programmed Cell Death in plants were differentially regulated. Estimation of JA levels in *athmgb15* mutant vs Wildtype Arabidopsis flowers shows a marked reduction of MeJA in the mutant seedlings and in the flowers compared to wild type. Further AtHMGB15 protein was found to bind the promoter/upstream region of JA biosynthetic genes. Our, analysis reveals that AtHMGB15 regulate the Jasmonic acid signaling thereby affect pollen development.

Future plan for 2022-23:

A. Study how JA signalling effect pollen development in *athmgb15* mutant plants
B. Study the effect of AtHMGB15 on PCD signaling: cross-talk between Jasmonic acid and ethylene
C. Characterization of chilling stress response in different rice landrace using genomics and epigenomics approach.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	01	–	01	–	–	01



PROF. GAURAB GANGOPADHYAY
Professor
Division of Plant Biology

Group Members:
Debabrata Dutta, *SRF-UGC*
Soumili Pal, *SRF- INSPIRE*
Vivek Awon, *SRF-UGC*
Diptasree Kumar, *SRF-WBDBT project*
Shinjini Sengupta, *PhD student (Collaborator Prof. S.K Datta)*
Mushtaq Ahmad Najar, *JRF-CSIR*
Saptadipa Banerjee, *JRF-UGC*

Research background and vision:

A plant scientist looking for the minute details of the plants - a belief that understanding the molecular basis of subtle variations can enhance a plant's performance in the field against biotic and abiotic stress.

Summary of research during April 1, 2021 – March 31, 2022:

- We performed an inter-specific hybridization between cultivated Indian sesame (*Sesamum indicum*) and *S. mulayanum* to bring a better oil profile to the cultivated sesame. The selected recombinant lines of advanced generations showed high oil content with a superior lignan profile and manifested distinct phenotypic selection traits.
- We have also developed an inter-specific hybrid between basally branched indeterminate cultivated *Sesamum indicum* genotype and wild *S. prostratum* with no branching yet synchronous pods on the shoot. The hybrid and a few exotic sesame germplasm were successfully screened with determinacy (*dt*) gene-based DNA marker.
- Through RNAi-mediated down-regulation of *ITPK-2*, we enhanced inorganic phosphorus and minerals in the transgenic rice.
- Of the three homologues of the pineapple Somatic Embryogenesis Receptor Kinase gene, we identified a unique extra leucine-rich repeat domain at the N-terminal region in *AcSERK3*. We also studied the expression pattern of the gene homologues in pineapple plants in response to the induced infection with *Fusarium* through qRT-PCR analysis.

Objectives as stated in the project proposal:

- To develop superior sesame variety better in the oil profile, both in terms of quality and quantity.
- To explore the pathway of sesame lignan biosynthesis, as many conversion steps are still unknown.
- Transcriptomic analysis of the selected lines and parents; it will indicate a handful of genes that have the credential for allele-specific marker development.

- alidation of those candidate genes in the breeding population for marker development.

Major accomplishment:

The Institute Germplasm Identification Committee (IGIC) evaluated the uniqueness of our inter-specific hybrid sesame. The germplasm (seeds) of this new hybrid was successfully submitted to the National Bureau of Plant Genetic Resources (NBPGR), Indian Council of Agricultural Research (ICAR) for its registration.

Future plan for 2022-23:

- Validation of SSR and SNP-based markers, obtained from the transcriptome analysis from the intra-mural grant (2019-2022) in the inter-specific hybrid lines of sesame.
- Transcriptomic analysis of rice genotypes differing in salt susceptibility and tolerance in the seedling stage to identify the differentially expressed genes regulating osmotic tolerance, ion exclusion, and tissue tolerance.
- Understanding the hormone-mediated molecular regulation during somatic embryogenesis in Darjeeling Tea.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	06	–	02	–	–	01

Average publication impact factor: **1.88**

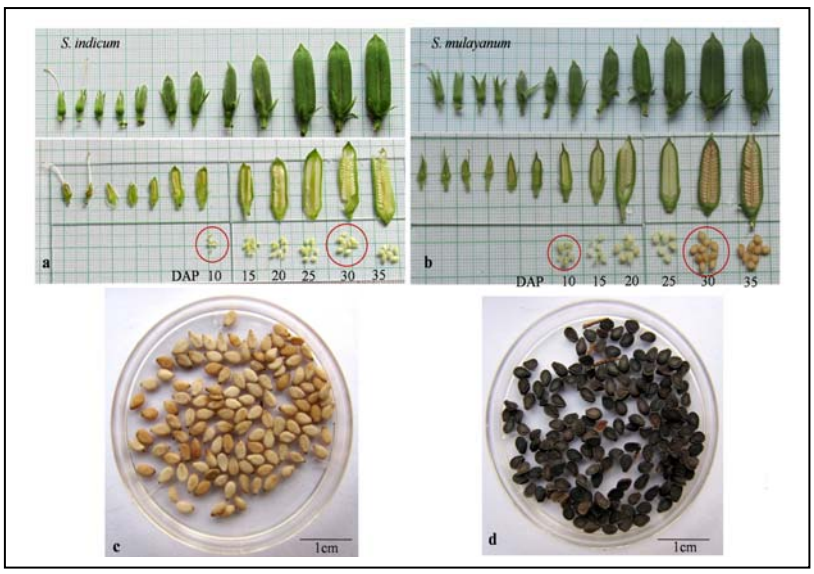


Figure : Sequential stages of pod and seed maturation in *S. indicum* (a) and *S. mulayanum* (b): red circles indicate the time points where samples were taken for transcriptomics analysis. The mature seeds of *S. indicum* (c) and *S. mulayanum* (d)

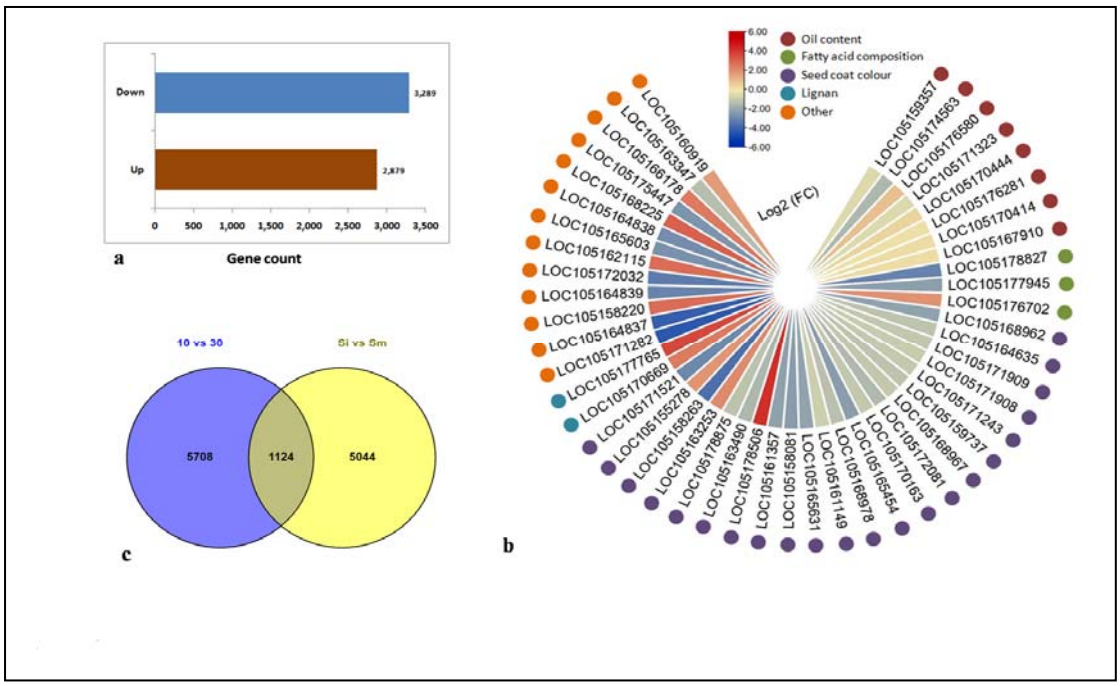


Figure : Differentially expressed genes (DEG) between the seeds of *S. indicum* (Si) and *S. mulayanum* (Sm): (a) The number of the DEGs, (b) Heat map of a few significant seed-related traits, (c) Venn diagram of the shared DEGs between the comparative group 1 (10 vs 30 DAP) and 2 (Si vs Sm)

PROF. PALLOB KUNDU
Professor
Division of Plant Biology

Group Members:
Sayani De, *SRF*
Rohit Das, *SRF*
Shreya Chowdhury, *SRF*
Shrabani Basak, *SRF*
Sayan Mal, *SRF*
Himadri Das, *SRF*
Ananya Mukherjee, *SRF*
Raghubir Singh, *SRF*
Sushmita Talukdar, *SRF*

Research background and vision:

Regulatory elements of molecular networks activated in response to pathogen stress in tomato plant: possible applications in engineering crops for enhanced stress tolerance

Mission: Understanding the multidimensional nature of the dynamic interactions between plant, pathogen and environment, and boosting plant's own immunity by biotechnological means.

Plants respond to stress by reprogramming of existing gene expression cascade to impose robustness and specificity to the response. Regulation of transcription initiation and microRNA (miRNA)-mediated posttranscriptional gene-silencing have crucial roles in this process. Important information regarding genomic and non-genomic regulations during pathogen stress has been derived from plant-biotrophic pathogen interactions; however, necrotrophic pathogenesis inflicted gene regulations have been explored the least. Unlike a resistance response against biotrophic pathogen, resulting in hypersensitive response-related cell death, necrotrophs induce cell death for deriving nutrients from dead tissues. In a way they hijack cellular cell death mechanism and turn it towards its own benefit. Genetic resistance against these pathogens is unknown and molecular response to cope with the stress remains elusive.

Major interest is on understanding the intricacies of gene regulation mechanisms shaping the stress-response in tomato plant during necrotrophic pathogenesis by tomato early blight pathogen *Alternaria solani*. Since gene regulatory circuits are interlinked the implicated genes' roles during biotrophic pathogenesis as well as environmental stresses are also investigated. We are using the Tomato leaf curl New Delhi Virus, *Xanthomonas* and *Pseudomonas* bacterial pathogens and thermal stresses to investigate the effect of environmental and other biotic factors in the necrotrophic pathogenesis.

Utilizing genomics, molecular biological, and plant biotechnological tools, my current research programmes are:

- **Understanding the mechanisms of regulation of *Alternaria* stress-responsive microRNA expression and significance of specific miRNA-mRNA interaction in the disease biology.**

- **Investigating the role of mediators of cell death, such as NB-LRRs and metacaspases, in disease development.**
- **Role of thermal stress responsive miRNAs in pathogenesis.**
- **Analyzing the mechanisms of signal perception, regulation of expression and biological functions of membrane-bound NAC transcription factors in tomato (NAC MTFs).**
- **Generation of stress-resilient crops of the future by biotechnological approaches.**

Vision: Unravelling the gene-regulatory circuit activated during a plant-pathogen interaction and confirming key regulatory nodes that distinguishes between resistance and susceptible interaction. Additionally, mapping the dynamic modulations in the regulatory circuit while the plant is exposed to the changing climatic conditions would be carried out. Thus, a guideline and methodologies can be developed for generating multi-stress resilient crop via fast forward genetics approaches, or seamless genetic modifications using genome editing/regulatory tools.

Summary of research during April 1, 2021 – March 31, 2022:

We are using tomato plant as the model and major focus is on understanding the disease biology of tomato-necrotrophic pathogen *Alternaria solani* interaction. Since the disease is a complex phenomenon resulting from plant-environment-pathogen interaction and plants are constantly exposed to alternative pathogens, I am also using other stress factors such as infection with Tomato leaf curl New Delhi virus, a biotrophic pathogen causing leaf curl disease and heat or cold exposure to better understand the molecular crosstalk. Recent developments in my research studies are highlighted under each project being pursed.

- **Understanding mechanisms of regulation of *Alternaria* stress-responsive microRNA expression and significance of specific miRNA-mRNA interaction in the disease biology**

We have previously confirmed miR398 and Cu-Zn SOD1 interaction during Alternaria stress and development of a miR398-knockout line. Knockout plants exhibited augmented superoxide dismutase activity, H_2O_2 accumulation and catalase activity. We are investigating the response of the mutant lines to *Alternaria* infection.

- **Investigating the role of mediators of cell death, such as NB-LRRs and metacaspases, in disease development.**

(i) Previously we have reported miR6024-NB-LRRs interactions during *Alternaria*-stress in tomato and development of miR6024 overexpressing tomato lines. miR6024 overexpressing plants are apparently showing heightened immune response which helps in a necrotrophic pathogenesis. We will carry on further studies to determine molecular basis and convergent actions of different miRNAs in the process.

(ii) I have previously reported that our focus is on two Metacaspases (MC1 and MC5) for investigating their role in tomato disease biology. Synthetic substrate-based assays have facilitated identification of their preference for recognition and cleavage of amino acid sequences. We are now investigating the structure-function relationship of MC1.

- **Role of thermal stress responsive miRNAs in pathogenesis.**

To find out thermal stress responsive miRNAs in tomato cultivar Pusa Ruby we have performed NGS-based whole transcriptome and degradome analysis. Data integration from different NGS is being carried out. Preliminary studies have identified multiple mRNA-miRNA interactions specific for heat or cold stress.

- **Analyzing the mechanisms of signal perception, regulation of expression and biological functions of membrane bound NAC transcription factors in tomato (NAC MTFs)**

We have confirmed the role serine proteases in membrane detachment of SlNACMTF3. Experiments are in progress to pinpoint the role of specific serine-proteases in the process. As mentioned in the previous report, transgenic tomato plants with over expression of SlNACMTF3 have been developed. Using this plant, we are performing ChIP-Seq and DAP-seq analyses to elucidate genes that are regulated by SlNACMTF3 during stress.

- **Generation of stress resilient crops of the future by biotechnological approaches.**

The major focus of this study is to develop inducible dCas9 based gene regulatory toolkit for tomato plant. We have generated tomato codon optimized dCas9 and activator and repressor constructs for gene regulation purpose. Using tomato miR167 and TRN1 promoter transgenic plants we have also tested effectiveness of these constructs which indicated capability of these in gene regulation. Current research focus is on developing gene constructs for regulating useful genes to alter traits in a favourable manner.

Major accomplishment (significant results):

We are working on several molecular aspects of plant stress response. Major focus is on understanding the signaling events during the necrotrophic pathogenesis caused by the fungus *Alternaria solani*.

We have shown that tomato miR6024 negatively impacts plant's resilience against Alternaria solani. As a result, a miR6024-overexpressing transgenic plant was succumbed to the disease in a shorter time compared to the control. Molecular mechanism includes downregulation of a set of NB-LRR type of genes in the transgenic via heightened production of the miRNA and secondary phasiRNAs.

We have shown that tomato TORNADO1 gene's, involved in leaf vein development and reticulation formation, expression is restored by tomato leaf curl virus infection in mature leaves which is otherwise transcriptionally silenced by DNA-methylation. Our study conclusively demonstrated that viral pathogenesis related proteins influence the expression of plant demethylases and controls the methylation status of TORNADO1. Mis-regulation of the TORNADO1 gene may have effect on leaf vein thickening as observed in infected plants.

Future Plan for 2022-23:

- miR6024 overexpressing plants are apparently showing heightened immune response which helps in a necrotrophic pathogenesis. We will carry on further studies to determine molecular basis and convergent actions of different miRNAs in the process.
- Analysis of miRNA-target interactions in Alternaria pathogen resistant/tolerant line vs. susceptible lines needs to be completed.
- Role of trans-acting factors in stress-dependent regulation of miR167 precursor-processing is being investigated. Current focus is on understanding the role of Cycling Dof and PIF4 transcription factors in miRNA processing and regulation of processing during stress. We have identified a few protein factors. Whether they are involved in modulating miRNA processing will be investigated.
- Two new membrane bound NAC transcription factors (SlNACMTFs) have been identified whose biological role was unknown. Our studies implicated these NACMTFs as facilitator of

plant stress response. In the quest for understanding the mechanism of their activation during stress we have identified a group of proteases which are involved in proteolytic-cleavage and subsequent rejuvenation of the transcription factor. Further studies are needed to understand their significance in plant stress biology.

- We are investigating the role of tomato metacaspases (MCs) in disease biology. We have found that cellular pH has profound effect in activation of a MC. Since diseased tissues typically experience alteration in pH-balance we are intending to investigate whether the MC has any role in sensing the altered pH for inflicting cellular hypersensitive response during the pathogen invasion.
- A new project has been initiated since August 2018 to develop improved tools for induced genome regulation. One of the requirements of the project is to express the Cas protein in a spatio-temporal manner. In order to achieve this, we have cloned a few novel tissue and time specific promoters from tomato and validating their expression pattern. More intricate construct designing for multiple gene regulation in order to create a favourable trait in a crop plant is ongoing.
- We will continue our integrative analysis of tomato heat and cold stress responsive transcriptome, small RNA transcriptome and degradome. Some key molecules have been identified, but further analysis will be performed for the identification of stress-responsive post-transcriptionally regulated genes.
- In the rural biotechnology project research and development of marginal crops have been proposed.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	04	–	02	05	–	–

Average publication impact factor: **3.55**

DR. ANUPAMA GHOSH
Associate Professor
Division of Plant Biology

Group Members:
Rahul Datta, *SRF*
Dibya Mukherjee, *SRF*
Udita Acharya, *SRF*
Subhasish Mukherjee, *SRF*
Aroni Mitra, *SRF*
Anisha Roy, *SRF*
Alka Kumari, *CSIR-RA*

Research background and vision:

We work on various aspects of plant microbe interactions. In particular the primary focus of our research involves exploring the molecular cross talks between a fungal phytopthogen *Ustilagomaydis* and its host *Zea mays* that leads to establishment of biotrophic interaction between them. The vision of the lab is to understand the molecular strategies of disease establishment by fungal phytopathogens involving a huge array of secreted effector proteins most of which are orphan proteins with no known functions.

Summary of research during April 1, 2021 – March 31, 2022:

In the past one year we carried out studies related to understanding the composition of the extracellular RNA pool of maize and what effect does *U. maydis* infection has on it. We carried out next generation sequencing analysis of the extracellular RNA from maize under both infection and normal conditions. Our data revealed representation of different cellular processes by the extracellular RNA transcripts. Analysis of the extracellular transcriptomes to reveal any influence of *U. maydis* infection on this pool of exRNA however is currently undergoing. In addition we initiated studies to explore the biological function of a small heat shock protein, HSP20 and how does it contribute towards regulating the filamentation in *U. maydis*. We have also demonstrated the major extracellular defense response pathways induced in rice during sheath blight infection using a transcriptomic approach. Here we compared the trascriptomes of rice either uninfected or infected with *Rhizoctoniasolani*. Among the differentially expressed genes (DEGs) we focused on those that code for proteins with N-terminal signal peptide.

Objectives:

- To investigate the localization of the two T2 type ribonucleases (ExNuc1 and ExNuc2) within the infected maize plants.
- To investigate the nuclease activities of ExNuc1 and ExNuc2.
- To identify the substrates of ExNuc1 and ExNuc2 during infection.
- To investigate whether ExNuc1 and ExNuc2 function in protein complexes.

Major accomplishment (Significant Results):

- Extracellular RNA pool of maize represents transcripts from both nuclear as well as the chloroplast and mitochondrial genomes.
- Different biological processes such as photosynthesis, response to stress including oxidative stress, chemical stress and biotic stress and peptide metabolic processes are represented by the exRNA transcripts.
- A set of two extracellular protease inhibitors, OsIn1 and OsIn2 from rice have been demonstrated to induce disease resistance in *Nicotianabenthamiana* during infection with *R. solani*.

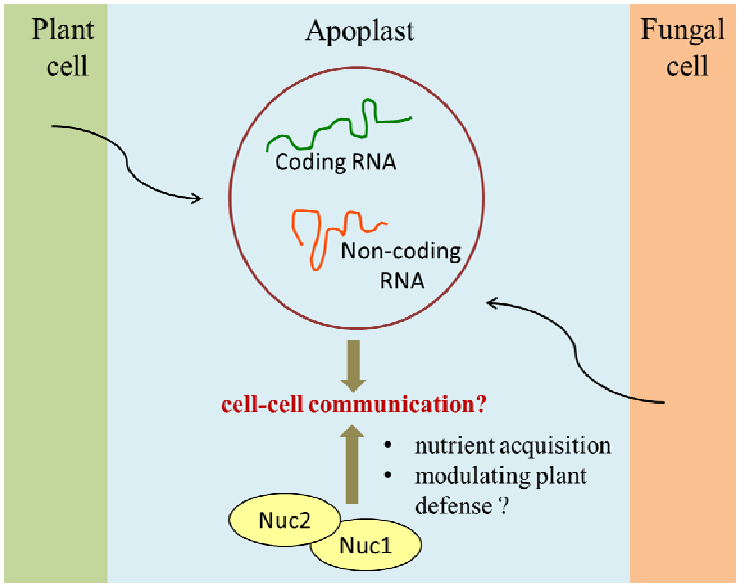
Future Plan for 2022-23:

- Influence of *U. maydis* infection and the secreted ribonucleases on the composition of maize apoplastic RNA pool.
- Investigating the biological function of HSP20 in *Ustilagomaydis*
- Exploring the involvement of a secreted lipase Lip1 in the pathogenic development of *U. maydis*.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	01	–	–	01	–	–

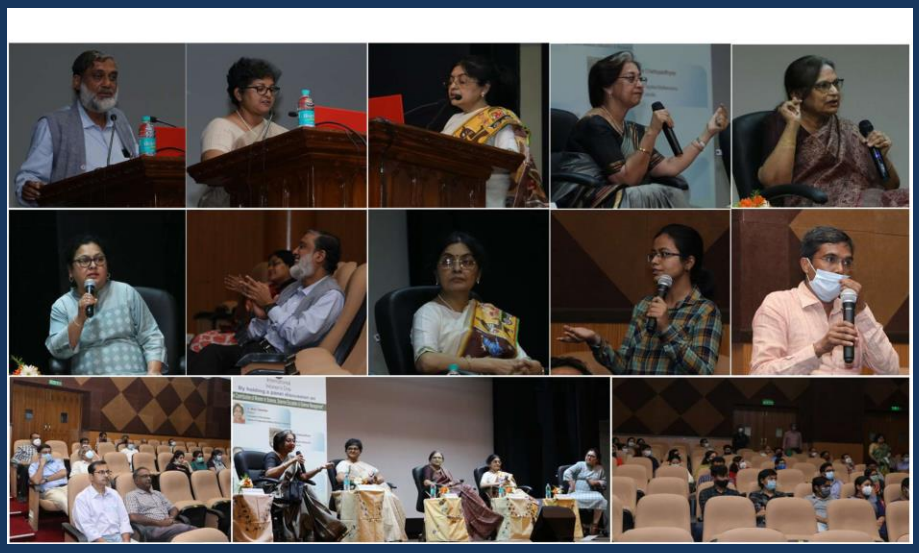
Average publication impact factor: **5.5**



The figure above depicts the broad composition of the apoplastic RNA pool of maize plants infected with *Ustilagomaydis*. A possible role of this RNA pool in the cell to cell communication between either two plant cells or two fungal cells or a plant cell and a fungal cell is hypothesized. Nuc1 and Nuc2 have already been shown to utilize this RNA pool as a phosphate source during its survival in planta. However, are these nucleases Nuc1 and Nuc2 also modulate cell to cell communication using apoplastic RNA during infection? This is the question that is currently being addressed through our studies.

– SCIENTIFIC REPORT –

SENIOR SCIENTISTS



International Women's Day Celebration at Unified Academic Campus, Bose Institute on 08.03.2022. There was a panel discussion on Women in Science, Science Education and Science Management. Speakers:

Dr. Mitali Chatterjee, Professor, Dept. of Pharmacology, Institute of Post Graduate Medical Education and Research

Dr. Tanuka Chattopadhyay, Dean of Science, Dept. of Applied Mathematics, University of Calcutta

Dr. Anindita Seal, Associate Professor, Dept. of Biotechnology, University of Calcutta

Dr. Rukhsana Choudhury, Professor, School of Biological Sciences, RKM Vivekananda University, Narendrapur.

PROF. JOYOTI BASU

J. C. Bose National Fellow

Scientific Report

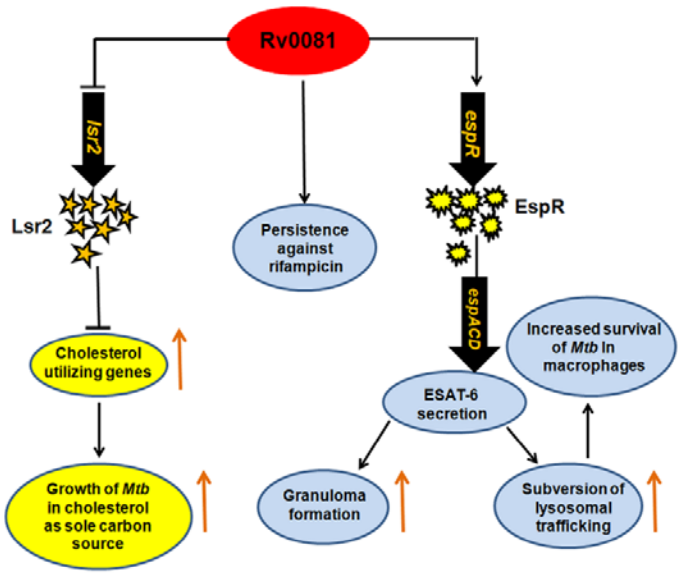
Background & Objectives:

The major objectives of our laboratory are to understand how *Mycobacterium tuberculosis*, the causative agent of tuberculosis interacts with host macrophages and to understand how the key regulators of its response to stress, function.

The transcriptional regulator Rv0081 regulates utilization of cholesterol by *Mycobacterium tuberculosis*

The transcriptional network of *M. tuberculosis* isdynamic, and enables the bacterium to withstand a variety of stresses that it encounters within the host milieu. Rv0081 (MT0088) is a transcriptional regulator whose interplay with other gene regulatory proteins enables *M. tuberculosis* to thrive in a hypoxic environment. Its role under conditions other than anaerobiosis, remain unexplored. We demonstrate that deletion of Rv0081 compromises the ability of *M. tuberculosis* to utilize cholesterol as sole carbon source, to subvert lysosomal trafficking, and to form granulomas in vitro. During growth in cholesterol as sole carbon source, Rv0081 downregulates expression of the nucleoid associated repressor Lsr2, leading to increased expression of the cholesterol catabolism-linked gene *kshA* and genes of the cholesterol importing operon, thereby facilitating cholesterol utilization. Further, Rv0081 activates EspRa regulator of a Type VII secretion machinery of *M. tuberculosis*, thereby regulating the secretion of ESX-1 substrates, which in turn are involved in subversion of lysosomal trafficking of *M. tuberculosis* and granuloma expansion. These results provide new insight into the role of Rv0081 under conditions which it is likely to encounter within the host.

Our studies cement the role of Rv0081 as a central regulator of genes linked to various pathways which are crucial for the survival of the bacterium *in vivo*. We show for the first time that cholesterol utilization by *M. tuberculosis* is regulated by the Rv0081-Lsr2 axis. Rv0081 emerges as a candidate drug target in *M. tuberculosis*.



The transcriptional regulator Rv0081 is a central hub in the *Mycobacterium tuberculosis* gene regulatory network. We show that Lsr2 is a repressor of cholesterol utilizing genes. Rv0081 facilitates bacterial growth on cholesterol by directly binding to the *lsr2* locus to repress *lsr2* expression. Further, Rv0081 activates the transcription factor EspR which enhances ESAT-6 secretion leading to subversion of lysosomal trafficking and granuloma formation.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
01	02	–	–	01	–	–

Average publication impact factor: **5.5**

PROF. SAMPA DAS
INSA Senior Scientist

Identification and Expression of pathogen resistant gene(s)/ protein(s) with special emphasis on understanding plant's defense response to biotic stress in chickpea

Scientific Report

On interaction between chickpea and wilt causing pathogen, *Fusarium oxysporum*, we identified few members of differentially expressed MYB transcription factor families. Among several members, MYB78 has been found to be significantly up-regulated during chickpea- Fusarium interplay in resistant chickpea genotype. Following a unique plumular meristem mediated transformation protocol, introgression of CaMYB78 (Cicer arietinum MYB78) coding gene sequence finally became possible in chickpea. The over-expressed plants developed resistance against the target pathogen, Fusarium. Interestingly, the anthocyanin production in transformed flowers were significantly perturbed and flower colour was changed from pink to white. *In silico* analyses of the anthocyanin biosynthetic key gene promoters reported the occurrence of multiple MYB binding cis elements. Detail molecular analyses unravelled the differential modulatory role of CaMYB78 in developing resistance against Fusarium as well as down regulation of anthocyanin production in flowers. This study had been accepted for publication in the Journal **Protoplasma.**

Most interesting investigation we made in the strict and partial lockdown phases during 2021 has also been recently published in the Journal, **Virus Research, 2022,** the highlights of that study are being described below. In continuation to our ongoing study on several mannose binding monocot lectins for developing resistance against plant attacking sap sucking insects and fungal pathogens, recently we isolated one such novel lectin, NTL-125 from *Narcissus tazetta* (daffodil) bulb. This protein has been found to be altogether different from earlier reported lectin isolated from the same plant by other group. During acute COVID-19 pandemic situation, in collaboration with scientists of IMTECH, Chandigarh we detected that the above novel NTL-125 lectin is inhibiting the entry as well as replication of SARS-CoV-2 virus in Vero E6 cell line. To resolve the molecular mechanism of currently detected viral inhibitory action of the NTL-125, independent molecular docking experiments was performed between NTL-125 and native as well as a series of mutant variants of SARS-CoV-2 spike protein and parallely between hACE2 receptor and native and mutant spike proteins. The native and all the mutant variants of Spike proteins were found to interact with NTL-125 and hACE2 through some common amino acid residues spanning in the receptor binding region but having more affinity to NTL-125. This establishes **NTL-125** as a promising antagonist from natural source against SARS- CoV-2. This is a new observation of its own kind which has great significance in plant biotechnology research as well as COVID-19 pandemic.

Group Members:

Dr. Papri Nag is working as **DST Women Scientist** (SR/WOS-A/LS-377) on a project entitled " Exploring Biological Nitrogen Fixation in Rice ".

Through this project two novel bacterial strains of genus *Paraburkholderia* and *Microbacterium* were isolated by Dr. Nag from rhizosphere of different rice cultivars. Out of which *Paraburkholderia bengalensis* sp. nov. was characterised in detail in an aim to improve the nitrogen utilising efficiency of rice which got published in Archives of Microbiology (2022).

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	05	02	–	–	–	–

Average publication impact factor: **2.5**

PROF. MANIKUNTALA KUNDU

CSIR Emeritus Scientist

Scientific Report

Background & objectives:

The major objectives of our laboratory are to understand how *Mycobacterium tuberculosis*, the causative agent of tuberculosis responds to stresses it is likely to encounter within the host environment and the mechanisms regulating its interaction with host macrophages. We also study the pathogenesis of *Helicobacter pylori* infection which is linked to gastric ulcer and gastric carcinogenesis.

(A)The response regulator RegX3 regulates the survival of *M. tuberculosis* in a hypoxic environment

Two-component systems (TCSs) are required for the ablity of *M. tuberculosis* to respond to stress. The paired TCS, SenX3-RegX3 is known to respond to phosphate starvation and acid stress. Using genome-wide microarray profiling to compare gene expression between wild type*M. tuberculosis* and a *ΔregX3* mutant under phosphate stress, we observed that a set of 85-hypoxia associated genes are downregulated at least 2 fold in *ΔregX3*. We identified potential RegX3 binding inverted repeats at the loci of 34 of these genes, in silico. We also observed that *ΔregX3* was attenuated in terms of its ability to withstand hypoxia, and this was reversed upon complementation with *regX3*, corroborating a role of RegX3 in the response of *M. tuberculosis* to hypoxia. We validated the binding of RegX3 at the upstream regions of a selected set of the aforesaid genes. Electrophoretic mobility shift assays confirmed that RegX3 binds to the upstream regions of the hypoxia-associated genes *Rv3334*, *whiB7*, *Rv0195*, *Rv0196* and *Rv1960c*. Gene expression analyses showed that the expression of these genes is regulated by RegX3 under hypoxia. We also showed that the expression of *whiB7*, *Rv3334* and *Rv0195* in macrophage-grown *M. tuberculosis*, is dependent on RegX3. Finally, we observed that attenuation of survival of *ΔregX3* under hypoxia is partly reversed upon overexpression of either*Rv0195* or *Rv3334*, suggesting that the RegX3-Rv0195 and the RegX3-Rv3334 axes are involved in the adaptation of *M. tuberculosis* to a hypoxic environment.

Our studies are the first to demonstrate that RegX3 serves as an important transcriptional regulator that is involved during adaptation of *M. tuberculosis* to hypoxia.

(B) *Helicobacter pylori* regulates the miR671-5p-CDCA7L axis in gastric epithelial cells

Helicobacter pylori (*H. pylori*), a gram-negative, flagellated, microaerophilic bacterium colonizes the gastric mucosa causing a spectrum of disorders ranging from gastritis and gastroduodonal ulcers to gastric carcinomas and lymphomas. Colonization of the stomach involves an interplay

between host immune mechanisms which attempt to eliminate the pathogen and bacteria-derived factors which exploit the host machinery to protect the niche where they reside, enabling the bacteria to multiply and survive. Chronic *H. pylori*-induced inflammation can eventually lead to loss of the normal gastric mucosal architecture, with destruction of gastric glands and replacement by fibrosis and intestinal-type epithelium. One of the objectives of our laboratory is to investigate the role of microRNAs in regulating the interaction between *H. Pylori* and gastric epithelial cells. We have analyzed the miRNAs which are differentially regulated during infection of gastric epithelial cells with *H. pylori*. We have elucidated the relationship between miR671-5p and its putative target CDCA7L, and its likely role in host-pathogen interaction. We have observed that miR671-5p is upregulated early during infection of the gastric epithelial cell line AGS, with *H. pylori*. We have further observed that one of its putative targets, CDCA7L is concomitantly downregulated. We have validated that miR671-5p targets CDCA7L. We have also demonstrated CDCA 7L serves as a repressor of monoamine oxidase A expression. We hypothesize that CDCA7L likely regulates apoptosis by regulating MAO-A. This will be tested in our future studies.

These studies highlight for the first time, the role of the miRNA miR671-5p and its target CDCA7L in *H. pylori*-mediated signaling in gastric epithelial cells.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	02	–	–	01	–	–

Average publication impact factor: **5.5**

PROF. SUJOY KUMAR DAS GUPTA

CSIR Emeritus Scientist

Group Members

Poulami Ghosh, *SRF*
Madhu Mantri Patra, *SRF*
Anik Burman, *SRF*
Rahul Shaw, *SRF*
Shreya Sengupta, *WS*

Scientific Report

Background:

My lab is interested to understand the molecular biology of Mycobacteria and its phages. Various species of Mycobacteria, *Mycobacterium tuberculosis* (Mtb), for example, can cause the deadly disease tuberculosis (TB). Even though Mtb was discovered over a hundred years ago, we have been unable to eradicate TB. Existing drugs often fail to act as these organisms become drug-resistant and sometimes tolerant. To develop novel therapies for TB, we need to understand mycobacterial molecular biology in detail. My lab addresses these issues with the help of Mycobacteriophages, the phages that infect and kill Mycobacteria. Our approach involves infecting Mycobacteria with Mycobacteriophages and studying the resulting molecular and metabolic changes. By taking this approach, we have gained considerable new information about mycobacterial metabolism, which could be used for drug development against Mtb.

Aims and objectives:

- In the area of mycobacteriophage research our objective is to investigate the mechanism by which the mycobacteriophage D29 expresses its genes in a regulated manner using transcriptomics, proteomic and molecular tools.
- Investigate how D29 phage inactivates its mycobacterial host and use the information derived for the development of drugs against TB.
- To study mycobacterial metabolism using gene replacement and CRISPR based gene knockout techniques.

Work Achieved:

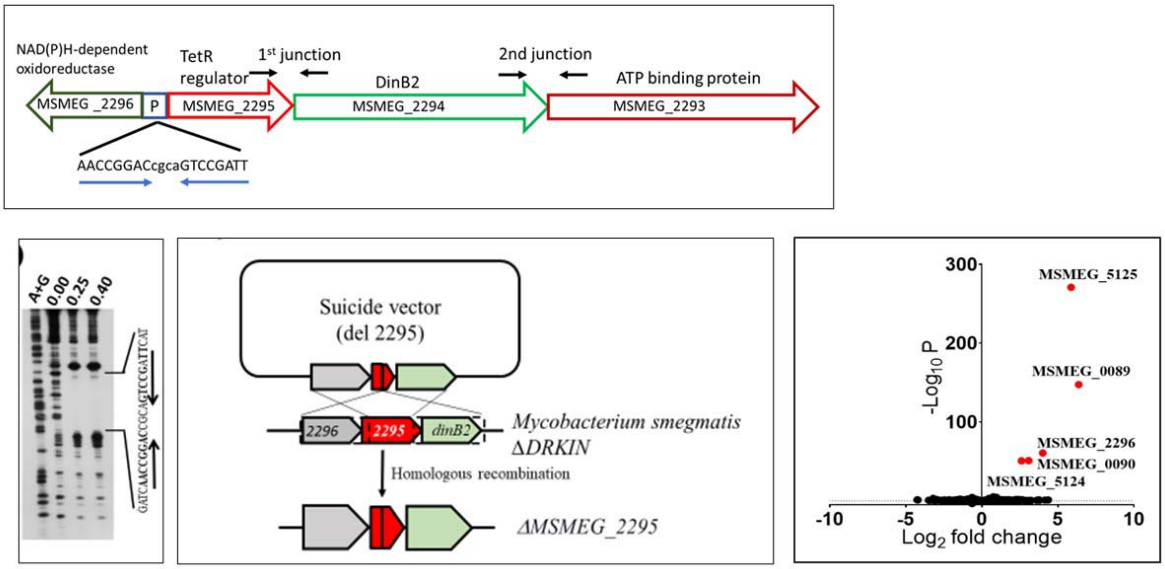
We earlier reported that DinB2, a DNA repair enzyme enables *Mycobacterium smegmatis* (Msm) to survive under thymidylate-deficient conditions. In this study, we asked how *dinB*2 expression is regulated. In Msm DinB2 is encoded by an operon comprising the genes *MSMEG_2295*,

MSMEG_2294 (*dinB2*), and *MSMEG_2293*. We demonstrate that MSMEG_2295 binds upstream of the operon and regulates its expression. Transcriptomic analysis of a ΔMSMEG_2295 strain revealed the upregulation of the *dinB2* operon and several other genes. MSMEG_2295, therefore, controls a regulon comprising multiple genes. *MSMEG_2295* modulates pyruvate metabolism by regulating the expression of *MSMEG_0089*, encoding an inhibitor of the pyruvate dehydrogenase complex. It also plays a role in managing oxidative stress. Plumbagin, a plant flavonoid used in traditional medicine, was found to induce the MSMEG_2295 regulon genes. The results indicate that MSMEG_2295 has a significant role in controlling energy metabolism in Mycobacteria.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
01	02	–	–	–	–	–

Average publication impact factor: **2.7**



The dinB2 operon of Mycobacterium smegmatis (Top.) MSMEG_2295 a TetR family regulator encoded by the first gene of the operon controls its expression by binding to an inverted repeat sequence upstream of it (Lower left). Volcano plot analysis (lower right) of a MSMEG_2295 knockout (middle) transcriptome revealed that the repressor controls the expression of multiple genes the products of which can influence metabolism under stress conditions (Lower right).

PROF. GAURISANKAR SA

NASI Platinum Jubilee Senior Scientist

Scientific Report

Background:

Anticancer immunotherapies involving the use of immune-checkpoint inhibitors (e.g., anti-CTLA4/-PD1) has emerged as new therapeutic pillars. While often many patients have innate-/acquired-resistance to immunotherapies. Avoidance of immune system is one of the major hallmarks in cancer progression that successively transforms immune-surveillance (tumor-eradication) to immune-tolerance (tumor-progression). Modulation of immune cells to harness the power of effective immune responses has been long-term goals for promising strategies of cancer immune therapy. However, long-term follow-up in a pooled meta-analysis exhibited long-term survival in approximately 20% of patients treated with immune checkpoint inhibitors, and a large fraction of patients experience aggressive disease progression after treatment. Earlier we reported that $FOXP3^+$ Treg cells augmentation in cancer patients causes immunosuppression, neo-angiogenesis and metastasis. Recent research has thus focused on the development of effective immunotherapeutic strategies that target tolerogenic-immune cells to become immunogenic and restore cancer immune surveillance to bypass the innate or acquired resistance to immunotherapies.

Aims and objectives:

- To understand the immune landscape of tumor-microenvironment for the development of innate or acquired resistance to immunotherapies.
- To understand the reason for failure of antibody response against tumor-antigen in cancer patients
- To understand the immunometabolomics in cancer patients to manipulate diet during therapy.
- To develop suitable combinations of chemotherapy, immunotherapy and rejuvenation-therapy to determine the efficacy of such therapy modules through clinical trials.

Work Achieved:

- Identification of a novel $CD4^+CD25^+CD127^-CTLA4^+FOXP3^+$ T-regulatory (Treg) cells in tumor micro-environment.
- Presence of high-level of tumor-associated $CD4^+$ Treg cells (tTregs) in the tumor-site results in poor prognosis of cancer patient.
- This tTregs use altered energy metabolisms to survive and expand in highly competitive tumor microenvironment.

- This tTregs exploit several immunosuppressive strategies such as induction of T-effector cell death, dysfunction of dendritic cells, and modulation of anti-tumorigenic (M1) macrophages towards tolerogenic (M2) macrophages which prevents the natural immune system to act against tumor and thus develops the resistance to immunotherapies.
- Tumor associated immunoregulatory B-regulatory cells deregulate H-chain class-switch recombination that finally leads to the inhibition in the development of class-switched memory and high-affinity antibody-producing plasma B cell in tumor-microenvironment.
- This tTregs secrets high-level of VEGF to instigate endothelial cells to undergo tumor-angiogenesis.
- Lentivirus clone containing miR-325 generated an immunogenic response against tumor by restricting the immuno-suppression that is caused by tTregs in tumor-bearer.

Future Research Plans:

- Determination of the status of the immune system in cancer patients for logistic application of immunotherapy.
- Development of adeno-associated virus (AAV)-mediated *in-vivo* delivery system for miR-325 for clinical trials
- Development of AAV-mediated *in-vivo* delivery system for anti-PD1/CTLA4 for cancer immunotherapy
- To develop combinatorial therapy modules of chemotherapy, immunotherapy for clinical trials.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
02	07	–	02	04	–	2

Average publication impact factor: **5.5**

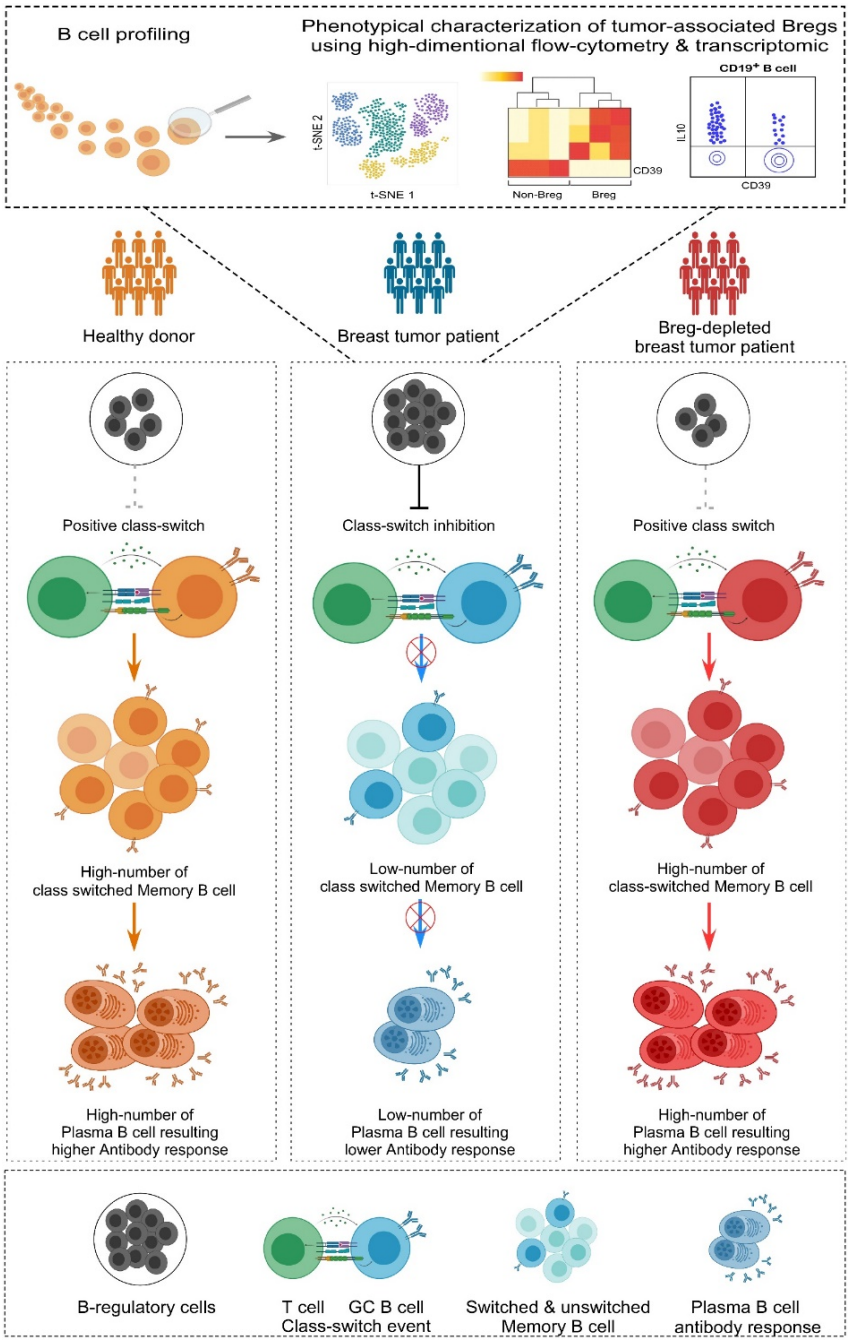


Figure. B cell profiling using high-dimensional flow-cytometric and transcriptomic analysis identified CD39-negativity as the key signature surface-marker for tumor-associated IL10^{+} Breg cells. As a functional perspective, this immunoregulatory Breg deregulates class-switch recombination that finally leads to the inhibition in the development of class-switched memory and high-affinity antibody-producing plasma B cell in tumor-microenvironment.

PROF. TANYA DAS

ICMR Emeritus Scientist

Group Members:
Apratim Dutta, *SRF*
Udit Basak, *SRF*
Sourio Chakraborty, *SRF*

Scientific Report

Background:

Cancer stem cells and immune system

Tumor-infiltrating immune cells play a key role against cancer. However a small population of cells protect themselves from the active immune system at the early elimination phase and is able to initiate tumor progression. According to cancer stem cell (CSC) theory, a delicate balance between symmetric (SCD) and asymmetric (ACD) cell divisions in CSCs decides the fate of the tumor by modulating the equilibrium between self-renewing CSC pool and lineage-specific progenitor cell pool. Moreover, CSCs are these immune escaped cells which initiate and propagate cancer. How these small population of cells protect themselves from the active immune cells at the early elimination phase remains poorly understood.

Aims and objectives:

- Mapping the molecular mechanism that decides whether CSCs will undergo ACD or SCD under normal as well as during chemotherapy.
- Exploring whether breast CSCs generate Treg cells thus procreating immunosuppressive microenvironment, and initiating cancer.
- If yes, whether CSCs generate Treg cells via contact-dependent or –independent manner.
- Delineating the mechanism of CSC-induced Treg cell generation.

Work Achieved:

- We, for the first time report that for adopting asymmetric cell division (ACD), pluripotency factor NANOG transactivates tripartite motif-containing protein 32 (TRIM32), one of the major inducers of ACD, by binding to its proximal promoter region.
- Chemotherapy inhibits NANOG-binding and restrains ACD. As a consequence, generation of chemo-susceptible non-stem cancer cells (NSCCs) is restricted while enriching chemo-resistant CSC pool by SCD.
- Accordingly, we propose a hitherto unknown fate-determining role of NANOG in breast CSCs.
- Identification of an intelligent strategy used by CSCs to induce *in-situ* generation of Treg cells at an early time-point by secretion of FOXP3-containing exosomes (CDEs).
- These CDE-derived FoxP3 after internalization converts $CD4^{+}$T cells to immunosuppressive Treg cells.

- Exosomal FOXP3 mediates CD25 gene expression and ensures stable maintenance of endogenous-FOXP3 by enabling demethylation of CNS2 locus on self-promoter.
- Collectively these results demonstrate an unprecedented role of CSC-derived FOXP3 in reprogramming T cells into pro-tumor Treg cells to escape initial immune attack.

Future Research Plans:

- Unveiling the detail mechanism of ACD to SCD switch-over of CSC division during chemotherapy.
- Determination of the complete mechanism of CSC-Treg cell interaction in cancer patients.
- To understand whether inhibiting CSC-Treg cell cross-talk can help in logistic application of cancer immunotherapy.
- To develop combinatorial therapy modules of chemotherapy, immunotherapy for clinical trials.

Scientific Activities:

Student Awarded Ph.D.	Publication	Book Chapter / Invited Review	Participation in Conference / Symposia / Workshop and Delivered Invited Talk	Extramural Funding	Patent Applied / Granted	Award / Honour / Membership
–	–	–	02	04	–	2

Average publication impact factor: **10.2**

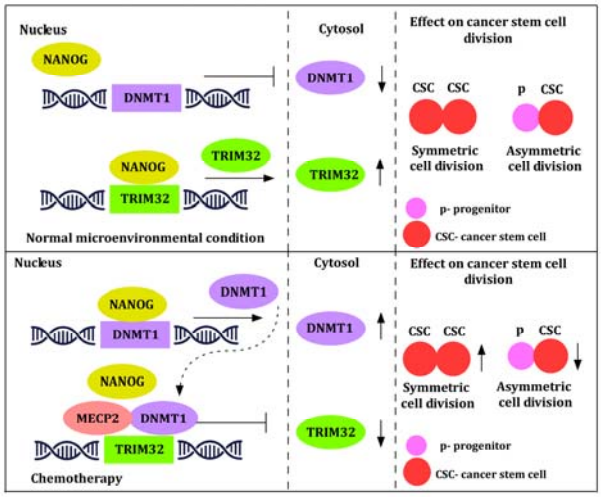
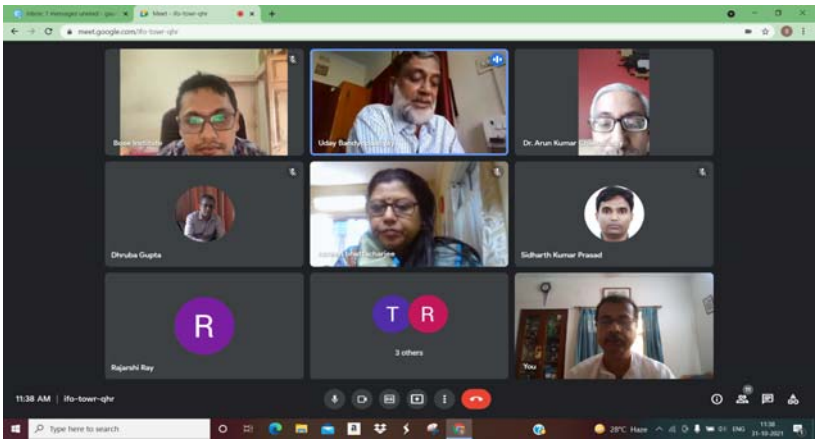


Figure. Nanog triggers asymmetric division in cancer stem cells by trans-activating Trim32 while chemotherapy impedes the same.



"Rashtriya Ekta Diwas" (National Unity Day) was observed by Bose Institute, Kolkata on October 31, 2021 to commemorate the birth anniversary of Sardar Vallabhbhai Patel. A Pledge taking ceremony was organized in a virtual mode via Internet.

SERVICE DEPARTMENTS / SECTIONS

Observed National Science Day 2022 at Unified Academic Campus, Bose Institute

Celebration of National Science Day 2022 at Falta Experimental Farm, Bose Institute

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.

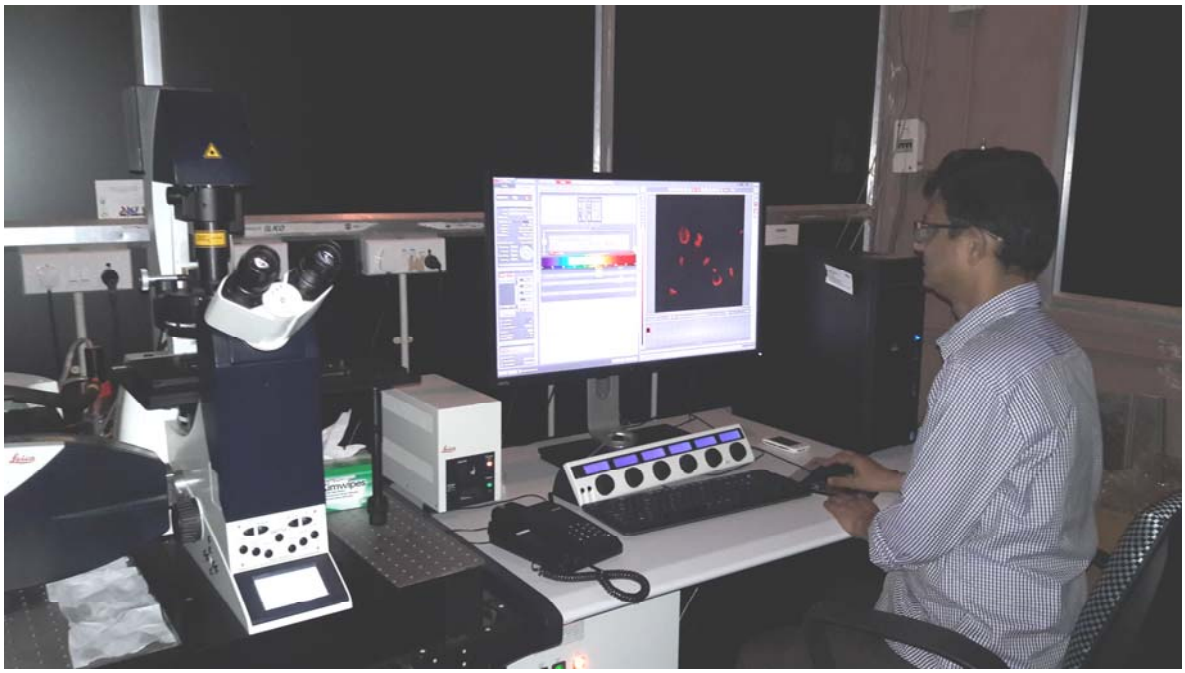
Beginning with a small facility to train postdoctoral fellows in the late ’80s, the CIF has grown in size and complexity. The facility provides an opportunity for researchers from this institute but also from neighboring ones to use not just high-end equipment such as a Confocal Microscope, NMR and Mass 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 equipments, 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 Unified Academic campus. The CIF generated revenue from external sources during this period. The number of external requisitions reached high day by day.



LIST OF PERSONNEL

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).

Staff Members : Ranjan Kumar Dutta, Smriti Ranjan Maji, Mrinal Das, Swaroop Biswas, Sheolee Ghosh Chakraborty, Amarandra Nath Biswas, Pallab Chakraborty, Souvik Roy, Alpana Chattopadhaya

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.

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

(CTAR/CAF)

(The Centre was inaugurated by Dr. Harsh Vardhan, Honorable Union Minister, Ministry of Science & Technology & Earth Sciences, Govt. of India on 2nd May, 2015)

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)

Bose Institute was founded over a 100 years ago, based on the ideals and belief of the legendary scientist, philosopher and doyen of Indian science, Sir J. C. Bose. Sir Bose, while delivering his landmark inaugural address on Nov. 30, 1917 named “The Voice of Life” expressed his belief towards the theory of “borderless science”, which he proved through his simple, yet elegant experiments, for eg his experiments on discovery of microwaves, and further how electrical waves could actually lead to chemical changes in not only animals, but also in plants, ultimately producing a biological function. He also implied that search of scientific truth is not possible through compartmentalization of science between Life and Non-life. And that knowledge obtained through scientific endeavors of subjects like Physics and Chemistry could be very well applied to understand basic and fundamental concepts of Life sciences, as well. Extending this ideology of translational science, the 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.**

LIST OF PERSONNEL

In Charge: Prof. Kaushik Biswas, Executive Chairman, Dr. Kuladip Jana, Scientist-in-Charge

Staff members: Arindam Basu, Ranjit Das

FALTA EXPERIMENTAL FARM

In-charge : Prof. Pallob Kundu

Overview

Bose Institute Falta Experimental Farm (FEF) is located at Falta Village of South 24 Parganas, which is about 80 km away from Bose Institute Unified Academic Campus. Several crops are raised throughout the year in this farm. Our proper planning, wholesome efforts and scientific approaches enabled production of multiple excellent quality and hygienic crops every year. In addition, rural biotechnology related research and training programmes are conducted in this farm.

This year, we have cultivated rice, cucumber, broccoli, bean, okra, knolkhol, Bokchoy, bitter gourd, bottle gourd, ridge gourd, radish, green pea, kakri, snake gourd. Additionally, coconut, green coconut, and different varieties of mango were harvested from trees around the campus. We have continued medium scale production of mushroom and spawn for in house cultivation and supply to enthusiastic farmers. Our staff members were able to collect mango-honey through apiculture in the farm. Falta Farm produced vermicompost is highly popular among all members of Bose Institute. All products obtained from the farm are sold at a reasonable cost to members of Bose Institute and the excess to the local market. All these activities led to significant amount of revenue generation.

National Science Day Celebration at the FEF:

National Science Day is celebrated every year on 28 February to commemorate the discovery of the 'Raman Effect'. On this occasion, with the encourgament of the Director, Bose Institute, we had organized one-day scientific programme for local school students on the topic: Commonly used Biotechnological Methods. Eight schools from the locality with 80 students as well as several teachers had participated in the programme. Following are the name of the schools participated in the programme: Parulia Shi Ramkrishna High School, Parulia, Diamond Harbour; Chanda High School, Khord-VI, Diamond Harbour-2 block; Bhadura High School Bhadura, Diamond Harbour, Khandalia High School, Kalatalahat-XIV, Diamond Harbour-2 block, Harindanga High School,Falta, South 24 Parganas; Falta Vivekananda Adarsha Vidyalaya, Falta, Southa 24 Parganas; Dostipur High School, Dostipur, South 24 Parganas; Mahirampur High School, Rasulpur, Falta, South 24 parganas.

Prof. Gaurab Gangopadhyay delivered two lectures on 'Scientist J.C.Bose - his transformation from a physicist to plant biologist' and 'Contribution of Bose Institute in modern plant biotechnology research' and demonstrated various biotechnology related techniques. Prof. Shubhra Ghosh Dastidar delivered a lecture on 'Computer simulations: A powerful tool to watch the molecules and their realistic behaviour' and spent long time addressing various queries of students. Mr. Sayan Mal, SRF; Mr. Himadri Das, SRF; and Mr. Raghubir Singh, SRF, also served as resource persons and demonstrated molecular biology, cell biology techniques. Mr. Shuvankar Roy and all casual staff members of the farm had actively helped in the organization of the event and demonstration of mushroom cultivation, apiary, vermicomposting etc. The programme was successful and all schools expressed their gratitude for such an event at the farm.

Rural Biotechnology based extramural project:

The project entitled "**Improvement and broad-scale implementation of different biotechnology-oriented programmes for the socio-economic upliftment of Scheduled Tribe 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 the knowledge of modern agricultural practices to the marginal people of West Bengal. We are in the process of recruiting several staff members and NGOs in the project.

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FALTA EXPERIMENTAL FARM (FEF)

Prof. Uday Bandyopadhayay, Director, Bose Institute and Monks of Ramakrishna Mission Institute of Culture participating in tree plantation at the Falta Experimental Farm

Crops produced in the Farm.

Celebration of National Science Day at the FEF: Prof. Gaurab Gangopadhyay delivering a lecture.

Celebration of National Science Day at the FEF: Prof. Shubhra Ghosh Dastidar delivering a lecture.

Various activities during Celebration of National Science Day at the FEF.

J. C. BOSE CENTRE
(PUBLICATION AND MUSEUM)

OVERVIEW

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.


Shri Visvajit Saray, Addl. Secretary & FA, DST, GoI visited the Main Campus of Bose Institute and J.C. Bose Museum on 08.02.2022

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. The Orientation Booklet provides a detailed account of the Ph.D. Course Work mandatory for the scholars entering Bose Institute for their doctoral research work. 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.50.00; 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.

Paticipation in Science Exhibition/ Fairs:

1. Bose Institute participated in the **24th National Science Exhibition, Kolkata 2022, organised by Central Calcutta Science & Culture Organiztion for Youth,** from 28.10.2021 to 31.10.2021 at Science City, Kolkata.

2. Bose Institute participated in the **Mega Science Technology and Industry Expo of 7th IISF 2021** held at Panaji, Goa from 10th-13th December, 2021. Prof. Uday Bandopadhyay, Director, BI actively attended the Science Festival alongwith Faculty members and staff of BI.

3. Bose Institute participated in the 45th International Kolkata Book Fair 2022 held in Central Park, Salt-lake from 28.02.2022 to 13.03.2022.

India International Science Festival (IISF) 2021

Bose Institute participated in the **Mega Science Technology and Industry Expo of 7th IISF 2021** held at Panaji, Goa from 10th-13th December, 2021. Prof. Uday Bandopadhyay, Director, BI actively attended the Science Festival alongwith Faculty members and staff of Bose Institute.

Bose Institute participated in the 45th International Kolkata Book Fair 2022 held in Central Park, Salt-lake from 28.02.2022 to 13.03.2022.

LIST OF MEMBERS

Prof. Gaurab Gangopadhyay (Chairman), Prof. Gautam Basu, Prof. Somshubhro Bandyopadhyay, Prof. Achintya Singha, Shri Tarun Kumar Maji, Dr. Ishani Chatterjee.

MADHYAMGRAM EXPERIMENTAL FARM (MEF)

OVERVIEW

Madhyamgram Experimental Farm (MEF) is the translational research hub of Bose Institute. Its main component is 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: Screening of the mutant lines and generation of mutant seeds of *Arabidopsis* at dedicated green-house (21ºC-23ºC) in connection to the research programme on "Role of nuclear architectural protein in modulating chromatin structure during pollen development". Growing of transgenic lines of rice at dedicated green-house (28ºC-30ºC) in connection to the research programme on "Understanding the regulatory role of rice epigenome during abiotic stress (salinity and cold)".

Prof. Gaurab Gangopadhyay: Inter-specific hybridization of Sesame for fungal stress tolerance, synchrony in pod maturation, and a better oil profile.

Prof. Pallob Kundu: Maintenance of VIGS-mediated knocked down and other transgenic lines of tomato in the transgenic green-houses in connection to the research programme on the "Investigating gene-regulatory circuit active during biotic stress response in tomato".

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.

LIST OF PERSONNEL

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

Staff members: Pulak Kr Roy, Asis Kumar Dalal, Sk Inal Ali, Mahesh Dasgupta, Laxmi Kanta Pradhan, Bhanu Kisku

Research personnel (project): Dr. Sambit Datta, RA

BOSE INSTITUTE LIBRARY

Unified Academic Campus Library

Members of the Library Committee:

Prof. Srimonti Sarkar, Dept. of Biochemistry, Chairperson
Prof. Pallob Kundu, Div of Plant Biology, Member
Prof. Jayanta Mukhopdhyay, Dept. of Chemistry, Member
Prof. Atin Kr. Mandal, Div of Molecular Medicine, Member
Prof. Shubhra Ghosh Dastidar, Div of Bioinformatics, Member
Prof. Achintya Singha, Dept. of Physics, Member
Mr. Achintya Mukherjee, Accounts Officer, Member
Mr.Vikas Kumar, Audit and Finance Officer, Member
Dr. Arun Kumar Chakraborty, Librarian & Convener (Superannuated on 31-12-2021)

Staff Members :

Ms. Ananya Raha
Ms. Sumita Dey
Ms. Tanusri Bhattacharyya

OVERVIEW

The Institute Library system is one of the best 'Science Reference' Libraries in Eastern India, set-up in 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. Library provides latest information to the BI faculty, researchers, staff members and students of Integrated M.Sc.-Ph.D. programme on Life Sciences and Physical Sciences. Library extends its physical Library facilities as well as online resources access to other Institutions /Universities /R&D organizations in and around Kolkata. 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.

Library aims to

- Reach informational and educational needs of its user community by providing pinpointed relevant personalized information services.
- Continue exchange program of the institute with other national and international organization.

The library total collection of reading materials is 45140 as on 31.03.2021 and subscribed to more than 5000+ online journals packages from more than 50 Publishers. Library also subscribed to online-only full–text journals / databases of different academic societies and national and international publishers. Library subscribed to e-books packages. All subscribed e-journals can be accessed from 1997 onwards. Library is also having very old rich print collection of important science journals.

Library Activities:

Collection Development:

- Books
- Bound Volumes of Journals
- Theses
- Online Journals subscribed
- Online journals through National Knowledge Resource Consortia (NKRC)
- Scientific Software(s)
- Back Volume Journals (online)
- Sir J.C. Bose Collection
- Reports, Newsletters, Annual Reports of other Institute(s),
- Publication of Bose Institute etc.
- A collection on Hindi books has also been expanded as advised by Official Language Implementation Committee.
- A few Books on Bengali literature.

1. Access Management of Resources

All Library resources can be accessed by Institute faculty / scholar from all campuses of Bose Institute. Library also provides Off Campus Access to its resources to Institute faculty members. Library uses open sources software KOHA for Web-OPAC and D-Space for IDR. For access management library maintains servers.

2. Resources of Bose Institute Library

Resources of BI Library can be accessed from Bose Institute Library Portal (www.jcbose.ac.in/library).

A. Journals Resources

Library subscribed to major publishers journals such as ASM, ACS, Life Sciences Reviews, Cell Press journals of Elsevier, Science Direct, Nature Journals, John Wiley & Sons, Inc, IOP, AIP, APS, Cambridge Journals Online, The Company of Biologists. EDP Sciences, Emerald Publishing Group /MCB University Press, Genetics Society of America, IEEE, Indian Academy of Sciences, Informa Healthcare, Japan Institute of Heterocyclic Chemistry, Japan Publications Trading Co. Ltd., Japanese Society of Allergology, Springerlink, Landes Bioscience, Microbiology Research Foundations, National Academy of Sciences, Physical Society of Japan, Portland Press, Rinton Press, Rockefeller University Press, Royal Society of Chemistry / Turpin Distribution UK, Thieme, Landes Bioscience, Karger. Current Protocols (Online) of John Wiley / Blackwell, Annual Reviews Online (Back volume), Methods in Enzymology (Online) etc.

B. Back Volume Journals:

Elsevier Backfiles on ScienceDirect	Wiley Blackwell Journal Backfiles
1.Biochemistry, Genetics and Molecular Biology	1. Biotechnology, Biochemistry, and Biophysics
2.High Energy Physics	2. Physics
3. Cell Press	3. Immunology
	4. Microbiology

C. E-Books Collection:

Library also has few E-books collection.

D. Databases:

Library also subscribed to different databases such as :

- SCOPUS the largest abstract and citation database of research literature and quality web sources of Elsevier.
- Clarivate Analytics Web of Science Core Collection: Citation database in the Sciences, Social sciences, Arts, and Humanities.
- SciFinder®: a research discovery tool that allows us to explore the comprehensive and authoritative CAS databases.

E. Scientific Softwares services by Library:

Sl. No.	Software	Publishers
1.	ENDNOTE X8 Multi-User Download-Research Software	Clarivate Analytics
2.	Upgradation of Sigmaplot 11 Software to Sigmaplot version 14	Starcom Information Technology Limited
3.	iThenticate-anti plagiarism software	Turnitin

F. Resources through NKRC (http://nkrc.niscair.res.in/indexpage.php):

Library has joined with the National Knowledge Resource Consortia (NKRC) since 2008 which is joint consortia of CSIR and DST Institutes for accessing online resources. 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 could fulfill faculty / scholar demands for article resources from CSIR / DST Institutes subscribed journals. BI Library also provides article resources to all faculty/ scholars of DST / CSIR Institutes and also other institutes in India.

G. New Addition(s) in 2021-2022:

- Thesis added : 20nos.

3. Services :

Reader's Service	The library is open to all faculty members, research scholars, students of Integrated M.Sc.-Ph.D. programme and staff members of BI for reading and consultation during institute working hours. Faculty members / scholars can access (24x7) E-resources from any of the seven campuses of Bose Institute. Faculty members also can access E-resources from off campuses/ home access (24x7). Faculty/Scholars from different Universities/Institutes in and around Kolkata can access BI library resources from CB Campus and MB campus Library.
Lending Service	Faculty members, scholars, students, staff can access library resources during Institute working hours.
Technical Query Service	Library responds to any query related to information regarding research insights, reference management, database(s) access, Software services or any access related issues of subscribed content or using Library OPAC/IDR etc.
Document Delivery Service	Library provides article resources to all faculty/ scholars of DST / CSIR Institutes and also other institutes in India.
Institutional Membership	The library used to have membership of various National and International organization(s) - Biomed Central upto March, 2020
e - Journals Access	The library provides access to electronic journals subscribed by Library as well as subscribed through National Knowledge Resource Consortia (NKRC).
User Awareness Programme	Library conducts user orientation programmes time to time for the benefit of users and optimal utilization of subscribed resources. User orientation programme also includes “Reference management” for publications, citing references in thesis, using databases, citation report, h-index compilation, using different scientific software, using of anti-plagiarism software, grammar checking software etc.

Reprographic Service	The library provides reprography services to its users. Photocopy services are provided to all its users of the Institute and outside users also.
Plagiarism Checking Service	Library provides plagiarism checking service of articles, book chapters, MSc. Ph.D. Dissertations. Libray also provide service of Thesis plagiarism checking for research scholars of the Institute.
Bibliographic & Full-text Search Services	Library provides Bibliographic and full text search services from various databases like Web of Science, Scopus, SciFinder, PubMed etc. for its users and also outside users.
Software Services	Library provides access to various Scientific Softwares (mentioned above in F.) from its different campuses.
WEB-OPAC	Online access to Library holdings data is available through WEB-OPAC (Online Public Access Catalouge). Users have the facility to browse and search the Library database and view the status of a document.
Institutional Repository	Library has created Institutional Repository using Dspace Software which is an open Access initiative. It is a digital repository of Thesis Collections of the Institute, Publication of Faculty members, Annual Reports of the Institute, J C Bose Collection, D M Bose Collection, Transactions etc.
New Initiatives	Library has become the participating library in the NDL (National Digital Library) project, initiated by MHRD, Govt of India.

Further Academic Activities:

Library also provides training to library school students like Internship programme to LIS school students, training to Library professionals, advising different libraries for developing modern automated library, organizing training programmes / workshops for LIS professionals etc.

SHYAMNAGAR EXPERIMENTAL FARM

Shyamnagar Campus, Bose Institute

OVERVIEW

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

OVERVIEW

The Workshop is the nucleus of the maintenance activities including the proposed projects at the seven campuses of the Bose Institute. Workshop is situated at Main 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 2021-22:-

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.

LIST OF PERSONNEL

Staff Members : Raju Chandra Paul ,Workshop Superintendent, Abdul Rahaman Molla, Pranab Banerjee, Sanjoy Santra, Kodan Das, Baidya Nath Murm.

OUTREACH AND MAN POWER DEVELOPMENT


OVERVIEW

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.

Rural Biotechnology Based New Extramural Project:

A new project proposal was developed and sent to the DST for funding consideration. The project entitled "**Improvement and broad-scale implementation of different biotechnology-oriented programmes for the socio-economic upliftment of Scheduled Tribe community of West Bengal", PI:** Prof. Pallob Kundu; **Co-PI:** Prof. Gaurab Gangopadhyay; **Co-PI:** Prof. Shubho Chaudhuri, Division of Plant Biology, has been sanctioned under Tribal Sub Plan of DST SEED programme. Total amount of sanctioned fund is Rs. 1419 lakh for 3 years. This project will allow us to continue our biotechnology-based outreach activities and bring the knowledge of modern agricultural practices to the marginal people

of West Bengal. Moreover, this programme will open up the possibility of active collaboration with other organizations and Universities of West Bengal. The objectives of the project are as follows:

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 Training programme at Falta Experimental Farm:

This year Bose Institute celebrated Golden Jubilee of Department of Science & Technology (DST), by organizing a Hands-on training programme on Mushroom Cultivation, Apiculture, Vermicompost Production & Fishery, during 17-19 March, 2021, at Falta Experimental Farm, along with other programmes. Among the 20 selected participants, 50% were of SC/OBC category, 50% were women and all were EWS category. Experts from Bidhan Chandra Krishi Viswavidyalaya, ex-faculty of Fisheries Research Institute, award winning farmers and block level agricultural workers served as resource persons. All participants were provided snacks and lunch during the duration of the programme and received a certificate along with some materials that would encourage them to initiate small scale cultivation. The Director, Dean, Departmental Heads, other faculty members and Registrar also attended the valedictory ceremony. The whole programme has been enjoyed by all participants, and all trainees have appreciated our efforts.

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.

French Embassy, Dr. Didier Raboisoon, Attaché for Scientific Cooperation, Embassy of France in India, Delhi , Dr. Meenakshi Singh, Scientific Coordinator, Embassy of France in India, Delhi and Mr. Amitava Das, Academic and Scientific Coordinator, Embassy of France in India, Kolkata visited the Unified Academic Campus, Bose Institute on 21.03.2022 to meet the Director, BI. The purpose of visit was to discuss and explore the possible collaboration between India and France in the field of training, research and innovation in healthcare.

BOSE INSTITUTE

BOSE INSTITUTE

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

Main Campus
93/1 APC Road
Kolkata-700 009, West Bengal
EPABX: 91-033-2303-0000

Unified Academic Campus
EN-80, Sector-V, Salt Lake
Kolkata-700091, West Bengal
EPABX: 91-033-2569-3200

Centenary Campus
P-1/12, CIT Scheme VII (M)
Kolkata-700054, West Bengal
EPABX: 91-033-2569-3200