BOSE INSTITUTE

KOLKATA

Bronze relief of the Sun-God within the Historic Lecture Hall

ANNUAL REPORT

2020-2021

BOSE INSTITUTE ANNUAL REPORT 2020-2021

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FROM THE DIRECTOR'S DESK

BOSE INSTITUTE ANNUAL REPORT 2020-2021

FROM THE DIRECTOR'S DESK

I take immense pleasure to present the Annual Report of Bose Institute for the year 2020-21, truly depicting the dedicated endeavours of this prestigious Institute for attainment of excellence in multi-disciplinary research areas, to develop solutions to the national problems with the objective to develop and disseminate knowledge freely for the benefit of the mankind.

I convey my heartfelt congratulations to all the faculty, staff and students for their tireless efforts during this stressful period of COVID-19 pandemic resulting lockdown, disruptions, delays, economic hardship, even when our survival was quite vulnerable.

It is needless to mention that knowledge is power and therefore has remained one of the most significant driving forces of sustaining human existence. New and effective ways of thinking have emerged considerably within the disciplines of science, philosophy, psychology and education. An emerging movement is there to transcend the fragmentation of knowledge connected with disciplinary specialization via interdisciplinary, multidisciplinary and transdisciplinary approaches. Academic researchers and research council bureaucrats need to pay greater attention that 'knowledge production', 'knowledge transfer' and 'knowledge dissemination' have become main commodities of the increasingly competitive global knowledge market economy. The systematic knowledge shifts of the last century are crucial aspects of complex processes that are least understood in terms of their significance for the future of ideas and the culture of education. These independent and divergent, yet interconnected movements prove the way for the emergence of more vibrant as well as pluralistic approaches to education and knowledge futures. In this regard, one must admit that education is one of the most pivotal weapons to fight against socio-economic maladies like poverty and inequality. Education is the key to augment the country's global competitiveness maintaining international quality in higher education as well as acceptability and sustainability of skilled manpower. Therefore accessibility to quality education for all, particularly for the poor, weaker sections and rural population, is key

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to the social and economic development of the country. Besides, apprehension of inefficaciousness and dilution in quality of education to online modules appears to be an important impediment on the way of accommodating required changes in the system. So, in order to disseminate the benefit of higher education at large, it is inevitable to reduce inequalities of access to higher education substantially. The inequalities vary from quality to gender, from technology to region. Notwithstanding its greater size, the higher education system in our country is far away from the reach of the bulk of the socially, economically and culturally underprivileged section of the population and fails to meet the increasing demand for higher education, especially from weaker sections of the society including economically, culturally and educationally backward people.

To bequeath the monumental scientific tradition to the nation, Aharya J. C. Bose, the doyen of Modern Indian Science, founded Bose Institute in the year 1917. In fact, the establishment of Bose Institute can rightly be termed as one of the earliest manifestations of India's quest to establish the nation's self-esteem as an equal to the colonizing West. Bose Institute pursues 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.

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. The major accomplishments of Bose Institute are focussed in the areas viz. Neurodegenerative Disorders, Cancer, Infectious Disease, Environmental Science and Microbiology, Bioinformatics, Plant and Agricultural Science, Physical Science, COVID-19 specific studies, Autoimmune and Metabolic Disorders etc.

Bose Institute had published 258 numbers of full length peer reviewed research papers in referred journals and 21 Books/Book Chapter/Invited Reviews during the year 2020-21. The Institute had produced 17 Ph.D students and trained 16 research manpower (B.Tech., M.Tech., M.Sc., Diploma etc.) who are working at various renowned institutes all over the world.

I may mention a considerable number of significant global and national collaborations with Bose Institute viz. *Study of cosmic ray interactions and cosmic ray aerosol cloud connection in the context of regional climate change in the eastern Himalaya; Indo-FAIR Co-ordination Centre:*

FROM THE DIRECTOR'S DESK

Oversee the designing, manufacturing and supply of in-kind items for accelerator and coordinate Indian Scientific activities at FAIR, Germany; Compressed Baryonic Matter – Muon Chamber (CBM-MUCH): Research on suitability of gas electron multiplier (GEM) foils as a high-gain detector and development of Muon Chamber for Compressed Baryonic Matter experiment at FAIR, Germany; A large ion collider experiment (ALICE) - upgrade, operation and utilization : Research on central readout unit and development of hardware for ALICE upgradation and exploring the new physics at higher energies, CERN, Switzerland; The development and implementation of sensors and treatment technologies for freshwater systems in India: Development of biosensors for detecting Endocrine Disrupting Compounds (EDC) in freshwaters for providing safe drinking water; Centre of Excellence in Bioinformatics: Investigate biological processes using computational tools, data mining, database management and statistical analyses; DBT-NOW: Unravelling 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 plasmonic photothermal 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; Fabrication of Infrared Photo-detector based on 2D systems and Tuning the Detection Windows by coupling with Nanostructures with Jadavpur University etc.

Bose Institute has been in the forefront of establishing many interdisciplinary areas, such as, bioinformatics/computational biology, Biophysics, High-altitude laboratories for physical and life sciences. Besides, COVID-19 specific studies were conducted quite appreciably by the scientists of the Institute viz. *(i) A study was conducted on the impact of over-spraying of hypochlorite solution (as surface disinfectant to stop spreading of Covid-19) on the atmospheric chemistry and public health (ii) Identified drugs/molecules which are already FDA approved (pharmaceuticals and nutraceuticals) for some diseases and now could be repurposed against COVID19 as well. These computational predictions, using molecular simulations and artificial intelligence, are already published and open for further testing by the scientific community (iii) High-throughput virtual screening of repurposing drugs and their characterization with SARS CoV-2 E-protein using high-resolution NMR spectroscopy.*

A number of lectures/colloquia/webinars by eminent scientists through virtual mode were hosted/organized by Bose Institute viz. *Prof. Mahan Maharaj, School of Mathematics, Tata Institute of Fundamental Research, Mumbai, delivered Professor D M Bose Memorial Lecture*

FROM THE DIRECTOR'S DESK

2020 on "Hyperbolic Geometry and Chaos in the Complex Plane" on 26-11-2020, the 136th Birth Day of Professor Debendra Mohan Bose; Dr. Gopal Mukherjee, Variable Cyclotron Energy Centre, Kolkata, delivered a colloquium talk on "Manifestation of Classical Motions in the Quantum World of Nuclei" on 24-09-2020; Dr. Oommen Varghese, Uppsala University, Sweden delivered a colloquium talk on "Designing biomimetic 3-D scaffold for regenerative medicine: A strategy for bone tissue engineering" on 18-02-2021; Dr. Janos Kriston-Vizi, University College London delivered a webinar talk on "Imaging informatics in Biological Research and Drug Discovery" on 23-09-2020; Prof. Abhijit Majumder, Wayne State University, Michigan, USA delivered a webinar talk on "A Framework for Precision Exploration of the Quark Gluon Plasma" on 03-11-2020; Dr. Areejit Samal, Computational Biology Group, The Institute of Mathematical Sciences, Chennai delivered a webinar talk on "A network prospective on biologically-relevant chemical spaces" on 07-12-2020; Dr. Birendranath Banerjee, Scientist and Founder & MD in DNA Life Sciences Private Limited, delivered a webinar talk on "21st Century Life Style monitoring: A giant leap from Blood to DNA" on 21-12-2020; Dr. Nimesh Gupta, Scientist, National Institute of Immunology, New Delhi, delivered a webinar talk on "A deep dive into the vaccines and its immunology" on 14-01-2021; Prof. Tamir Tuller, Head of the Laboratory of Computational Systems and Synthetic Biology, Tel Aviv University, delivered a webinar talk on "Computational modelling of novel gene expression codes and their applications" on 17-02-2021.

Last but not the least, I am really indebted to Bose Institute Council Members especially to our Hon'ble Chairman for kind support, wisdom, vision and valued guidance to translate the ideas/plans into practice for all round development of the Institute maintaining integrity and sustainability. I am grateful to our funding agency, Department of Science and Technology, Government of India, for their generous support in terms of incessant flow of funds as well as administrative and financial assistance ensuring to nurture a research-conducive environment in the Institute and also enabling us to render exemplary contributions by fulfilling the research needs of the country.

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

MANAGEMENT OF THE INSTITUTE

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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

Members of the Research Advisory Council (RAC)

Prof. D. N. Rao, *Chairman*
Department of Biochemistry, IISc, Bangalore

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, Secretary, Bose Institute, Kolkata

ABOUT BOSE INSTITUTE

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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

ABOUT BOSE INSTITUTE

need for an institute, which will cater to the need generations to come. He found generous support in his resolve from stalwarts like Rabindra Nath Tagore, Sister Nivedita, Gokhale, and Mahatma Gandhi, to name a few.

After retirement from Presidency College in Kolkata (then Calcutta), J. C. Bose devoted himself entirely to the establishment of this haven, Bose Institute. He committed the savings of his and his wife Lady Abala, and the inheritances to this task but that were, expectedly inadequate. Many patriots, some of whom named above, helped and contributed him at that time. J. C. Bose even resorted to giving scientific demonstration-lectures all over India. The organizers charged the admission fees to help found the Institute. Thus, the establishment of Bose Institute is the manifestation of India's hope to establish the nation's self-esteem as an equal to the colonizing west. On 30th November 1917, which coincided with his birthday, J. C. Bose inaugurated Bose Institute at the premises located at 93/1, Upper Circular Road (now A. P. C. Road) adjacent to the Rajabazar Science College.

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.

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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 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:

Neurodegenerative Disorders:

- Studies on the possible treatment of the severity of brain disorders such as Huntington's, Parkinson's and Spinocerebellar complications using protein engineering and natural products.
- Identification, through structural studies, of key steps in fibril formation mechanism that can be targeted for drug development for Protein aggregation diseases related to Alzheimer's, Parkinson's and Type-2 Diabetes.

Cancer:

- Studies on the possible treatment of Cancer using the biomolecules present in the central nervous system (such as glycolipids GM2), as potential targets.
- Investigating the role of regulatory RNAs in cancer: LncRNA loci harbouring SNPs has been elucidated for the three most prevalent female cancers in India viz. breast, cervical and ovarian cancer.

Infectious Disease:

- Identification of a drug target in ***Mycobacterium tuberculosis***, causative agent of tuberculosis.
- Understanding of the association of homoplasy and pleiotropy with the drug-resistant of Mycobacterium tuberculosis using Genomic analysis.
- Deciphering the functional mechanism of the transcription factor delta in ***Bacillus subtilis*** (bacteria).
- Development of carbohydrate derived vaccine candidates for the treatment of bacterial infections such as meningitis, salmonellosis and enteric diseases.

Environmental Sciences and Microbiology:

- Bose Institute has been selected as the Institute of Repute for mitigation and control of air pollution program in West Bengal under national clean air program of Govt. of India.
- Detailed study of impact of air pollution on the low lying clouds over eastern Himalaya.
- Understanding of important chemical aspects of plant-microbe interaction in the context of mangrove vegetation, and their ecological implications.
- Discovery of environment-guided thermal endurance in natural populations of mesophilic bacteria stochastically introduced to extreme environments of Trans-Himalayan hot springs.
- Geomicrobiological explorations of the Arabian Sea oxygen minimum zone sediments revealed a central role of polythionates in the sulfur cycle, besides discovering crypto-aerobic carbon-degraders and sulfur-oxidizers in these anoxic (sulfidic) sediments.
- Biochemical and molecular characterization of catabolic gene regulation in the degradation of endocrine disrupting chemicals.

MAJOR ACCOMPLISHMENTS

Bioinformatics:

- Development of databases for applications in healthcare:
  (i) ClinicLSNP: has been hosted within LncRBase V.2 (2nd version of lncRNA database has been launched) which contains detailed information about these SNPs.
  (ii) DRAGdb: A manually curated repository of mutational data of drug resistance-associated genes (DRAGs) across pathogens (ESKAPE), which are specially relevant for Mycobacterium tuberculosis (MTB).
- Obtained molecular insight into the thermodynamic basis of the membrane anchoring capacity of the peptides in terms of residue composition and polar characteristics.

Plant and Agricultural Science:

- Characterization of cold and salt tolerant lines of ***Oryza sativa*** L. ssp. ***Indica*** (**rice**) using high-throughput genomic approach.
- Development of inter-specific hybrid sesame (**emerging oilseed crop with high anti-oxidant value**) with high lignan content in oil and tolerance to charcoal rot in the seedlings.

Physical Science:

- Complete characterization of quantum teleportation using two-qubit states in terms of fidelity and fidelity deviation.
- Physics analysis along with Designing as well as characterization of different kinds of detectors for high energy physics International collaborations (ALICE at CERN and CBM at FAIR, Germany) and cosmic ray experiments.
- Demonstration of the tuning of light-matter coupling in exciton-plasmon (2D-0D) hybrid system for application in optoelectronics devices.

COVID-19 specific studies:

- A study was conducted on the impact of over-spraying of hypochlorite solution (as surface disinfectant to stop spreading of Covid-19) on the atmospheric chemistry and public health.
- Identified drugs/molecules which are already FDA approved (pharmaceuticals and nutraceuticals) for some diseases and now could be repurposed against COVID19 as well. These computational predictions, using molecular simulations and artificial intelligence, are already published and open for further testing by the scientific community.
- High-throughput virtual screening of repurposing drugs and their characterization with SARS CoV-2 E-protein using high-resolution NMR spectroscopy.

Autoimmune and Metabolic Disorders:

- Studies on key immunologically relevant macromolecular complexes using X-ray crystallography and Cryo-Electron microscopy giving new insights in inflammatory and autoimmune disorders.
- Identified a non-toxic and serum stable heptapeptide that inhibits insulin amyloid fibrillation, implicated in Type II Diabetes.
- Found that andrographolide can bind to ATP binding pocket of VEGFR2 receptor to suppress angiogenesis in malignant carcinoma.

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.

IMPORTANT INTERNATIONAL AND NATIONAL COLLABORATIONS

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International Collaborations - Mega Projects

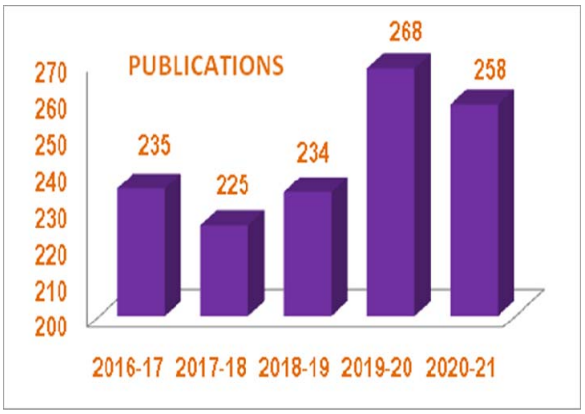
- **F**acility for **A**nti-proton **I**on **R**esearch (**FAIR**) is one of the largest accelerator facilities being built at Darmstadt, Germany. This will facilitate research in low energy atomic physics to high-energy heavy ion collision and physics with high energy anti-protons under the same roof. 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 scientists in 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.

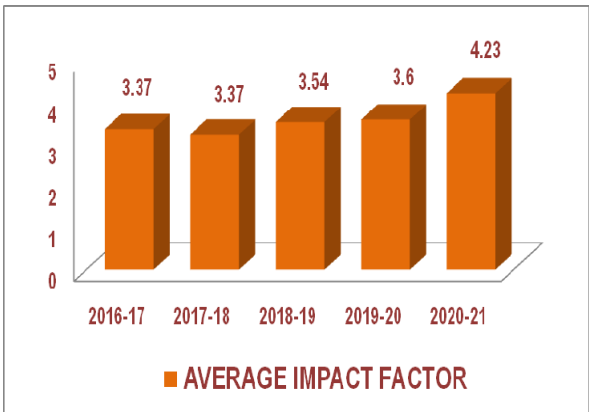
National Collaborations

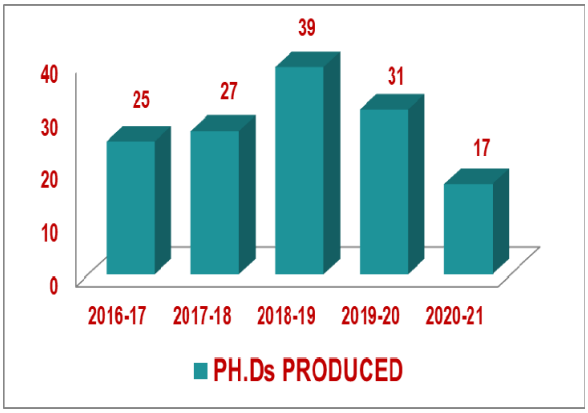
- The development and implementation of sensors and treatment technologies for freshwater systems in India : Development of biosensors for detecting Endocrine Disrupting Compounds (EDC) in freshwaters for providing safe drinking water. Also, focusing to engineer biodegrader bacteria for bioreactor-based remediation of EDC in industrial wastewater.
- 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 plasmonic photothermal 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 2020-21	258
AVERAGE PUBLICATION IMPACT FACTOR 2020-21	4.23
BOOKS/BOOK CHAPTERS/INVITED REVIEWS	20
PH.D. AWARDED 2020-21	17
NO. OF MANPOWER TRAINED (B.TECH., M.TECH., M.SC., DIPLOMA ETC)	16
NO. OF SEMINARS, TRAINING, CONFERENCES, WORKSHOPS, WEBINARS ETC.	11



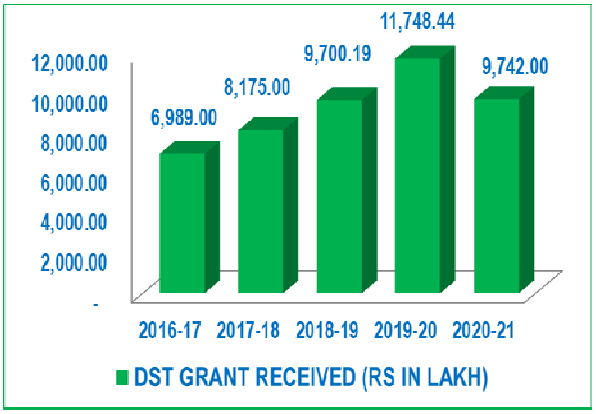


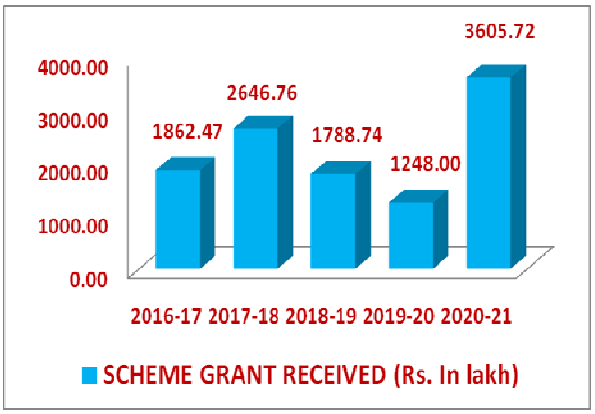


FINANCIAL INPUTS

DST GRANT RECEIVED 2020-21	9,742
EXTRA MURAL GRANT RECEIVED 2020-21	3,605.72
NO. OF ON-GOING EXTRA MURAL PROJECTS 2020-21	57
AVERAGE EXTRA MURAL PROJECTS PER FACULTY	1.50

(Rupees in Lakh)





LIST OF PERSONNEL (ADMINISTRATION)

Prof. (Dr.) Uday Bandyopadhyay, Director

Prof. Rajarshi Ray, Registrar (Officiating)

Noreen Bhattacharjee, Deputy Registrar

Sougato Banerjee, Assistant Registrar

Achintya Mukherjee, Accounts Officer

Vikash Kumar, Audit & Finance Officer

Rina Roy
(Retd. on 31.12.2020)
Vineet Kumar Tandon
Debdas Nandi
Sudam Ch. Jana
Satyaswaroop Behara
Nitin Sharma
Sanjoy Krishna Chaki
(Retd. on 31.03.2021)
Sujata Roy
Biplab Malakar
Animesh Jana
Atanu Deb
Mahendra Nath Shee
Khairul B. Mollah
Kali Charan Turi
(Retd. on 28.02.2021)
Sarda Devi
Bablu Mondal
Goutam Behera

Sisir Chakraborty
(Retd. on 31.07.2020)
Supriya Das
Somnath Das
Amitava Bhattacharyya
(Retd. on 31.07.2020)
Gopa Dasgupta
Debasish Koley
Angshuman Bhowmik
Dr. Ishani Chatterjee
Bipul Kr. Nag
Ratan Saha
Sumanta Ghosh
Kanai Hazra
Madhu Sudan Marrick
(Retd. on 30.04.2020)
Chandra Kanata Sasmal
(Retd. on 31.03.2021)
Rajbrat Ram
Gourango Paramanick

Mantu Bhattacharya
Tarun Kumar Maji
Kamal Sing
Ruby Sarkar
Babli Marrick
Ananya Malgope
Rina Das
(Retd. on 31.08.2020)
Sukanta Chakraborty
Arjun Das
Arpita Bose
Shaubhik Ghosh
Tuhin Saha
Sanat Kumar Dhara
Sk. Md. Kalu
Prafulla Bhuiya
Duryodhan Nayak
Raj Kumari Balmiki
Hemanta Kr. Sahoo

PH.D. AWARDED

Biochemistry

- **Ananya Jana:** Identification and Characterization of Proteins Involved in Vesicular Trafficking Events of *Giardia lamblia.* Supervisor: Prof. Srimonti Sarkar.
- **Sayani Sarkar :** A Biochemical And Structural Study on Ubiquitination Activities by RING E3 Ligases. Supervisor: Prof. Ajit Bikram Datta.

Bioinformatics

- **Aritra Deb**: Role of Regulatory RNAs in Mammalian Development. Supervisor: Dr. Zhumur Ghosh.
- **Debangana Chakravorty :** Bioinformatics Based Knowledge Map of C-MYC Regulatory Networks and Modulators. Supervisor: Dr. Sudipto Saha.

Biophysics

- **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.
- **Bhisma Narayan Ratha:** Peptide Based Biophysical Studies and Inhibitor Designing for Signalling and Amyloidogenic Class of Proteins. Supervisor: Prof. Anirban Bhunia.

Environmental Sciences

- **Arindam Roy:** Physical and Chemical Characterization of Wet Precipitation and its Interaction with Aerosol over Eastern Himalaya, India. Supervisor: Dr. Abhijit Chatterjee

Microbiology

- **Satamita Deb:** Exploration of Microbial Regulatory Modules in Gene Expression for Biotechnological Application. Supervisor: Prof. Tapan K. Dutta
- **Arindam Dutta:** An Insight Into Evolutionary Relationships of Naphthalene and Nitroarene Dioxygenase. Supervisor: Prof. Tapan K. Dutta
- **M. J. Rameej**: Molecular Biology of Chemolithotrophic Sulfur Oxidation by *Paracoccus thiocyanatus* SST. Supervisor: Dr. Wriddhiman Ghosh
- **Subhrangshu Mandal:** Exploration of Extreme Habitats for Novel Sulfur Chemotrophs. Supervisor: Dr. Wriddhiman Ghosh

PH.D. AWARDED

Physics

- **Soumya Jyoti Banerjee:** Structural aspects of complex networks and their applications. Supervisor: Prof. Soumen Roy
- **Rajdeep Kaur Grewal:** Studies on Biological Networks. Supervisor: Prof. Soumen Roy
- **Saptarshi Sinha:** Competition and cooperation in microbes. Supervisor: Prof. Soumen Roy

Plant Biology

- **Rwitie Mallik:** Investigating The Role of AtHMGB15 (AT1G04880) Protein In Transcriptional Regulation of Cold Stress Responsive Genes. Supervisor: Prof. Shubho Chaudhuri
- **Sananda Bhattacharya:** Development of low phytate rice for increment of bio-available phosphorus and other nutrients. Supervisor: Prof. Gaurab Gangopadhyay.
- **Dibya Mukherjee:** An insight into different survival strategies of Ustilago maydis under conditions of stress. Supervisor: Dr. Anupama Ghosh

AWARDS / HONOURS / MEMBERSHIP

Bioinformatics

Dr. Zhumur Ghosh

1. Member of the National Academy of Science.

Environmental Sciences

Dr. Abhijit Chatterjee

1. Working with the WBPCB and Ministry of Environment, Forest and Climate Change, Govt of West Bengal for continuous monitoring of air pollutants over several "non-attainment" cities in West Bengal and building action plans for their mitigation under National Clean Air Mission of Govt of India. Bose Institute has also been selected as the Institute of Repute for this mission.
2. Selected as the member of Editorial Board of the prestigious international journal, "Earth and Space Chemistry" of American Chemical Society.

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**)
3. Indian Aerosol Science and Technology Association (IASTA)
4. Indian Physics Association (IPA)
5. Asia Oceania Geosciences Society (AOGS)
6. American Geosciences Union (AGU)
7. European Geosciences Union (EGU)
8. Japan Geosciences Union (JpGU).

Microbiology

Dr. Wriddhiman Ghosh

1. Paper *Aerobic microbial communities in the sediments of a marine oxygen minimum zone* (DOI: 10.1093/femsle/fnaa157) was declared Editor's Choice article and promoted by Federation of European Microbiological Societies through its Twitter (https://twitter.com/FEMSmicro/status/1336985475043766285) and facebook (https://www.facebook.com/permalink.php?story_fbid=10157877260606404&id=287956361403) channels.

AWARDS / HONOURS / MEMBERSHIP

2. Paper *Trends of mutation accumulation across global SARS-CoV-2 genomes: Implications for the evolution of the novel coronavirus* (DOI: 10.1016/j.ygeno.2020.11.003) featured in FluTrackers (https://flutrackers.com/forum/forum/welcome-to-the-scientific-library/genetics-aa/898440-genomics-trends-of-mutation-accumulation-across-global-sars-cov-2-genomes-implications-for-the-evolution-of-the-novel-coronavirus#post898440) and **IndiaBioscience** (https://indiabioscience.org/news/2021/study-finds-patterns-in-mutations-of-sars-cov-2).

Physics

Prof. Achintya Singha

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

Dr. Saikat Biswas

1. Appointed as one of the judges for selecting the three best posters in the DAE-HEP symposium organized by NISER, Jatni during December 14 – 18, 2020.
2. Sayak Chatterjee was selected for the Highlight talk on “Physics performance studies with MuCh setup” in the 37th CBM Collaboration Meeting (online), March 1-5, 2021. Sayak is the only selected student from India.

Dr. Sidharth Kumar Prasad

1. I am 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. Served as a committee **member for the election of Spokesperson** and **Chair** of ALICE India Collaboration.
3. Served as one of the **Internal Review Committee (IRC) members**by the ALICE Collaboration to review an ALICE paper.
4. Served as one of the **Analysis Review Committee (ARC) members**by the ALICE Collaboration to review two ALICE analysis notes.
5. Served as **one of the judges for selecting the three best posters** in the DAE-HEP symposium 2020.
6. Mr. Abhi Modak received one of the three **best posters award** out of 66 posters in the Relativistic Heavy Ion Physics and QCD group of the DAE-HEP symposium 2020.

AWARDS / HONOURS / MEMBERSHIP

Plant Biology

Prof. Gaurab Gangopadhyay

1. Invited to participate at the virtual MoU signing event of the Department of Science and Technology and Biotechnology (DSTBT), Govt. of WB with the IIM, Joka to set up the Technology Development and Adaptation Centre (TDAC) on October 05, 2020.
2. Nominated (by the Director, BI) to present on behalf of the Bose Institute in an online meet on the prospect of student fellowship, summer training, research areas etc. organized by the DST, Govt. of Rajasthan on November 19, 2020.
3. Acted as the external examiner of the online Ph.D. viva-voce examination of Ms Umme Salma, Department of Agricultural Biotechnology; Faculty of Agriculture BCKV on August 18, 2020.
4. Acted as the external examiner of the online Ph.D. viva-voce examination of Ms Jeeta Sarkar, Department of Botany Visva-Bharati University on October 14, 2020.
5. Acted as the external examiner of the online (Google Meet platform) Ph.D. viva-voce examination of Ms Monimala Mondal, Department of Botany University of Calcutta on November 11, 2020.
6. Acted as the External Member of the Departmental Research Committee in Botany, University of Kalyani on February 04, 2021.

LIST OF PUBLICATIONS

1. Sarkar K., Sil P C, Nabavi S F, Berindan-Neagoe I, Cismaru C A, Nabavi S M, Habtemariam S (2020) Possible targets and therapies of sars-cov-2 infection, *Mini-Reviews in Medicinal Chemistry*, 20 (18), pp. 1900-1907.

2. Bhattacharyya R, Dhar J, Dastidar S G, Chakrabarti P, Weiss M S (2020) The susceptibility of disulfide bonds towards radiation damage may be explained by S.O interactions, *IUCrJ*, 7, pp. 825-834.

3. Shendge A K, Panja S, Basu T, Mandal N (2020) A tropical lichen, *Dirinaria consimilis* selectively induces apoptosis in MCF-7 cells through the regulation of p53 and caspase-cascade pathway, *Anti-Cancer Agents in Medicinal Chemistry*, 20 (10), pp. 1173-1187.

4. Kumar M, Majumder D, Mal S, Chakraborty S, Gupta P, Jana K, Gupta U D, Ghosh Z, Kundu M and Basu J (2020) Activating transcription factor 3 modulates the macrophage immune response to Mycobacterium tuberculosis infection via reciprocal regulation of inflammatory genes and lipid body formation, *Cellular microbiology.* 22, e13142. (IF: 4.060). PMID: 31709711.

5. Mohid S A, Bhunia A (2020) Combining antimicrobial peptides with nanotechnology: An emerging field in theranostics, *Current Protein and Peptide Science*, 21 (4), pp. 413-428.

6. Saha P, Ghosh S, Roy-Barman S (2020) MoLAEA regulates secondary metabolism in Magnaporthe oryzae, *mSphere*, 5 (2), art. no. e00936-19 .

7. ALICE Collaboration (2020) Production of (anti-) He 3 and (anti-) H 3 in p-Pb collisions at $\sqrt{sNN}$ =5.02 TeV, *Physical Review* C, 101 (4), art. no. 044906.

8. Chakraborty A K (2020) Understanding Information Literacy Resources in Libraries: A Conceptual Analysis, Page.14.

9. ALICE Collaboration (2020) Production of charged pions, kaons, and (anti-)protons in Pb-Pb and inelastic pp collisions at $\sqrt{sNN}$ = 5.02 TeV, *Physical Review* C, 101 (4), art. no. 044907.

10. ALICE Collaboration (2020) Global polarization of Λ Λ hyperons in Pb-Pb collisions at $\sqrt{sNN}$ = 2.76 and 5.02 TeV, *Physical Review* C, 101 (4).

11. Maity A G, Das D, Ghosal A, Roy A, Majumdar A S (2020) Detection of genuine tripartite entanglement by multiple sequential observers *Physical Review* A, 101 (4), art. no. 042340.

12. ALICE Collaboration (2020) Underlying event properties in pp collisions at √s = 13 TeV(2020) *Journal of High Energy Physics*, (4), art. no. 192.

13. Basu M, Gupta P, Dutta A, Jana K, Ukil A (2020) Increased host ATP efflux and its conversion to extracellular adenosine is crucial for establishing *Leishmania* infection, *Journal of Cell Science*, 133 (7), art. no. jcs239939.

14. Das S, Satpati B, Bhattacharya T S, Bala T (2020) Synthesis of Au–Ag triangular nanocomposite with promising SERS activity, *Nano-Structures and Nano-Objects*, 22, art. no. 100438.

LIST OF PUBLICATIONS

15. Singha S S, Rudra S, Mondal S, Pradhan M, Nayak A K, Satpati B, Pal P, Das K, Singha A (2020) Mn incorporated MoS2 nanoflowers: A high , performance electrode material for symmetric supercapacitor, *Electrochimica Acta*, 338, art. no. 135815.

16. Chakravorty D, Ghosh A, Saha S (2020) Computational approach to target USP28 for regulating Myc, *Computational Biology and Chemistry*, 85, art. no. 107208.

17. Sheikh M S, Ghosh D, Bhowmik T K, Dutta A, Bhattacharyya S, Sinha T P (2020) When multiferroics become photoelectrochemical catalysts: A case study with BiFeO3/La2NiMnO6, *Materials Chemistry and Physics*, 244, art. no. 122685.

18. Pandit G, Biswas K, Ghosh S, Debnath S, Bidkar A P, Satpati P, Bhunia A, Chatterjee S (2020) Rationally designed antimicrobial peptides: Insight into the mechanism of eleven residue peptides against microbial infections, *Biochimica et Biophysica Acta - Biomembranes*, 1862 (4).

19. Ghosh A, Roy A, Das S K, Ghosh S K, Raha S, Chatterjee A (2020) Identification of most preferable reaction pathways for chloride depletion from size segregated sea-salt aerosols: A study over high altitude Himalaya, tropical urban metropolis and tropical coastal mangrove forest in eastern India, *Chemosphere*, 245, art. no. 125673.

20. Barua A, Maity S, Kumar S, Dutta A, Sinha T P (2020) Structural, optical and electrical characterization of Ba2YbTaO6, *Physica B: Condensed Matter*, 583.

21. Mukherjee M, Banerjee N, Chatterjee S (2020) De Novo designed 13 mer hairpin-peptide arrests insulin and inhibits its aggregation: Role of OH-π interactions between water and hydrophobic amino acids, *RSC Advances*, 10 (25), pp. 14991-14999.

22. Dattagupta S (2020) *Current Science*, 118 (9), pp. 1331-1332.

23. Momin M S A, Biswas A (2020) Extrinsic noise of the target gene governs abundance pattern of feed-forward loop motifs, *Physical Review E*, 101 (5), art. no. 052411.

24. Sett S, Aggarwal V K, Singha A, Raychaudhuri A K (2020) Temperature-dependent Thermal Conductivity of a Single Germanium Nanowire Measured by Optothermal Raman Spectroscopy, *Physical Review Applied*, 13 (5), art. no. 054008, .

25. Bandyopadhyay M, Dattagupta S, Dubey A (2020) Effect of noise on quantum transport of a charged particle in a tight-binding lattice, *Physical Review* B, 101 (18).

26. ALICE Collaboration (2020) Higher harmonic non-linear flow modes of charged hadrons in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV, *Journal of High Energy Physics*, (5), art. no. 85.

27. Das T, Deb A, Parida S, Mondal S, Khatua S and Ghosh Z (2020) LncRBase V.2: an updated resource for multispecies lncRNAs and ClinicLSNP hosting genetic variants in lncRNAs for cancer patients, RNA biology, 1-16. (IF: 4.200). PMID: 33112702.

LIST OF PUBLICATIONS

28. Panda S, Banerjee N, Chatterjee S (2020) Solute carrier proteins and c-Myc: a strong connection in cancer progression, *Drug Discovery Today*, 25 (5), pp. 891-900.

29. Pariary R, Ghosh B, Bednarikova Z, Varnava K G, Ratha B N, Raha S, Bhattacharyya D, Gazova Z, Sarojini V, Mandal A K, Bhunia A (2020) Targeted inhibition of amyloidogenesis using a non-toxic, serum stable strategically designed cyclic peptide with therapeutic implications, *Biochimica et Biophysica Acta - Proteins and Proteomics*, 1868 (5), art. no. 140378.

30. Asthana S, Bhattacharyya D., Kumari S, Nayak P S, Saleem M, Bhunia A, Jha S (2020) Interaction with zinc oxide nanoparticle kinetically traps α-synuclein fibrillation into off-pathway non-toxic intermediates, *International Journal of Biological Macromolecules*, 150, pp. 68-79.

31. Silwal P, Kim Y S, Basu J, Jo E-K (2020) The roles of microRNAs in regulation of autophagy during bacterial infection, *Seminars in Cell and Developmental Biology*, 101, pp. 51-58.

32. ALICE Collaboration (2020) Measurement of electrons from semileptonic heavy-flavour hadron decays at midrapidity in pp and Pb–Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV, *Physics Letters, Section B: Nuclear, Elementary Particle and High-Energy Physics*, 804, art. no. 135377.

33. ALICE Collaboration (2020) Longitudinal and azimuthal evolution of two-particle transverse momentum correlations in Pb–Pb collisions at $\sqrt{s_{NN}}$ = 2.76TeV, *Physics Letters, Section B: Nuclear, Elementary Particle and High-Energy Physics*, 804, art. no. 135375.

34. Seal S, Chowdhury N, Biswas R, Chakraborty T, Sinha D, Bagchi A, Sau S (2020) Removal of an atypical region from a staphylococcal cyclophilin affects its structure, function, stability, and shape, *International Journal of Biological Macromolecules*, 151, pp. 1287-1298.

35. Gucchait A, Ghosh S, Misra A K (2020) Synthesis of Novel Glycosyl Carbamo (dithioperoxo) thioate Derivatives, *Synthesis (Germany),* 52 (10), pp. 1523-1530.

36. Banerjee S, Mukherjee S, Bhattacharya A, Basak U, Chakraborty S, Paul S, Khan P, Jana K, Hazra T K, Das T (2020) Pyridoxine enhances chemo-responsiveness of breast cancer stem cells via redox reconditioning, *Free Radical Biology and Medicine*, 152, pp. 152-165.

37. ALICE Collaboration (2020) Jet-hadron correlations measured relative to the second order event plane in Pb-Pb collisions at $\sqrt{s_{NN}}$ =2.76 TeV, *Physical Review C,* 101 (6), art. no. 064901.

38. Sen A, Chatterjee S, Roy S, Biswas S, Das S (2020) Characterisation of an RPC prototype with moderate resistivity plates using tetrafluoroethane (C2H2F4), *Journal of Instrumentation*, 15 (6), art. no. C06055.

LIST OF PUBLICATIONS

39. ALICE Collaboration (2020) Coherent photoproduction of ρ 0 vector mesons in ultra-peripheral Pb-Pb collisions at $\sqrt{sNN}$ = 5.02 TeV, *Journal of High Energy Physics*, (6), art. no. 35.

40. ALICE Collaboration (2020) Non-linear flow modes of identified particles in Pb-Pb collisions at $\sqrt{sNN}$ = 5.02 TeV(2020) *Journal of High Energy Physics*, (6), art. no. 147.

41. Mukherji S, Ghosh A, Bhattacharyya C, Mallick I, Bhattacharyya A, Mitra S, Ghosh A (2020) Molecular and culture-based surveys of metabolically active hydrocarbon-degrading archaeal communities in Sundarban mangrove sediments, *Ecotoxicology and Environmental Safety*, 195, art. no. 110481.

42. Guha I, Bhuniya A, Shukla D, Patidar A, Nandi P, Saha A, Dasgupta S, Ganguly N, Ghosh S, Nair A, Majumdar S, Saha B, Storkus W J, Baral R, Bose A (2020) Tumor Arrests DN2 to DN3 Pro T Cell Transition and Promotes Its Conversion to Thymic Dendritic Cells by Reciprocally Regulating Notch1 and Ikaros Signaling, *Frontiers in Immunology*, 11, art. no. 898.

43. ALICE Collaboration (2020) Centrality and transverse momentum dependence of inclusive J/ψ production at midrapidity in Pb–Pb collisions at sNN=5.02 TeV, *Physics Letters, Section B: Nuclear, Elementary Particle and High-Energy Physics*, 805, art. no. 135434.

44. ALICE Collaboration (2020) Measurement of the (anti-) 3He elliptic flow in Pb–Pb collisions at $\sqrt{sNN}$ =5.02TeV, *Physics Letters, Section B*: Nuclear, Elementary Particle and High-Energy Physics, 805, art. no. 135414.

45. ALICE Collaboration (2020) Investigation of the p–Σ^0 interaction via femtoscopy in pp collisions, *Physics Letters, Section B*: Nuclear, Elementary Particle and High-Energy Physics, 805, art. no. 135419.

46. Chatterjee S, Roy S, Sen A, Chakraborty S, Biswas S, Das S, Ghosh S K, Prasad S K, Raha S (2020) Long term stability study of triple GEM detector using different Argon based gas mixtures: An update, *Journal of Physics: Conference Series*, 1498 (1), art. no. 012037 .

47. Gucchait A, Kundu M, Manna T, Shit P, Misra A K (2020) Influence of Functional Groups towards the β-Selective Glycosylation of 2-Azido-2-deoxy Glycosyl Thioglycosides, *European Journal of Organic Chemistry*, (23), pp. 3398-3409.

48. Dasgupta P, Das A, Datta S, Banerjee I, Tripathy S, Chaudhuri S (2020) Understanding the early cold response mechanism in IR64 indica rice variety through comparative transcriptome analysis, *BMC Genomics*, 21 (1), art. no. 425.

LIST OF PUBLICATIONS

49. Victor M P, Acharya D, Chakraborty S, Ghosh T C (2020) The combined influence of codon composition and tRNA copy number regulates translational efficiency by influencing synonymous nucleotide substitution, *Gene*, 745, art. no. 144640.

50. Roy S, Ghosal A (2020) Rating the performance of noisy teleportation using fluctuations in fidelity, *Physical Review A*, 102 (1), art. no. 012428.

51. Biswas D, Deka K, Jaiswal A, Roy S (2020) Viscosity, nonconformal equation of state, and sound velocity in Landau hydrodynamics, *Physical Review C*, 102 (1), art. no. 014912, .

52. ALICE Collaboration (2020) Measurement of nuclear effects on ψ(2S) production in p-Pb collisions at $\sqrt{s_{NN}}$ = 8.16 TeV, *Journal of High Energy Physics*, (7), art. no. 237.

53. Bera S, Gayen N, Mohid S A, Bhattacharyya D, Krishnamoorthy J, Sarkar D, Choi J, Sahoo N, Mandal A K, Lee D, Bhunia A (2020) Comparison of Synthetic Neuronal Model Membrane Mimics in Amyloid Aggregation at Atomic Resolution, *ACS Chemical Neuroscience*, 11 (13), pp. 1965-1977.

54. Chatterjee A (2020) Use of hypochlorite solution as disinfectant during COVID-19 outbreak in India: From the perspective of human health and atmospheric chemistry, *Aerosol and Air Quality Research*, 20 (7), pp. 1516-1519.

55. Banerjee S, Ghosh S, Mandal A, Ghosh N, Sil P C (2020) ROS-associated immune response and metabolism: a mechanistic approach with implication of various diseases, *Archives of Toxicology*, 94 (7), pp. 2293-2317.

56. ALICE Collaboration (2020) Evidence of Spin-Orbital Angular Momentum Interactions in Relativistic Heavy-Ion Collisions, *Physical Review Letters*, 125 (1), art. no. 012301.

57. Chakraborty J, Sen S, Ghosh P, Jain A, Das S (2020) Inhibition of multiple defense responsive pathways by CaWRKY70 transcription factor promotes susceptibility in chickpea under Fusarium oxysporum stress condition, *BMC Plant Biology*, 20 (1), art. no. 319.

58. ALICE Collaboration (2020) Probing the Effects of Strong Electromagnetic Fields with Charge-Dependent Directed Flow in Pb-Pb Collisions at the LHC, *Physical Review Letters*, 125 (2), art. no. 02300.

59. ALICE Collaboration (2020) ϒ production in p–Pb collisions at $\sqrt{s_{NN}}$ = 8.16 TeV, *Physics Letters*, Section B: Nuclear, *Elementary Particle and High-Energy Physics*, 806, art. no. 135486, .

60. Bhattacharyya T, Chatterjee A, Das S K, Singh S, Ghosh S K (2020) Study of fair weather surface atmospheric electric field at high altitude station in Eastern Himalayas, *Atmospheric Research*, 239, art. no. 104909.

LIST OF PUBLICATIONS

61. Paul D, Roy A, Nandy A, Datta B, Borar P, Pal S K, Senapati D, Rakshit T (2020) Identification of Biomarker Hyaluronan on Colon Cancer Extracellular Vesicles Using Correlative AFM and Spectroscopy, *Journal of Physical Chemistry Letters*, 11 (14), pp. 5569-5576.

62. Modak A, Prasad S K (2020) Photon Detection in heavy-ion experiments, *Journal of Physics: Conference Series*, 1579 (1), art. no. 012010.

63. Das P, Adak S, Lahiri Majumder A (2020) Genetic Manipulation for Improved Nutritional Quality in Rice, *Frontiers in Genetics*, 11, art. no. 776.

64. ALICE Collaboration (2020) K□(892)0 and φ(1020) production at midrapidity in pp collisions at √s =8 TeV, *Physical Review C*, 102 (2), art. no. 024912.

65. Khanra S, Juin S K, Jawed J J, Ghosh S, Dutta S, Nabi S A, Dash J, Dasgupta D, Majumdar S, Banerjeeid R (2020) In vivo experiments demonstrate the potent antileishmanial efficacy of repurposed suramin in visceral leishmaniasis, *PLoS Neglected Tropical Diseases*, 14 (8), art. no. e0008575, pp. 1-20.

66. Singh S, Halder A, Abdul Mohid S K, Bagchi D, Sinha O, Banerjee A, Kumar Sarkar P, Bhunia A, Ghosh S K, Mitra A, Pal S K (2020).Nonthermal Atmospheric Plasma-Induced Cellular Envelope Damage of Staphylococcus aureus and *Candida albicans* Biofilms: Spectroscopic and Biochemical Investigations, *IEEE Transactions on Plasma Science*, 48 (8), art. no. 9147056, pp. 2768-2776.

67. Sarkar M, Saha S (2020) Structural insight into the role of novel SARSCoV-2 E protein: A potential target for vaccine development and other therapeutic strategies *PLoS ONE*, 15 (8 August), art. no. e0237300.

68. ALICE Collaboration (2020) Multiplicity dependence of π , K, and p production in pp collisions at √s = 13 TeV, *European Physical Journal* C, 80 (8), art. no. 693.

69. Guha I, Bhuniya A, Nandi P, Dasgupta S, Sarkar A, Saha A, Das J, Ganguly N, Ghosh S, Ghosh T, Sarkar M, Ghosh S, Majumdar S, Baral R, Bose A (2020) Neem leaf glycoprotein reverses tumor-induced and age-associated thymic involution to maintain peripheral CD8+T cell pool, *Immunotherapy,* 12 (11), pp. 799-818.

70. Datta S K (2020) Induced mutations: technological advancement for development of new ornamental varieties, *Nucleus (India)*, 63 (2), pp. 119-129.

71. Nag P, Shriti S, Das S (2020) Microbiological strategies for enhancing biological nitrogen fixation in nonlegumes, *Journal of Applied Microbiology*, 129 (2), pp. 186-198.

72. Dhar A, Ahmed I, Mallick S, Roy S (2020) A Peptide-PNA Hybrid Beacon for Sensitive Detection of Protein Biomarkers in Biological Fluids, *ChemBioChem*, 21 (15), pp. 2121-2125.

LIST OF PUBLICATIONS

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Books/Book Chapters/Invited Reviews:

1. Biswas K (2020) The role of science and scientists in mitigating the COVID-19 pandemic (Part 1), published by *IndiaBioscience*, the first part of a two part series, which discusses how innovative scientific endeavours are paving the way for better prevention and treatment strategies for this rapidly-spreading disease. (https://indiabioscience.org/columns/opinion/the-role-of-science-and-scientists-in-mitigating-the-covid-19-pandemic)

2. Biswas K (2020) The role of science and scientists in mitigating the COVID-19 pandemic (Part 2), published by *IndiaBioscience*, the second part of a two part series. (https://indiabioscience.org/columns/opinion/the-role-of-science-and-scientists-in-mitigating-the-covid-19-pandemic-part-2).

3. Bhattacharyya D, Bhunia A (2021) Gut-Brain axis in Parkinson's disease etiology: The role of lipopolysaccharide, *Chemistry and Physics of Lipids*, 235, art. no. 105029.

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5. Haldar S, Ghosh A (2020) Microbial and plant-assisted heavy metal remediation in aquatic ecosystems: a comprehensive review 3 *Biotech*, 10 (5), art. no. 205.

6. Rajarshi Ray (2020) Chemical Equilibration of Conserved Charges; AAPPS Bulletin 30; *Physics Focus*, 54.

Conference Proceedings:

1. Das Sanat Kumar (2020) Investigation of Winter-time Background Air Quality Index of Indo-Gangetic Plain over Sundarban Mangrove Reserve Forest in India, at AGU Fall meeting 2020 at New Orleans, LA and Online Everywhere.

Database submissions:

Prof. Gaurab Gangopadhyay

NCBI Submissions (MW787034, MW787039) - 22.03.2021

SRA database Accession PRJNA644139 (SRX8672958 - SRX8672973) 05.07.2020

SRA database Accession PRJNA642699 (SRX8648465 - SRX8648470) 29.06.2020

ON GOING PROJECTS

Sl No.	Date of Commencement	Date of Termination	Principal Investigator	Title of the Projects	Grant Sanctioned
1	01-Jul-17	30-Jun-20	Prof. Anirban Bhunia	CSIR - "Structural insight and Dynamical properties of Alpha synuclein fibrillation in the context of Mitochondrial membrane or Biological membrances : Pathological role in synaptic transmission Aggregation property and cellular toxicity"	24,43,800
2	10-Jul-17	31-Jul-20	Prof. Subrata Majumdar	CSIR- "Crucial role of transcription factor-EB(TFEB) in regulating differential antigen presentation and cross presentation during Leishmania donovani infection"	25,93,800
3	01-Aug-17	31-Jul-20	Prof. Samir Ranjan Sikdar	CSIR - "Proteome analysis during Lipaphis erysimi - Rorippa indica incompatible interaction to identify putative proteins responsible for aphid tolerance and their interacting partners"	15,00,000
4	25-Jul-17	31-Jul-20	Prof. Swati Gupta Bhattacharyya	CSIR - "Deciphering the in-planta secretome of Rhizoctonia solani AG1-1A during infection of rice"	28,93,800
5	19-Jan-17	18-Jul-20	Prof. Tapan K. Dutta	DBT - "Hydrogenogenic carbon monoxide conversion under mesophilic condition using anaerobic granular sludge biomass for biodesulphurization "	25,74,000
6	09-Jan-17	08-Jan-21	DIRECTOR, BOSE INSTITUTE	DBT - "Multi-dimensional Reserch to Enable Systems Medicine: Acceleration using a Cluster Approach' at Kalyani, West Bengal"	14,05,32,000
7	13-Jul-17	12-Jul-20	Prof. Manikuntala Kundu	DBT - "Transcriptional regulator RegX3-dependent modulation of the macrophage immune response by Mycobacterium tuberculosis"	61,84,000
8	30-Jan-18	29-Jul-21	Prof. Mahadeb Pal	DBT - "Understand molecular mechanism of action of a protein chaperone inducer azadiradione and its therapeutic development for Parkinson's disease treatment"	36,02,000

ON GOING PROJECTS

Sl No.	Date of Commencement	Date of Termination	Principal Investigator	Title of the Projects	Grant Sanctioned
9	16-Jul-18	15-Jul-21	Prof. Pallob Kundu	DBT - "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
10	24-Sep-18	23-Sep-21	Prof. Gaurisankar Sa	DBT - "Development of delivery system for miR-325-3p for immunotherapy of cancer"	79,29,800
11	23-Mar-18	22-Mar-21	Prof. Siddhartha Roy	DBT - "Solid tumor targeting using homing peptides and plasmonic photothermal technique"	46,84,800
12	02-Sep-15	19-Aug-20	Prof. A. N. Lahiri Majumder	DBT - "Unraveling the role of PLC in plant drought and heat stress tolerance: Exploring the potential of PI metabolism to improve crop yield"	1,26,87,600
13	31-Aug-16	30-Aug-20	Prof. Amita Pal	DBT-WB - "Genome wide transcriptome analysis to develop strategies for quality improvement of blackgram"	30,47,320
14	15-May-18	14-May-21	Prof. Gaurab Gangopadhyay	DBT-WB - "Development of Transgenic Pineapple Over-expressing AcSERK to Combat Fungal Pathogens"	19,99,645
15	02-Jul-18	01-Jul-21	Prof. Shubho Chaudhuri	DBT-WB - "Investigating the role of Trithorax factor ULTRAPETALA1 in salt stress response in rice"	43,31,840
16	28-Aug-18	27-Aug-21	Prof. Gautam Basu	DBT-WB - "The significance of feedback loop between ZEB1 and PRMT in Fbroblast growth factore (FGF)-mediated epithelial-mesenchymal transition in Breast Cancer"	30,30,000
17	10-Jul-14	30-Sep-20	Prof. Sibaji Raha	DST - "ALICE - A Large Ion Collider Experiment (ALICE) upgrade, operation and utilization"	6,05,00,000

ON GOING PROJECTS

Sl No.	Date of Commencement	Date of Termination	Principal Investigator	Title of the Projects	Grant Sanctioned
18	28-Mar-19	27-Mar-21	Prof. Sanjay K. Ghosh	DST - "Development of a cost effective and portable electro-optical 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
19	22-Mar-18	21-Mar-21	Dr. Abhijit Chatterjee	DST - "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
20	26-Feb-18	25-Feb-21	Prof. Tapan K. Dutta	DST - "The development and implementation of sensors and treatment technologies for freshwater systems in India"	3,42,27,700
21	01-Aug-16	31-Jul-22	Prof. Sanjay K. Ghosh	IFCC - "CBM MUCH"	28,80,40,000
22	13-Sep-18	12-Sep-21	Dr. Abhijit Chatterjee	MOES - "Study on Biosphere-Atmosphere Exchange of Carbon Dioxide, Water Vapour and Energy in a High Altitude Forest Canopy at Eastern Himalaya"	25,08,000
23	29-Mar-17	28-Jun-22	Dr. Abhijit Chatterjee	MoEFCC - "National Carbonaceous Aerosols Programme (NCAP) WGIII: Carbonaceous Aerosols Emmissions, Source appointment and Climate effects"	1,06,08,000
24	10-Mar-17	09-Sep-20	Dr. Zhumur Ghosh	SERB - "Elucidating the GWAS-Associated Genetic Variants within IncRNA candidate loci: Role in Cancer"	45,18,800/-
25	16-Mar-18	15-Mar-21	Dr. Anupama Ghosh	SERB - "Evaluation of secreted proteases of Ustilago maydis as potential effector proteins"	25,53,394
26	24-Jul-18	23-Jul-21	Prof. Shubho Chaudhuri	SERB - "Investigating the role of Arabidopsis ARID-HMG protein, AtHMGB15, in the pollen development process"	46,29,744

ON GOING PROJECTS

Sl No.	Date of Commencement	Date of Termination	Principal Investigator	Title of the Projects	Grant Sanctioned
27	09-Aug-18	08-Aug-21	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
28	15-Sep-18	14-Sep-21	Prof. Achintya Singha	SERB - "Fabrication of Infreared Photo-detector based on 2D systems and Tuning the Detection Windows by coupling with Nanostructures"	50,33,714
29	11-Oct-18	10-Oct-21	Prof. Jayanta Mukhopadhyay	SERB - "Evaluating the role and mechanism of function of delta factor of Bacillus subtilis"	30,69,000
30	26-Mar-19	25-Mar-22	Dr. Abhrajyoti Ghosh	SERB - "Response of B. aryabhattai AB211 to maize root exudates: insights from transcriptome analysis"	38,68,803
31	03-May-07	02-May-22	Prof. Pinakpani Chakrabarti	Award of J.C. Bose Fellowship to Prof. Pinakpani Chakrabarti	40,00,000
32	26-Mar-07	31-Mar-22	Prof. Siddhartha Roy	Award of J.C. Bose Fellowship to Prof. Siddhartha Roy	9000000 (FOR LAST 5YEARS)
33	01-Apr-17	31-Mar-22	Prof. Joyoti Basu	Award of J.C. Bose Fellowship to Prof. Joyoti Basu	54,00,000
34	05-Mar-18	04-Mar-21	Prof. Tanya Das	SERB - "Role of Cancer Stem Cells in Tumor Neo-Angiogenesis : A mechanistic study"	48,76,800
35	21-Mar-18	20-Mar-21	Prof. Sujoy K. Das Gupta	SERB - "Phage inspired antibiotics for mycobacteria"	38,96,800
36	15-Mar-18	14-Mar-21	Prof. Parames C. Sil	SERB - "Nanoparticle-mediated co-delivery of chemotherapeutic drugs and genes for synergistic cancer treatment"	28,66,800
37	01-Aug-19	31-Jul-22	Prof. Gaurisankar Sa	CSIR - "Developmental and functional aspects of newly identified CD8+ T-regulatory cells in tumor microenvironment"	21,00,000
38	20-Dec-18	19-Dec-21	Prof. Gaurisankar Sa	DBT - "Investigation of the Transcriptional Regulation of miR-325 and Evaluating its Potential as a Therapeutic Agent for Cancer"	80,00,000
39	01-Aug-19	31-Jul-20	Prof. Gaurisankar Sa	CCRH - "Role of Silica in Cancer regression : A mechanistic study"	11,59,830

ON GOING PROJECTS

Sl No.	Date of Commencement	Date of Termination	Principal Investigator	Title of the Projects	Grant Sanctioned
40	05-Dec-18	04-Dec-21	Prof. Anirban Bhunia	SERB - "Intracellular Dyamics of Small Molecules During Novel AMP-mediated Resilience in Planta: A Multidisciplinary Approach"	30,70,000
41	06-Jul-19	05-Jul-22	Prof. Pallob Kundu	SERB - "Convergent miRNA actions in coordination of stress-response to Alternaria solani infection in tomato lines"	52,30,828
42	07-May-19	06-May-22	Prof. Srimonti Sarkar	SERB - "Characterization of the cellular roles of the proteasome and its deubiquitinase GIRpn11 of the differently-diverged eukaryote Giardia lamblia"	42,33,000
43	01-Sep-19	31-Aug-22	Dr. Sanat Kr. Das	CSIR - "Physico-chemical factors influencing Aerosol Hygro-scopicity 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
44	26-Aug-19	31-Aug-22	Dr. Anupama Ghosh	CSIR- "Deciphering the involvement of programmed cell death in the pathogenic development of *Ustilago maydis*"	19,60,000
45	24-Jun-19	23-Jun-23	Prof. Siddhartha Roy	Indo-Swiss - "Next generation advanced therapies for fight β-hemoglobinopathies via rational intervention in ϒ-globin regulatory network"	1,16,21,600
46	08-Aug-19	07-Aug-21	Dr. Sudipto Saha	ICMR - "Development of knowledge base on pulmonary diseases for estimating the prevalece and etiology : a pilot study in eastern India"	1,66,000
47	09-Oct-19	08-Oct-22	Prof. Anirban Bhunia	DBT - "Tailor Made Peptidomimetics Designing Against Human Islet Amyloid Polypeptide (hIAPP) Aggregation: A Therapeutic Approach Associated With Type-2 Diabetes"	66,74,500
48	30-Sep-19	29-Sep-22	Prof. Debabrata Basu	DBT - "Understanding the mechanisms of resistance to sucking pest, Helopeltis theivora and development of microbe -- based bioformulation against major tea pests"	39,00,396

ON GOING PROJECTS

Sl No.	Date of Commencement	Date of Termination	Principal Investigator	Title of the Projects	Grant Sanctioned
49	26-Aug-19	31-Aug-22	Dr. Abhrajyoti Ghosh	CSIR - "Decipherig the cross-talk between rhizosphere microbiome and the plant: insights from tea rhizosphere microbiome, metabolome and culture dependent analyses"	20,00,000
50	28-Aug-19	27-Aug-22	Prof. Kaushik Biswas	ICMR - "Understand the epigenetic regulation of GM2-synthase gene in cancer"	25,30,000
51	04-Dec-18	03-Dec-21	Prof. Mahadeb Pal	SERB - "Understand regulation of heat shock factor 1 activities in human cells"	30,65,148
52	29-Jan-20	28-Jan-23	Prof. Anup Kumar Misra	SERB - "Synthesis of the polysaccharide fragments of opportunistic human pathogens Providencia strains and their glycoconjugate derivatives"	26,02,800
53	12-Jan-21	11-Jan-24	Dr. Abhrajyoti Ghosh	CSIR - "Diversity and Distribution of Antibiotic Resistance Genes in the Sundarban mangrove estuary : coordination of anthropogenic and evolutionary influences"	23,50,000
54	18-Dec-20	17-Dec-25	Dr. Smarajit Polley Prof. Atin K. Mandal Prof. Jayanta Mukhopadhyay	SERB - "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
55	17-Mar-21	16-Mar-24	Prof. Atin Kumar Mandal	DBT-WB - "Characterizing the interaction between Phosphodiesterase 8 (PDE8A) and 14-3-3 with CRAF: Gaining insights into CRAF regulation"	21,40,000
56	30-Mar-21	29-Mar-24	Prof. Pallob Kundu	DST - "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
57	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

PARTICIPATION IN CONFERENCES / SYMPOSIA / WORKSHOPS / INVITED TALKS DELIVERED AND TRAVEL GRANT

Biochemistry

Prof. Srimonti Sarkar

1. Delivered an invited lecture in the Human Resource Development Group of Calcutta University
2. Delivered an invited lecture in the Human Resource Development Group of North Bengal University.

Dr. Abhrajyoti Ghosh

1. Delivered an invited lecture entitled "A need for two wings: Basic and Applied Research" in the "Faculty development program: An approach towards the development of human resources in Life and Allied Sciences"*held at Neotia University***,** West Bengal, India during March 22 – 27, 2021.

Bioinformatics

Prof. Shubhhra Ghosh Dastidar

1. Invited talk at the webinar organized by in DNA Life Sciences as a part of the celebration of World DNA day on April 2020.
2. Invited talk at the Webinar organized by University of Kalyani, West Bengal on June 11, 2020.
3. Invited talk at the Webinar organized by Asustosh College and Moulana Azad college of University of Calcutta during August 2020.
4. Invited talk at the Webinar organized by Barasat College under West Bengal state university on September 8, 2020
5. Invited talk at the webinar on the theme “From Biology to Omics” organized by ACTREC, Mumbai, during March 10-12, 2021.
6. Delivered Keynote at the workshop organized by JIS institute of Advanced studies and research, Kolkata, May 24, 2021.

Dr. Zhumur Ghosh

1. Delivered an invited talk entitled “Long noncoding RNAs: Versatile molecules guiding mammalian development” at the meeting- IBRO-APRC Associate School on “Regulatory RNAs And The Brain: Development To Disease” from January 20 to 25, 2021 organised by IGIB, Delhi.
2. Participated and organized a series of BIC webinars from September 2020 onwards where speakers from India and abroad were invited to deliver talk on different topics.

Dr. Sudipto Saha

1. Delivered an invited lecture entitled "Systems and Synthetic biology' in the online AICTE-ATAL (FDP) programme on “Synthetic Biology” conducted by Madurai University on December 03, 2020.

PARTICIPATION IN CONFERENCES / SYMPOSIA / WORKSHOPS / INVITED TALKS DELIVERED AND TRAVEL GRANT

Biophysics

Prof. Anirban Bhunia

1. Delivered lecture in the NMRS webinar, Organized by Nuclear Magnetic Resonance Society of India.
2. Delivered Invited in the NMR and Spectroscopy of Biological Macromolecules, organized by IISc Bangalore
3. Delivered lecture at Translational Biomedical Research Society, Lucknow
4. Delivered lecture at Guru Nanak Institute of Pharmaceutical Sciences and Technology, Kolkata

Dr. Smarajit Polley

1. Delivered Invited lecture in the webinar on *COVID 19 PANDEMIC :A PARADIGM SHIFT TOWARDS NEW NORMAL LIFE,* organized by the Department of Chemistry, Bankura Sonamukhi College, WB on June 27, 2020.
2. Delivered Invited lecture in the webinar on *Recent Developments in COVID19,* organized by the Department of Microbiology, Ramakrishna Mission Vidyamandira, Belur Math, WB *Research* on July 25, 2020.
3. Participated as invited Panellist at the Science and Research Opportunities in India (Sci-ROI) annual event 2020, to discuss on the New Faculty Perspective for an audience of Indian postdoctoral fellows abroad who aim to return to India, held on Sep 12, 2020

Environment Sciences

Dr. Abhijit Chatterjee

1. Delivered oral presentation on "Dominance of Biogenic Emissions in Aerosol-CCN Activation under Limited Anthropogenic Emissions over Eastern Himalaya, India", at Three-day online international conference on Aerosol Air Quality, Climate Change and Impact on Water Resources and Livelihoods in the Greater Himalayas, ARIES, Nainital from 14-16 September 2020.
2. Delivered oral presentation and hosted the international workshop on "Quality Assurance Plan for Monitoring using Air Quality Sensors" organized by Wisconsin-Madison University and Duke University on March 30, 2021.
3. Delivered invited lecture for Ph.D students registered in Environmental Science, University of Calcutta as a resource person on March 05, 2021.
4. Delivered invited lecture for Refresher Course in Environmental studies organized by UGC-HRDC and University of Calcutta on March 19, 2021.

PARTICIPATION IN CONFERENCES / SYMPOSIA / WORKSHOPS / INVITED TALKS DELIVERED AND TRAVEL GRANT

Dr. Sanat Kumar Das

1. Delivered an invited talk on "*Atmospheric Aerosols: Are they really so important for the world?*" as a delegate speaker in the one week national level Faculty Development Program "Recent Advancements In Physics" (RAIP) 2020, organized by the Department of Applied Science (Physics), RCC Institute of Information Technology, Kolkata, W. B, India during September 4-8, 2020.
2. Participated at The American Geophysical Union (AGU) Fall Meeting 2020 at New Orleans, LA and Online Everywhere during December 13-17, 2020.

Microbiology

Prof. Sujoy Kumar Das Gupta

1. Delivered two lectures on the topics 'DNA the beautiful molecule of life' and 'The evolving story of CRISPR cas' as a part of the Online Multidisciplinary Refresher Course in Life Science: Synthetic Biology, during December 14-28, 2020 organized by Pandit Ravishankar Shukla University (PRSU), Raipur, Chhattisgarh.
2. Delivered invited lecture on the topic "Reconnecting with our viral ancestors" at a one day symposium organized by the Department of Biotechnology and Bioinformatics, North-Eastern Hill University,Shillong on March 25, 2021.

Molecular Medicine

Prof. Kaushik Biswas

1. Delivered invited lecture on "Understanding Carcinogenesis : Multidirectional Role of Gangliosides in Tumor Growth, Progression and Metastasis", at the national seminar as part of the curtain raiser event of the "**India International Science Festival**", organized by the Department of Science and Technology (DST) on Nov 27, 2020.

Physics

Prof. Dhruba Gupta

1. Delivered a lecture on "High-lying resonances in the ^{7}Be + d reaction" at the ISOLDE Workshop and Users Meeting 2020;attended ISOLDE - EPIC 2020 Workshop at CERN, Geneva, Switzerland, November 24-27, 2020, Zoom Meeting
2. Attended Xth Tastes of Nuclear Physics, University of the Western Cape, S Africa, November 30 -December 4, 2020, Zoom Meeting
3. Attended NuPECC Mini-Workshop: Nuclear Science in Finland, October 15, 2020, Zoom Meeting.

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Prof. Achintya Singha

1. Online Science Workshop for Underprivileged School Children of West Bengal "Vigyan Parikrama II -2021", February 28, 2021.
2. Delivered invited talk at International Webinar on Advancements in Condensed Matter Physics (ACMP-2020) organized by Department of Physics, Assam University, Silchar, India during August 7-8, 2020.
3. Delivered invited talk at Webinar organized by Department of Physics, Jadavpur University, Kolkata, India on August 27, 2020.
4. Season Chaired in 3rd Annual Conference of Quantum Condensed Matter (Q-MAT : 2020).

Prof. Supriya Das

1. Delivered lecture on "Event Generators: an overview" at ALICE-India School (online) during Nov 19-20, 2020.
2. Delivered INO webinar on "Matter at extreme density: Core of neutron stars" on June 6, 2020.

Dr. Saikat Biswas

1. Delivered INO online lecture series for general audience, with Q&A session, entitled "Detectors for High Energy Physics" on April 29, 2020.
2. Participated and delivered lecture entitled "Particle Identification in High Energy Physics' at ALICE-India school, (Online), IIT Indore on November 12, 2020.
3. Attended 37th CBM Collaboration Meeting (online) during March 1-5, 2021.

Group Member:

Sayak Chatterjee (on behalf of CBM collaboration) presented talk on "Feasibility studies of J/ψ measurement with CBM detector setup at FAIR SIS100 energies" in XXIV DAE-BRNS Symposium on High Energy Physics during December 14–18, 2020, NISER, Jatni.

Dr. Sidharth Kumar Prasad

1. Invited talk on "Exploring the Early Universe Matter (QGP) via Heavy-Ion Experiments" in the 18th Refresher Courses in Physical Sciences and Nano Sciences, UGC-HRDC, JNU, New Delhi.
2. Organized "ALICE India Collaboration Meeting July 2020" during July 27 – 30, 2020 at VECC, Kolkata.

PARTICIPATION IN CONFERENCES / SYMPOSIA / WORKSHOPS / INVITED TALKS DELIVERED AND TRAVEL GRANT

3. Organized "ALICE-STAR-India Collaboration Meeting" during March 09 – 12, 2021 at NISER, Jatni.
4. Organized following webinars on behalf of ALICE-STAR-India Collaboration:
   a. September 28, 2020; Speaker: Prof. D. K. Srivastva, Homi Bhabha Chair Professor, National Institute of Advanced Studies, Bengaluru (India).
   b. November 03, 2020; Speaker: Prof. Abhijit Majumder, Wayne State University, Detroit, Michigan (USA).
   c. December 08, 2020; Speaker: Prof. Raju Venugopalan, BNL (USA).
   d. February 19, 2021; Speaker: prof. Peter Braun-Munzinger, Scientific Director, EMMI, GSI (Germany).
   e. March 18, 2021; Speaker: Prof. Zhangbu Xu, Senior Scientist, BNL (USA).

Group Member:

1. Mr. Abhi Modak delivered a talk on "Charged- and neutral-particle production in proton-lead collisions at 5.02 and 8.16 TeV with ALICE " in IS2021 on 13 January, 2021.
2. Ms. Debjani Banerjee delivered a bullet talk on "Multiplicity dependence of charged jet properties in pp collisions at 13 TeV with ALICE" in IS2021 on 13 January, 2021.
3. Mr. Prottoy Das presented a poster on "Multiplicity and transverse spherocity dependent study of inclusive charged jet propertiesin pp collisions using PYTHIA" in XXIV DAE-BRNS HEP SYMPOSIUM on 14 – 18 December, 2020.
4. Mr. Abhi Modak presented a poster on "Measurement of inclusive photon multiplicity at forward rapidity in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV with ALICE" in XXIV DAE-BRNS HEP SYMPOSIUM on 14 – 18 December, 2020.
5. Ms. Debjani Banerjee presented a poster on "Jet shape modifications in JEWEL" in XXIV DAE-BRNS HEP SYMPOSIUM on 14 – 18 December, 2020.

Plant Biology

Prof. Gaurab Gangopadhyay

1. Invited to deliver an online lecture in the "Virtual journey through botanical world" organized by the Department of Botany, THK Jain College, Kolkata on August 15, 2020.
2. Invited to deliver an online lecture in the lecture series on Life Sciences organized by the Department of Botany, Government General Degree College, Singur, Hooghly, WB on August 16, 2020.

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3. Invited for a talk in the orientation program of the 1st year B. Tech students of Techno India University, West Bengal on November 06, 2020.

4. Participated in the ICAR's Webinar on 'Genomics Strategies for Improvement of Abiotic Stress Tolerance in Crop Plants' on November 27, 2020.

5. Invited to deliver an online lecture for commemorating 162nd Birth Anniversary of Sir J C Bose organized by the Department of Botany, Brahmananda Keshab Chandra College; Kolkata on November 30, 2020.

6. Invited to deliver an online lecture in the webinar on "Biodiversity Conservation and Forest Genetic Resource Management", organized by the Genetics and Tree Improvement Division, Institute of Forest Productivity at Ranchi on February 05, 2021.

7. Invited to participate in the webinar entitled 'The awareness session on Technology Commercialization', organized by WBSCST in association with IIM Kolkata Innovation Park (IMCIP) on February 06, 2021.

Oral presentation by the Group Member:

Debabrata Dutta presented a paper entitled "Transcriptome analysis of three sesame genotypes reveals differentially expressed genes in response to *Macrophomina phaseolina* infection" by D. Datta, V. Awon and **G. Gangopadhyay** at the **National Virtual Conference on Genomics to Phenomics**: A New Horizon in Plant Science Research on **March 01, 2021** (Organized by Department of Botany, University of Calcutta).

Group Members of Prof. Pallob Kundu :

1. **Shrabani Basak :** Delivered an oral presentation on 'Tomato Metacaspases MC1 and MC5 Are Mediators of Cell Death During Development and Disease' in the American Society for Plant Biology (ASPB) annual meeting 2020, and received the ASPB 2020 travel grant during July 27-31, 2020.

2. **Shrabani Basak :** Presented a paper on 'Death and defense - Dynamic regulation during stress and functional analyses of tomato metacaspases' and awarded the "Best Oral Presentation" in 7th International Conference - Phytopathology in Achieving UN Sustainable Development Goals organized by ICAR-IARI, New Delhi, India during January 16-20, 2020.

3. **Shreya Chowdhury :** Presented a paper on "miR398: An integrator of biotic and abiotic stress signalling in tomato" and awarded the "Best Oral Presentation" in 7th International Conference - Phytopathology in Achieving UN Sustainable Development Goals, IPSCONF2020, organized by ICAR-IARI, New Delhi, India during January 16-20, 2020.

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4. **Ananya Mukherjee :** Presented a paper on "Optimization of different promoters for spatio-temporal regulation of transgene expression in tomato" and awarded the "Best Oral Presentation" in 7th International Conference - Phytopathology in Achieving UN Sustainable Development Goals, IPSCONF2020, organized by ICAR-IARI, New Delhi, India during January 16-20, 2020.

Library

Dr. Arun Kumar Chakraborty

1. In a One Day State Level Webinar on "Bangla Sahityer Pathikrit O Grantha Premik Yuga Purush Raja Ram Mohan Ray er Chinta Chetonai Nari Samaj" in collaboration with Medinipur Anchalik Unit, Medinipur Samanway Sanstha on 28 June, 2021. Organized by the Central Library, K.D. College of Commerce & General Studies.
2. On "Re-building Indian Public Library Services after Covid-19: Role of RRRLF " on 01.06.2021.
3. Acted as one of the Resource Persons for IASLIC Program IBRM-LIS on "Image Building and Reputation Management of Library and Information Systems and Services (IBRM-LISaS)" conducted by IASLIC in online mode from May 15-24, 2021.
4. Invited to an International Conference on Revisiting the Legacy of Netaji Subhas in 21st century on 23rd Jan, 2021, organized by National Library, Kolkata, Ministry of Culture in association with Netaji Subhas Bose-INA Trust, New Delhi &The Institute of Social & Cultural Studies, India.
5. Delivered lecture in a Refresher Course (RC) in LIS at Gauhati University on Innovative Library Services during COVID 19 Pandemic." on 29.12.2020.
6. Delivered a lecture through WEBINAR: organized Jointly - DLIS, the University of Calcutta in collaboration with Kent State University, USA on 08.12.2020.
7. Guest Speakers for the webinar on " Rastriya Sikshniti aur Aaj ki Samay " organized by the "Bharatiya Samskriti Samsad", Kolkata on 10.10.2020.
8. Invited as one of the resource persons in the UGC sponsored Online Refresher Course in LIS planned by UGC-HRDC, Gujarat University, Ahmedabad.
9. Acted as Guest Speaker for the Webinar of the Central Library, Brainware University, Kolkata: on "Digital Rights Management: Slant to University Libraries" on 07.09.2020.
10. Delivered lecture in the 34th Training Programme on Science Communication and Media Practice -- Web lecture-7 on the topic "Digital Rights Management" on 29 September, 2020 by INSA.
11. Acted as one of the panelists in the BLA Webinar on the topic "Relevance of Books in the Age of Internet" Organized by: BLA & iLEAD Library on 29.08.2020.

PARTICIPATION IN CONFERENCES / SYMPOSIA / WORKSHOPS / INVITED TALKS DELIVERED AND TRAVEL GRANT

12. One of the panelists in the National Webinar on the topic "Virtual Library Services During COVID-19 Challenges & ways" organized by Info-Lib Academia and Sarsuna College, Behala on 01 September, 2020.
13. Coordinated the Virtual mode "Librarians' Day program" 12.08.2020 jointly organized by IASLIC, BLA, and WBPLEA.
14. Delivered the lecture to MLISC students of Dept. of Library & Information Science, Central University, Haryana on 13 July, 2020.
15. Delivered lecture as one of the Resource Persons of the State Level Webinar on "Reorientation of Information Literacy in the Library and Information Centres" on 08.07.2020 organized by "Sudhirranjan Lahiri Mahavidyalaya, Majdia, Nadia - 741507"
16. Online Roundtable on "Various policy decisions and some issues and challenges to be confronted by the Library Department, NSOU in post-COVID-19 situations on July 4, 2020.
17. Delivered lecture in the seminar- Intellectual Property Rights in Higher Education organized by Basirhat College on 29.06.2020.
18. Acted as one of the Panelist for the Webinar-2020 of BLA in collaboration with Patuakhali Science &Technology University (PSTU), Barishal, Bangladesh - topic: "Library Services During Pandemic (in Bengali)" on 28 June, 2020
19. Delivered lecture as one of the Resource Personnel in the Maharashtra University and College Librarian's Association" (MUCLA) (a premier Association in Maharashtra working for the betterment of National issues on Libraries) WEBINAR on Sunday 14-06-2020 on "Changing Paradigms of Academic Librarianship.
20. Acted as One of the Panelist on Post Covid-19 Library Management on 04-06-2020 through Webinar.
21. Acted as One of the Panelist on "Maintaining Social Distance -- Issues and challenges organized by BLA through Webinar on 19-05-2020.
22. Delivered a lecture in BLA organized Webinar on 09-05-2020 and 12-05-2020 on Plagiarism.

Disease and Therapeutics

Plant Development Stress and Yield

Microbes and Microbiome

Structure Function Dynamics of Proteins

CLUSTERED PERFORMATION OF BOSE INSTITUTE

Physics of Materials & Quantum Systems

Climate Change, Aerosols and Cloud Formation

Biological Systems, Information and Networks

High Energy and Nuclear Physics

– SCIENTIFIC REPORT –

DEPARTMENT OF BIOCHEMISTRY

BOSE INSTITUTE ANNUAL REPORT 2020-2021

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.

DEPARTMENT OF BIOCHEMISTRY

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)*.

Students : JRF/SRF : Avishikta Chatterjee, Pritha Mondal, Trisha Ghosh, Debasmita Sinha, Sangita Mondal, Anurupa Sett, Manish Sarkar, Ankita Das, Soham Seal, Mousam Roy, Sayantan Mukherjee, Sayandeep Gupta, Tushar Chakraborty, Kaustav Bhakta, Arghya Bhowmick, Nabanita Patra. ***RA :*** Dr. Triparna Mukherjee, Dr. Swapan Kr. Jana, ***Project Assistant (J. C. Bose Fellowship of Prof. Pinakpani Chakrabarti) :*** Jesmita Dhar, Supriyo Bera.

Staff Members: Subhash Chakraborty (Retired on 30.06.2020), Asim Kumar Poddar (Retired on 30.08.2020), Rama Chatterjee, Dipak Ch. Konar (from 18.09.2020), Debarati Kanjilal (Transferred 08.01.2021), Atanu Pramanik, Kissun Turi.

PROF. SUBRATA SAU

Professor

Group Members:
Soham Seal, *SRF*
Tushar Chakraborty, *JRF*
Debasmita Sinha, *JRF*
Debabrata Sinha, *PA*

Scientific Report

Background and Vision:

Staphylococcus aureus, a Gram-positive bacterium, causes various human diseases using many virulence factors and virulence regulators. Currently, staphylococcal infections become nearly untreatable primarily due to the lack of proper vaccine and the appearance of antibiotic-resistant *S. aureus* strains. Such pathogen may be easily removed using some anti-virulence agent. *S. aureus* will hardly develop any resistance to the anti-virulence agent as the virulence determinants are not required for growth. Thus far, only a few anti-virulence agents have been identified but their effectiveness is yet to be understood clearly. So, attempts of discovering additional anti-virulence agents should be kept on. The structure, function, folding mechanism, and stability of the virulence determinants have been very little studied though it may expedite the discovery of new anti-virulence agents. Under the above perspective, we are investigating the structure, function, stability of some *S. aureus*-specific virulence determinants such as σ^B, Cyp, and CapF. While the alternative sigma factor σ^B is involved both in stress-management and pathogenesis, the capsule-synthesizing enzyme CapF and cyclophilin Cyp act as the virulence factors. In addition, we have also been studying an anti-σ^B factor RsbW and RsbV,an RsbW antagonist. Both RsbV and σ^B interact with RsbW under opposite environmental conditions.

PROF. SUBRATA SAU

SCIENTIFIC REPORT ***Professor***

Summary of Research Work:

To better understand the mechanism of interaction between RsbW and RsbV/σ^B or σ^B domains (σ^{B2}, σ^{B3}, and σ^{B4}), we performed various studies. Our data indicated that three σ^B domains (σ^{B2}, σ^{B3}, and σ^{B4}), unlike rσ^B, do not bind to a cognate DNA in the presence of an RNA polymerase. Conversely, both σ^{B2} and σ^{B3}, like rσ^B, bound to RsbW, and the order of their RsbW binding affinity wasσ^B>σ^{B3}>σ^{B2}. RsbV also showed binding to RsbW and was phosphorylated by the latter in the presence of ATP. Additionally, the reaction between RsbW and RsbV or σ^B/σ^{B3}released heat and followed freely. The stoichiometry of interaction between RsbW and σ^{B3} or RsbW and rRsbV was observed 2:1 or 2:2. Structural models, developed for the RsbW- $\sigma^{B3}$and RsbW-RsbV complexes, indicated that the dimerization region at the N-terminal end of RsbW interacts with a σ^{B3} molecule, whereas, its rest part interacts with RsbV. Of the amino acid residues involved in the above complex formation, Arg 23 of RsbW interacts with both σ^{B3} and RsbV residues. Genetic studies revealed that the N-terminal end of RsbW is critical for maintaining its σ^B binding ability, phosphorylation activity, and dimerization ability. Arg 23 of RsbW was also found vital for preserving its structure, stability, and phosphorylation activity.
To understand the folding mechanism and stability of CapF, the unfolding of a recombinant CapF (rCapF) was studied in the presence of urea. rCapF was unfolded by a reversible pathway and formed three dimeric intermediates that retained NADPH binding activity. Their structure and hydrophobic surface area differed not only from each other but also from that of rCapF. One of the Trp residues in the intermediates was found more surface-exposed. Further, two intermediates, compared to rCapF, had a compacted shape.

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	–	–	–	–	–

PROF. SRIMONTI SARKAR

Professor

Group Members:

Nabanita Patra, *CSIR-SRF Adhoc*
Ankita Das, *INSPIRE Fellow-JRF Adhoc*
Avishikta Chatterjee, *INSPIRE Fellow-SRF Adhoc*
Pritha Mondal, *CSIR-JRF Adhoc*
Trisha Ghosh, *UGC-JRF Adhoc*
Anurupa Sett, *UGC-JRF Adhoc*
Shankari Prasad Datta, *PA*

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

Scientific Report

Background and Vision:

The enteropathogenic protist *G. lamblia* undergoes stage switching between its two morphological forms, the flagellated trophozoite (responsible for disease manifestation) and the non-motile cysts (responsible for pathogen transmission). Given the considerable structural differences between the two forms, interconversion from one to the other depends on both of the eukaryotic protein degradation pathways- proteasomal and lysosomal. We are studying the machinery for both pathways with the aim of identifying parasite-specific features that may serve as therapeutic targets.

Besides being a human pathogen, the *Giardia* has an enigmatic subcellular architecture. It harbours several aberrations from the canonical eukaryotic organellar composition and morphology, which include the presence of two transcriptionally-active nuclei, and the lack of ubiquitous compartments like the Golgi, mitochondria and peroxisomes. Even the endolysosomal system appears unusually homogeneous, with small, ~100 nm compartments discharging both protein sorting and degradation functions. *Giardia* is also the only known unicellular eukaryote to possess a suction cup that enables suction-based attachment of the

PROF. SRIMONTI SARKAR

SCIENTIFIC REPORT *Professor*

pathogen to the host gut wall. Also, each of its four flagellar pairs exhibit unique beating patterns, even though they are attached to the same cell body. In addition, *Giardia* is a rare example of a bilaterally symmetrical unicellular eukaryote. Thus, the study of this organism will enable us to understand the cellular machinery that are necessary to sustain these unique features

Summary of Research Work:

We continue to use molecular genetic approaches to interrogate the functions and assemblies of the molecular machines of *Giardia* involved in protein degradation. Comparison between the subunit composition of several supramolecular protein assemblies of the host and the parasite indicate that the ones from *Giardia* are composed of a lesser number of components. A key finding of our research over the past year is uncovering the altered intra-subunit interactions within the proteasomal lid components of *Giardia*. This change may be a reason why the proteasomal lid of the pathogen can assemble despite the *Giardia* genome not encoding two crucial proteins whose orthologues play a major role in the stability of the proteasomal lid assembly of higher eukaryotes. We have also directed our efforts towards understanding the events preceding fusion of a transport vesicle to the target compartment membrane and uncovered the presence of a very minimalized form of a tethering complex that is likely be responsible for vesicle docking.

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	–	02	01	–	–

PROF. AJIT BIKRAM DATTA

Professor

Group Members:

Pritam Naskar,
Sayani Sarkar
Shubham Jha

Collaborator:

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

Scientific Report

Background and Vision:

Post-translational modifications (PTMs) of proteins regulate diverse cellular processes in eukaryotes. Two prime examples of PTMs are ubiquitination and phosphorylation, where the substrate proteins are modified by covalent conjugation with either ubiquitin or a phosphate moiety. In fact, kinases and ubiquitin E3 ligases constitute two largest classes of enzymes coded by eukaryotic genomes. Phosphorylation/dephosphorylation has been established as an indispensable regulatory step in various signaling cascades. Similarly, ubiquitination is also reported to take part in a plethora of sub-cellular processes that includesproteostasis, cell-cycle progression, transcription regulation, and DNA repair. Understandably, defects in these PTMs lead to various pathophysiological consequences such as cancers and neurodegenerative disorders. Our laboratory attempts to understand the specificity of these modification machineries and the regulatory mechanisms that bring spatio-temporal control over these processes.

Specific Objectives:

The specific objectives, that have been worked on in this year are as follows-

- Role of a glutamate to aspartate mutation in E2s in their E3 recognition.
- The basis of E2 discrimination and plasticity in UbL recognition by non-canonical human ubiquitin E1, Uba6.
- Understanding the functional aspects of a orphan receptor kinase from leguminous plant *Arachis hypogea*, in collaboration with Prof. Maitrayee Dasgupta.

PROF. AJIT BIKRAM DATTA

SCIENTIFIC REPORT ***Professor***

Summary of the work:

- ***Role of aglutamate to aspartate mutation in E2s in their E3 recognition:*** Previously, we had identified that a glutamic acid residue found in the Helix 1 of E2s play an important role in dictating their E3 recognition and affinity. Thus, Ube2N could interact with ZNRF1 with high affinity while Ube2B failed to do so despite having identical E3 binding residues. Our experiments had showed that mutating that glutamic acid to apartate in Ube2N reduced its ZNRF1 affinity by ~25 fold. Whereas, replacing the analogous aspartic acid in Ube2B with glutamate allowed its recognition by ZNRF1. These studies underscored the importance of small changes in protein structures in dictating their roles. To prove this point further, we carried out MD simulations and showed that despite dynamic variations in the structures, a small but reproducible difference do exist between the aspartic containing and glutamic acid containing E2s.
- ***The basis of E2 discrimination and plasticity in UbL recognition by non-canonical human ubiquitin E1, Uba6:***Uba6, the non-canoncal human ubiquitin activating E1 enzyme can only interact with a subset of E2s coded by the genome. It is also unique amongst all E1s, as it could activate ubiquitin together with a second UbL, FAT10. Our previous attempts to purify Uba6 from bacterial overexpression systems had failed repeatedly. This year we utilized a synthetically designed Uba6 construct to successfully purify the protein from prokaryotic hosts. The biochemical studies with the purified proteins are now underway.
- ***Understanding the functional aspects of a orphan receptor kinase from leguminous plant Arachis hypogea***: SYMRK receptor kinase from *Arachis hypogea* plays important role in development of root nodules. In collaboration with Prof. Dasgupta's lab we determined the X-ray crystallographic structures for a few SYMRK mutants both in apo form and also in complex with the non-hydrilyzable ATP analog AMP-PNP/Mg^{2+} that showed phenotypic difference in root nodule formations. We are in the process of finding the correlation between structural differences with the functional differences of the 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	–	–	–	–	–	–

DR. ABHRAJYOTI GHOSH

Associate Professor

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*

Scientific Report

Background and Vision:

The central focus of my laboratory is to understand microbial adaptation under stress conditions in the natural environment. We study stress adaptation in model organisms as well as in microbial communities of various environmental niches. To achieve our goals, we use multiple techniques starting with biochemistry, microbiology, and genomics to unravel the molecular players important in the adaptation and evolution of microorganisms.

Summary of research work:

a) We investigated the cross-talk in the heat shock response pathway of thermoacidophilic crenarchaeon ***Sulfolobus acidocaldarius***. We looked into the ability of heat shock protein repertoire comprising Hsp14, Hsp20, and Hsp60 to interact with each other to execute the substrate proteins' folding under stress conditions in this organism. We demonstrated that in the absence of Hsp70 in archaea, Hsp14 transfers sHsp-captured substrate proteins to Hsp60 for refolding.

DR. ABHRAJYOTI GHOSH

SCIENTIFIC REPORT *Associate Professor*

b) The archaeal SRP RNA has been demonstrated to stabilize the SRP54-FtsY targeting complex (TC) and facilitate protein translocation at high temperatures (70-80°C).

c) Several plant-growth-promoting rhizobacteria were isolated and characterized from the tea rhizosphere of Darjeeling, India. These rhizobacteria have been demonstrated to induce an antioxidative defense mechanism in rice plants and protect them from the sheath blight disease caused by *Rhizoctonia solani*. Furthermore, a consortia-based bioformulation comprising a different combination of rhizobacteria has been developed and demonstrated to protect rice plants from *R. solani* infection.

d) We investigated the tea and mangrove rhizosphere microbiome using high throughput sequencing approaches. Our results indicated that the 'rhizosphere effect' plays an essential role in shaping the microbial diversity in the tea and mangroverhizosphere.

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	03	–	–

– SCIENTIFIC REPORT –

DIVISION OF BIOINFORMATICS

BOSE INSTITUTE ANNUAL REPORT 2020-2021

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.

DIVISION OF 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, Jibananda Mondal, Sarama Pradhan, Birendra Kumar Bari.

PROF. SHUBHRA GHOSH DASTIDAR

Professor

Group Members:

Souvik Sinha
Debadrita Basu
Debarati Paul
Nibedita Raychaudhuri
Premananda Basak

Scientific Report

Background and Vision:

The atoms and molecules in a cell are always jiggling, dancing and bumping into each other and occasionally carrying out a specific reaction or a process. Hence it is important to understand how exactly this is choreographed, i.e. how such motions influence the molecular structures. Such dynamics of the molecular structures forms the basis of the conformational changes of the molecules, their interaction with other molecules and thus determines the function of the molecules. Therefore dissecting the characteristics of the dynamics of a bimolecular system paves the way to the understanding of the molecular mechanism of their function. The general interest of our group is to gain novel insight into biology analyzing the structure, dynamics and the statistical thermodynamics of the molecular systems using computer simulations. These methods not only help to understand the biomolecular mechanism of functions but can also reveal how the molecular defects can lead to a disease, which becomes useful for designing drugs in a rational manner. Overall, we are dealing with protein-protein, protein-lipid bilayers, and protein-ligand interactions in all atom description

Summary of Research Work:

The overall research activities of the group could be broadly classified into the following directions: (i) Computational drug design against COVID19, particularly to find molecules from the list of already FDA approved drugs for some other diseases, which could be repurposed against COVID19, (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 tubulin conformation is a possible key to control the cell proliferation and has the promise for getting applied in designing promising therapeutic molecules against cancers, (iii) understanding the mechanism of allosteric activation and deactivation of Kinases

(iv) miscellaneous collaborative works with the experimentalists. Such activities have led to several specific achievements which in very brief would be the following:

(a) a list of promising drug molecules have been identified which could be tested further form possible repurposing against COVID19, (b) a substantial understanding on the ligand induced changes in the α,β-tubulin conformations have been understood which could tell the molecular mechanism of the drugs that inhibits cell proliferation that binds to Tubulin to bias their conformations; a key insight for drug design (c) a path for much deeper understanding on the allosteric regulations of the Kinase functions has opened, more work is underway (d) complemented experimental observations with insights from molecular modeling that has reconciled the experimental results with molecular 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
–	03	–	06	–	–	–

DR. ZHUMUR GHOSH

Associate Professor

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*

Scientific Report

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.

Aims and Objectives:

Aim 1: Investigating the role of regulatory RNAs in cancer and early embryonic development.

Aim 2: Role of regulatory RNAs and transcription factors in maintaining cellular pluripotency and their differentiation.

Work Achieved:

A. Investigating the role of regulatory RNAs in cancer: LncRNA loci harbouring SNPs has been elucidated for the three most prevalent female cancers in India viz. breast, cervical and ovarian cancer. Apart from those reported in dbSNP, several novel variants have also been detected by our SNP detection pipeline. A database named ClinicLSNP has been hosted within LncRBase V.2 (2nd version of lncRNA database has been launched) which contains detailed information about these SNPs **(Das et al., RNA Biol 2020)**.

B. Devising a therapeutic approach to combat Covid-19 infection by implementing Artificial intelligence (AI) and pattern recognition techniques followed by molecular docking to predict FDA approved pharmaceuticals and nutraceuticals to target E protein (**Das et al.,Genomics 2021**).

DR. ZHUMUR GHOSH

SCIENTIFIC REPORT ***Associate Professor***

Future Research Plans:

a) Detecting the role of miRNAs as epigenetic modulators inducing oncogenicity in stem cell derivatives.

b) Studying the role of regulatory noncoding RNAs(ncRNAs) as regulators during fertilization and early stages of murine development and identifying potential ncRNA-mRNA interaction which is having significant role in determining fertility.

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	05	–	02	01	–	01

DR. SUDIPTO SAHA

Associate Professor

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

Scientific Report

Background and Vision:

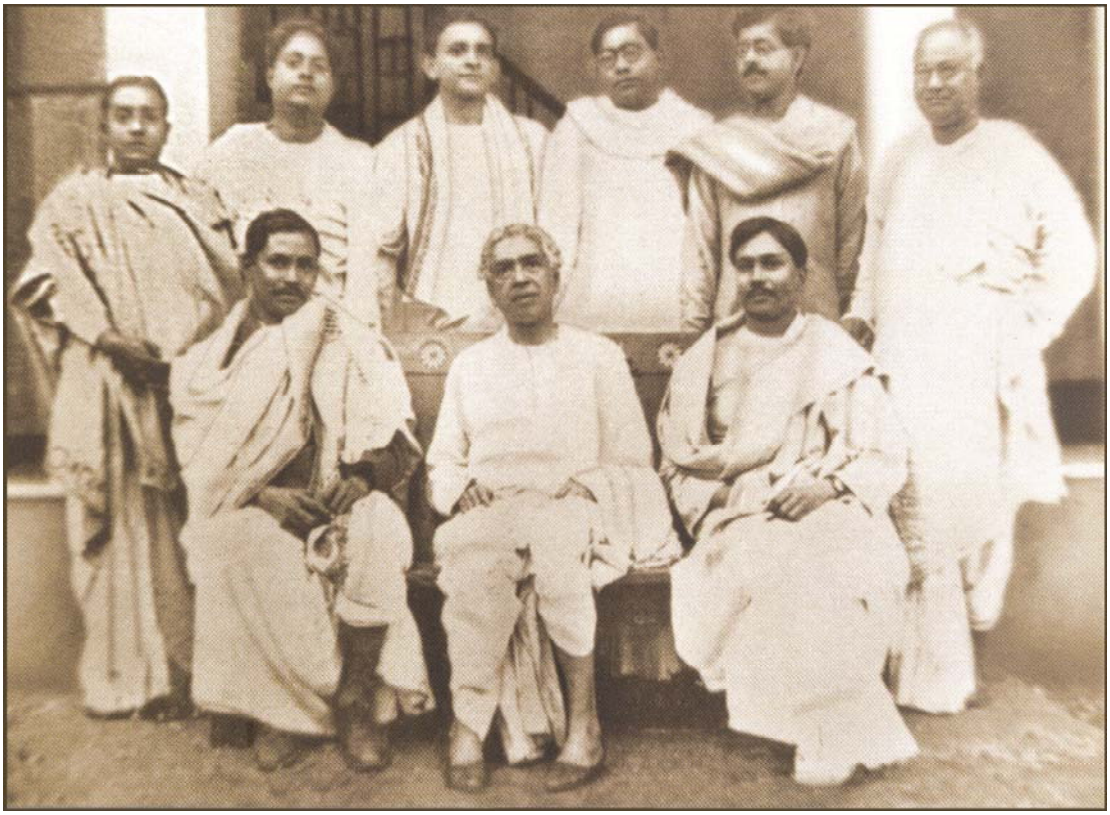
My laboratory studies lung diseases including asthma, multi-drug resistant tuberculosis (MDR-TB) with specific goal of understanding and improving diagnosis, prognosis and treatment using bioinformatics and systems biology approaches.

Summary of Research Work:

- During this period, we have contributed in the area of COVID-19, MDR-TB, c-myc regulation (for details see publications). We have developed a database of drug resistance-associated genes and build statistical models for predicting drug-resistant TB isolates from whole-genome sequencing data.

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	07	01	01	01	–	–



Acharya Jagadis Chandra Bose with some of his pupils in 1928
Standing (left to right) : S. Datta, S. N. Bose, D. M. Bose, N. R. Sen, J. N. Mukherjee, N. C. Nag
Sitting (left to right): Meghnad Saha, Jagadis Chandra Bose, J. C. Ghosh

– SCIENTIFIC REPORT –

DEPARTMENT OF BIOPHYSICS

BOSE INSTITUTE ANNUAL REPORT 2020-2021

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.

DEPARTMENT OF BIOPHYSICS

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. GAUTAM BASU

Professor

Group Members:

Dr. Aditya Dev, *RA*
Dr. Debamitra Chakravorti, *RA*
Sudakshina Ganguly, *SRF*
Chandradeep Basu, *SRF*
Bhavna Pandey, *SRF*

Scientific Report

Background and Vision:

All biological phenomena are driven by specific molecular interactions via cognate recognition and non-cognate discrimination processes. Both recognition and discrimination are mediated by specific structural and dynamic elements of the interacting molecules. Therefore in order to understand molecular triggers of biological functions it is important to understand structure and conformations of molecules. Given known structures (or a known set of sequences), it is also important to know how different elements interact via specific or non-specific physical forces. In my lab we use biophysical, spectroscopic as well as computational tools to understand structural properties of biologically important molecules and their significance in biology.We work on a number of diverse projects with specific aims. Here are some specific objectives: (i) Structure-function-evolution of aminoacyltRNA-synthetases, (ii) Peptide conformation and design, (iii) Electrostatic interactions in biomacromolecules, (iv) Protein and Nucleic Acid dynamics, (v) Small molecule-DNA interaction.

PROF. GAUTAM BASU

SCIENTIFIC REPORT ***Professor***

Summary of Research work:

- We established for the first time that the DNA minor groove can induce cis−trans isomerization in a ligand it binds (a Near-Infrared Fluorescent Probe).
- We experimentally established that the replacement of a single residue in a β-hairpin by Gly-Pro, a 'united-residue' known to be overrepresented in protein β-sheets as Gly-*cis*Pro without causing much structural distortion, and comparison of the resulting β-hairpin with those of other single/double residue substitutions show that Gly-Pro but not Pro-Gly is well accommodated in the isolated β-hairpin.
- We established the structure of a novel amphipathic α-helix forming segment in *Physcomitrella patens*dehydrin that play a key role in abiotic stress mitigation.

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	–	–	–	–	–

PROF. GAUTAM BASU

SCIENTIFIC REPORT | Professor

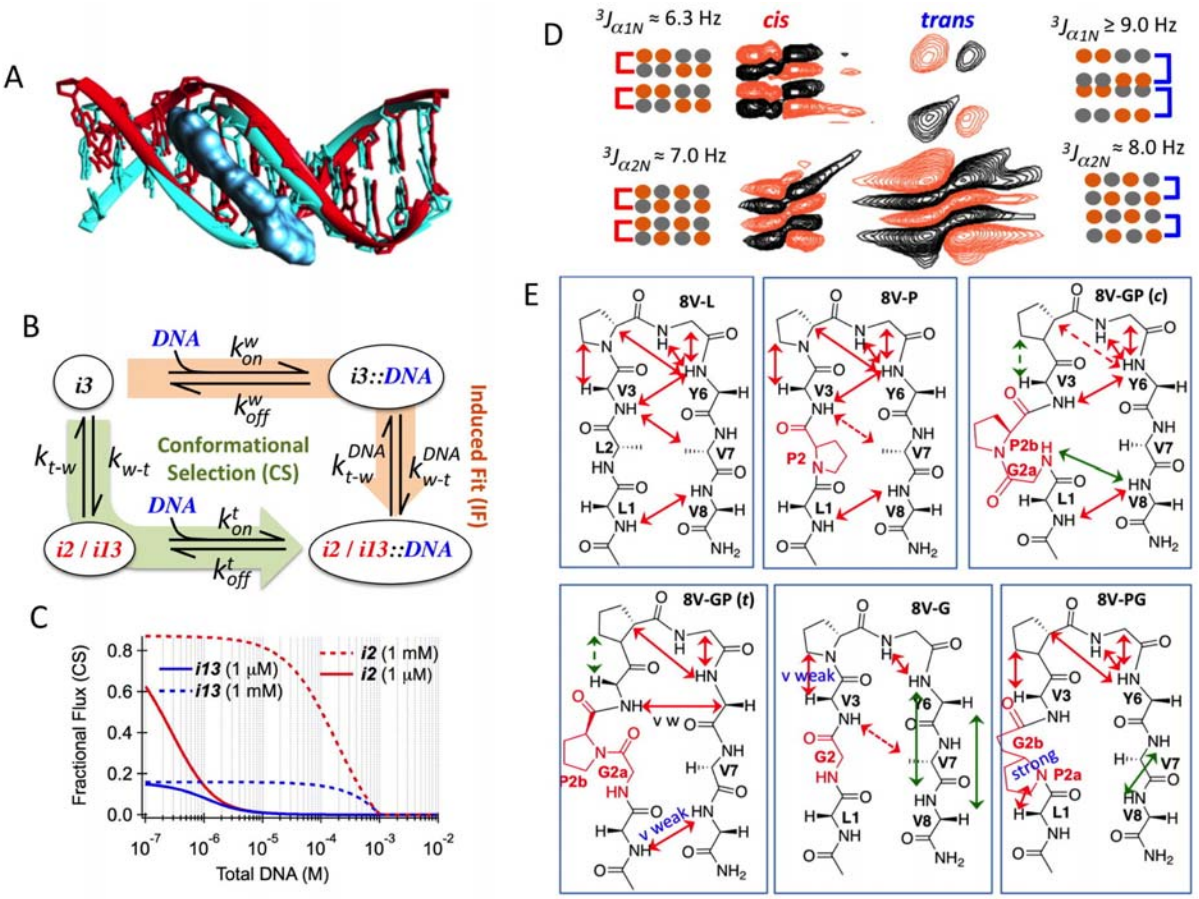


Figure 1.A. Structure of free and QCy-DT-bound DNA (CGCGAAATTTCGCG) determined by NMR Spectroscopy. **B.** The two possible mechanisms of DNA binding by QCy-DT **C.** Flux analysis of QCy-DT binding to DNA revealing the relative contributions of the induced fit and the conformational selection pathways. **D**. The amide to alpha hydrogen coupling constants of Gly (difference between the cis and the trans conformations) in the peptide series that was studied to test how well a Gly-Pro can be accommodated in a beta-hairpin. **E.** A summary of intra-strand backbone NOE crosspeaks in the peptide series.

PROF. ANIRBAN BHUNIA

Professor

Group Members:

Aaishi Bhattacharya, *JRF*
Dipanwita Roy, *SRF*
KarishmaBiswas, *SRF*
Dipita Bhattacharyya, *SRF*
Sk. Abdul Mohid, *SRF*
Humaira Ilyas, *SRF*
Ranit Pariary, *SRF*
DibakarSarkar, *SRF*
Shruti Mukherjee, *SRF*
Dr. IpsitaChakraborty, *RA*
Dr. Sourav Kumar, *RA*

Scientific Report

Background and Vision:

Biological membranes are an important functional interface for a plethora of physiological reactions, taking place within the cell. Thus all biological membranes serve as an indispensable platform for several surface proteins, membrane-integrated proteins/peptides and other ions and signalling molecules. The determination of molecular structure and dynamics of biomembranes and the associated functional peptides and proteins is, in fact, one of the most significant challenges in contemporary science. In this connection, vesicles and liposomes mimicking the lipid bilayer structure have been used to study membrane-protein/peptide interaction. Recently, nanodiscs, composed of lipid bilayer and membrane scaffold proteins (MSP), represent a more native environment than liposomes/ bicelles or detergent micelles. Recent developments of NMR

PROF. ANIRBAN BHUNIA

SCIENTIFIC REPORT *Professor*

spectroscopy have facilitated in-depth characterization of the dynamics of interactions at the atomic-resolution. This precise structural knowledge is very much crucial to correlate with their membrane-directed functioning. Dr. Bhunia's laboratory involves several biophysical techniques, including cutting-edge solid- as well as solution-state NMR spectroscopic techniques to characterize the membrane-associated functioning of several biologically active peptides and proteins.

Summary of Research Work:

- Three-dimensional solution structure of several antimicrobial peptides targeting pathogenic model membrane mimic.
- Probed transient non-native states in Aβ40 fibril formation by NMR.
- Understanding the role of Alzheimer pathogenicity from the investigation of core amyloid forming Aβ40 fragments in membrane.
- Pioneer in determining three-dimensional solution structure in live cell.
- Decipher the epitope of early nucleation events for α-synucle in familial mutants using NMR.
- Probing the LPS binding structural motif in α-synucle in that modulates disease propagation from gut to brain.
- Developed reduced dimensionality experiments to record 3D HNCACB and CBCACONH to monitor the kinetics and dynamics of Aβ fibrillation.
- Developed solvent relaxation NMR as a tool for Real-time monitoring Water- Dynamics in Protein Aggregation Landscape.

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	14	01	04	–	–	–

DR. SUBHRANGSU CHATTERJEE

Associate Professor

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*

Scientific Report

Background and Vision:

The main goal of my research is to employ high resolution multidimensional (1D/2D/3D) NMR spectroscopy in the biophysical and structural studies of biomolecules. Both Nucleic Acid and Protein NMR in conjunction with the use of Molecular Dynamics simulation, Modelling and CD, Fluorescence, IR, TEM, SEM and other spectroscopies etc. are used to unravel Nucleic Acid Protein interactions, Nucleic Acid-Drug/Ligand interactions, protein/peptide aggregation/ dissociation and biomolecular folding and unfolding. In addition to that our laboratory works on both on cell biological and computational studies on G-quadruplex and G-quadruplex-protein/peptide interactions. We try to unravel the role of G-quadruplex structures in dictating the epigenetic landscape of oncogenes. We also focus on the G-quadruplex mediated transcriptional regulation of oncogenes and other coding and non-coding genes.

Summary of Research Work:

In this year we have published many papers among which I am describing the brief of two papers.

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

Biochimica et Biophysica Acta (BBA) - General Subjects Volume 1865, Issue 8, August 2021, 129899.

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 remodeling the region.

DR. SUBHRANGSU CHATTERJEE

SCIENTIFIC REPORT ***Associate Professor***

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 remodeling 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 700bp 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.

Prion-derived tetrapeptide stabilizes thermolabile insulin via conformational trapping [iScience (Cell Press) Volume 24, Issue 6, 25 June 2021, 102573**]**

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.

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
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DR. DEBJANI ROY

Assistant Professor

Scientific Report

Background:

Over the past several years we have been developing new methods by introducing robust network parameters that facilitated our genome-wide network-based studies. These parameters are similarity index, degree ratio, relative scaling, and on target ratio. These parameters have been used to recreate strong networks to better understand the biological system including aging. These parameters helped us to identify new biomarkers from next-generation sequencing data and human interactome. We have developed several algorithms for the identification of protein complexes from the biological network. In recent days, COVID-19 infection has become a pandemic all over the world.The COVID-19 infections share similar symptoms with malaria infections and thus caused asymptomatic complications for the diagnosis of the disease.*Plasmodiumfalciparum* is a member of the phylum Apicomplexa and possesses a unique plastid-like organelle called the apicoplast. In 2006 we homology modeled the three-dimensional structure *P. falciparum* apicoplast specific dihydrolipoamide dehydrogenase dimeric enzyme and submitted it to the protein data bank (PDB ID: 2G7D). This enzyme controls the first step of the apicoplast-specific fatty acid synthesis.Understanding the structure-function relationships of several significant pathway-specific enzymes including the dihydrolipoamide dehydrogenase is of major interest.

Vision:

1. Detailed understanding of the active sites and the catalytic mechanisms of the enzymes.
2. Study Structure-function relationships of the major biochemical pathways and enzymes.
3. Detailed understanding of the scaffolds that influences the structure-function relationships.
4. Computer hardware design of the biological system and simulation

DR. DEBJANI ROY

SCIENTIFIC REPORT ***Assistant Professor***

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Summary of Research Work :

a. We proposed an integrated pipeline to discover potential inhibitors against protozoa and the virus. We generated *P.falciparum* apicoplast and antiprotozoal pathway-specificscaffoldlibraries. Several inhibitors and peptides for the interface region of *P.falciparum* apicoplast specific dihydrolipoamide dehydrogenase enzyme have beenreported which may inhibit the dimerization of this enzyme. We have also identified the inhibitors for each biochemical pathway of the apicoplast of *P. falciparum*. We have predicted targets of unknown target containing antiprotozoal DrugBank drugs. Based on the developed antiprotozoal drug scaffolds library we have retrieved four inhibitors from the database Asinex. The interactions of these molecules with their corresponding SARS CoV-2 targets, cysteine protease, and the angiotensin-converting enzyme have been studied.

b. Alzheimer's disease (AD) is the most prevailing neurodegenerative disorder which causes memory loss and cognitive decline. New computational approaches are required for the identification of new uses of existing drugs or drug repositioning for Alzheimer's Disease. We have developed a novel pipeline that combines both network and pharmacological approaches for providing new insights into the drug repositioning approach of AD. Drugs with high connectivity with AD-specific proteins and high disease specificity have been selected as significant repositioning candidates for AD. The chemical fingerprint similarity study revealed that anisole, indole, and piperazine fingerprints are the most promising chemical motifs to develop new drugs for AD in the future. We identified five new molecules with significant drug-likeness properties. Five new molecules can be effective inhibitors of several AD-specific targets. This work opens up ways for developing potential drugs that are of high importance in AD medical research.

c. We studied the role of the cysteine protease (CP) enzyme in the SARS-CoV2 and several protozoa families. Based on the catalytic side residues of all CPs, we identified several chemical scaffoldsthat may be used to modify interactions at the active site of these enzymes to control the pathogenesis. These approaches are cost-effective and have an immediate effect to control infections amid the COVID-19 pandemic.

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
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DR. SMARAJIT POLLEY

Assistant Professor
Wellcome Trust DBT India Alliance Intermediate Fellows

Group Members:

Dr. Trina Dutta, *RA*
Dr. Dwijit Guha Sarkar, *RA*
Prateeka Borar, *SRF*
Samrat Mitra, *JRF*
Deeparna Sutradhar, *JRF*
Pranita Ray, *JRF*

Scientific Report

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

DR. SMARAJIT POLLEY

SCIENTIFIC REPORT

Assistant Professor
Wellcome Trust DBT India Alliance Intermediate Fellow

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.

I want to develop and establish multidisciplinary research themes to understand the signaling modularity of eukaryotic protein kinases in their biological contexts:

- *Structural and Biochemical Basis of IKK complex formation and regulation*
- *Novel autocatalytic mechanism of IKK and its implication in signaling*
- *Structural and Biochemical Basis of DLK1 activation and function*

The other themes of the lab include, but not limited to:

- Understanding the Structural basis of cancer promoting function of p53 GoF (Gain of Function) mutants.
- Enzymatic remediation of environmental pollutants.

I am developing workflows in the laboratory that depend upon truly cross-disciplinary experimental approaches including: *In vitro* and cellular biochemistry, cellular and chemical genetics, chemical biology, omics studies and analytical studies using mass spectrometry, structural biology using X-ray crystallography and CryoEM.

Summary of Research Work:

We have been able to set up large scale expression Sf9 expression system in the laboratory that was previously elusive in the institute. We have purified a number of eukaryotic protein kinases as well as other proteins to near homogeneity from soluble fractions using this system. We were able to establish the *analogue sensitive* kinase workflow in the laboratory that informs about the hitherto unknown substrates of a kinase of interest. We have established this workflow for IKK2. Similar approach has been adopted for other kinases including IKK1. We were also able to reconstitute mononucleosomes from in-house purified components and optimized its interaction with IKK1. To study IKK1-nucleosome interaction in a quantitative fashion, we are employing non-radioactive mononucleosome preparation. We have been able to reconstitute Cy5-labeled mononucleosome where the DNA is end-labeled with the dye. In solution assays are currently being optimized. Structural analyses of a number of kinase-signaling complexes using CryoEM at national facilities had begun, however we failed to continue due to COVID19 pandemic. On a different theme, we obtained crystals for at least two enzymes that degrade polluting dyes. Initial

DR. SMARAJIT POLLEY

SCIENTIFIC REPORT

Assistant Professor
Wellcome Trust DBT India Alliance Intermediate Fellow

X-ray diffraction data collected elsewhere indicated the requirement for bigger, better single crystals. Crystallization conditions have now been optimized and data collection shall begin at the newly installed X-ray diffractometer in BI when the situation permits. By using different methodologies used in directed evolution, we have been able to generate a number of mutants for the AzoR3A enzyme. Medium-throughput screening methodology to obtain beneficial mutants are underway..

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
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– SCIENTIFIC REPORT –

DEPARTMENT OF CHEMISTRY

BOSE INSTITUTE ANNUAL REPORT 2020-2021

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.

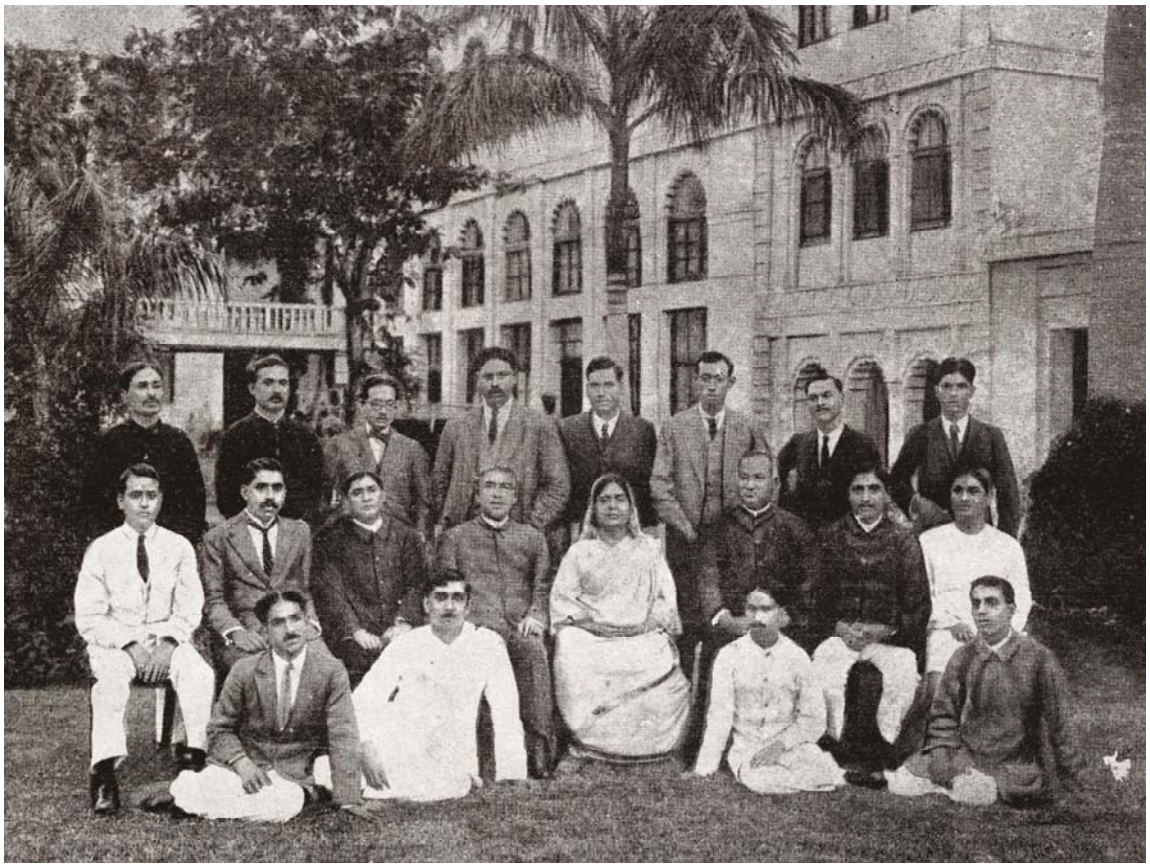
LIST OF PERSONNEL

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, Ayan Biswas, Soumya Mal, Soumya Mukherjee, Md. Sorique Aziz Momin, Nilanjana Hazra. ***RA :*** Arun Kumar Sharma.

Staff Members: Dipak Ch. Konar (upto 17.09.2020), Gaurab Kumar Roy, Mrityunjoy Kundu, Sachchidanand Ram, Asoke Kr. Maity.



Acharya Jagadis Chandra Bose and Lady Abala Bose with
Research Assistants of Bose Institute (1926)

PROF. SUMAN KUMAR BANIK

Professor

Participants :

Ayan Biswas, *Project Assistant*
Tuhin Subhra Roy, *SRF*
Md Sorique Aziz Momin, *JRF*

Collaborators :

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

Scientific Report

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.

Aims and Objectives:

Our lab aims to develop theoretical frameworks to study signal transduction in GRNs using the tools of information theory. The broad focus of our research group is to understand the basis of signal transduction in biochemical networks within the purview of fluctuations in a single cell.

PROF. SUMAN KUMAR BANIK

SCIENTIFIC REPORT ***Professor***

Work Achieved:

We present a theoretical formalism to study steady-state information transmission in a coherent type-1 feed-forward loop motif with an additive signal integration mechanism. Our construct allows a two-step cascade to be slowly transformed into a bifurcation network via a feed-forward loop, which is a prominent network motif. Using a Gaussian framework, we show that among these three network patterns, the feed-forward loop motif harnesses the maximum amount of Shannon mutual information fractions constructed between the final gene- product and each of the master and coregulators of the target gene. We also show that this feed-forward loop motif provides a substantially lower amount of noise in target gene expression, compared with the other two network structures. Our theoretical predictions, which remain invariant for a couple of parametric transformations, point out that the coherent type-1 feed-forward loop motif may qualify as a better decoder of environmental signals when compared with the other two network patterns in perspective.

Future Research Plans:

We aim to study information processing in other gene regulatory networks, e.g, feed-forward loop. In addition, we also plan to develop theoretical formalism in the context of information transfer in biochemical motifs.

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
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PROF. JAYANTA MUKHOPADHYAY

Professor

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*

Scientific Report

Fundamental Mechanism of transcription and gene regulation in bacteria

Transcription is the first step in gene expression where most regulation occurs and is one of the most important targets for antibacterial therapy. RNAP core enzyme together with sigma factor(s) and/or numerous regulator(s) orchestrates the gene expression in bacteria. Our lab seeks to characterize the interactions among RNAP, 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 vitro* transcription system to address the following specific aims:

1. *Mechanism of gene regulation by various transcriptional factors and sigma factors in prokaryote.*

PROF. JAYANTA MUKHOPADHYAY

SCIENTIFIC REPORT ***Professor***

2. Identify and characterize inhibitors of M. tuberculosis gene expression.

3. Identify new target for anti-tuberculosis agents.

Summary of Research Work:

Our laboratory is involved in characterizing of delta factor of B. subtilis and understanding the nature of sigma release of *B. subtilis* and *M. tuberculosis* during transition from transcription initiation to elongation. Our recent finding showed that the affinity of delta factor to DNA increases significantly when RNAP is present at the promoter. When RNAP escapes the promoter for transcription elongation, delta releases from its site. We further showed that the interaction of α-CTD of RNAP with delta factor is responsible for this enhanced DNA binding affinity. Using ChIP-RTPCR assay, we demonstrated that the *in vivo* delta occupancy on DNA is higher at the promoter region compared to the other region on the structural gene.Based on our observation we proposed a model for mechanism of transcription activation by the delta factor.

We have also identified an inhibitor for Mtb RNA polymerase from plant extracts that inhibit transcription.

Future Plans:

- Study the mechanism of σ-release in *B. subtilis* and *M. tuberculosis*
- Indentify and characterizethe inhibitors of (MDR) *M. tuberculosis* transcription
- SELEX based approach to identify promoters of the sigma factors of *M. tuberculosi.*

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
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– SCIENTIFIC REPORT –

ENVIRONMENTAL SCIENCES SECTION

BOSE INSTITUTE ANNUAL REPORT 2020-2021

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.

ENVIRONMENTAL SCIENCES

LIST OF PERSONNEL

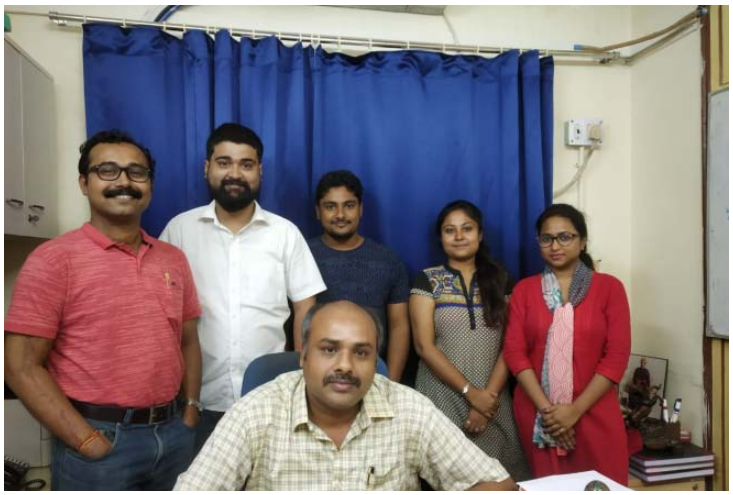
Faculty Members: Prof. Sanjay K. Ghosh (Chairman), Dr. Abhijit Chatterjee and Dr. Sanat K. Das.

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

Staff Member: Dr. Anandamay Adak.

DR. ABHIJIT CHATTERJEE

Associate Professor



Group Members:

Arindam Roy, *SRF*
Abhinandan Ghosh, *SRF*
Monami Dutta, *SRF*
Sauryadeep Mukherjee, *SRF*
Durba Das, *Jr. Project Associate*

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*

Scientific Report

Background and Vision:

The research activities are based on the “Air Quality and Climate Change” especially over the Indian regions vulnerable to human health as well as climate change and extreme weather events. Air quality studies are mainly carried out over the regions of high population density, for example, urban metropolis in eastern India, the entire Indo-Gangetic Plain, etc. The characterization, temporal variability, atmospheric changes, sources etc of the gaseous and particulate air pollutants like CO, O_3, NO_2, SO_2, VOC, $PM_{2.5}$, PM_{10} are studied. Climate change

DR. ABHIJIT CHATTERJEE

SCIENTIFIC REPORT *Associate Professor*

studies are mainly focused on the geographgically and ecologically sensitive regions like eastern Himalaya, Sundarban mangrove ecosystem etc. The major questions addressed are: How aerosols interact with the clouds and rain? How aerosols and gases are exchanged between the different spheres of our environment? How aerosols and gases alter the microphysical and chemical properties of clouds?

Vision: Accurate determination of the quantitative contributions of various sources of air pollutants and building strategic action plans towards their mitigation over Indian urban regions; Long-term chemical characterization of aerosols and gases for refining and tuning of existing regional climate models.

Summary of Research Work:

Aerosols chemical transformation: We have identified the major reaction pathways through which sea-salt aerosols transported from Bay of Bengal interact with the polluted inorganic acids and quantitatively estimated the loss of potentials of sea-salt aerosols as cloud condensation nuclei

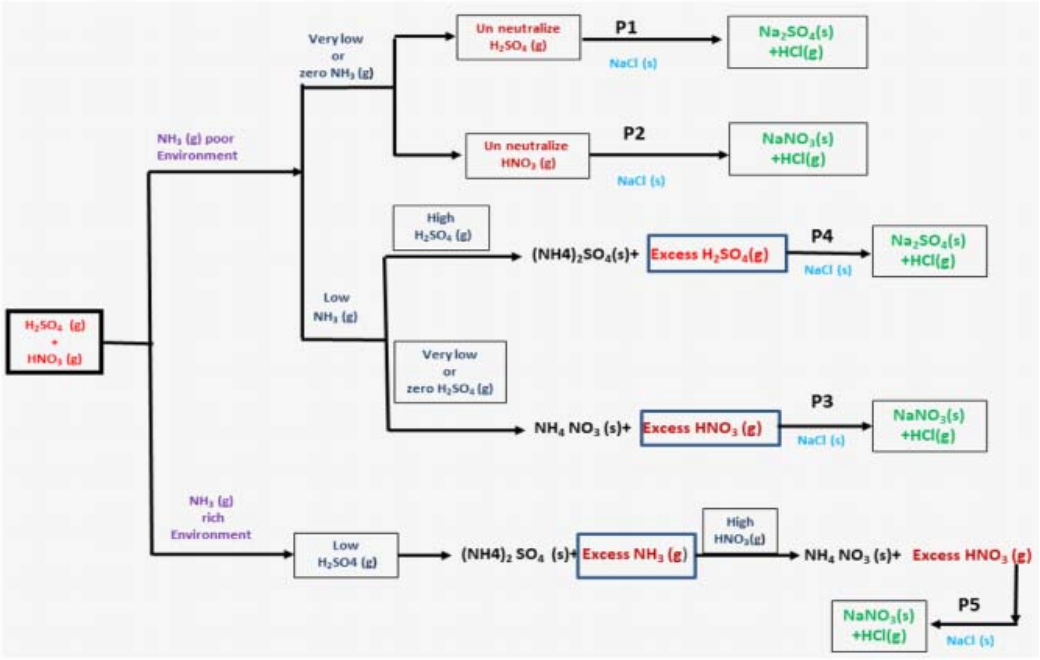


Fig 1: Possible reaction pathways between sea-salt aerosols and inorganic acids

DR. ABHIJIT CHATTERJEE

SCIENTIFIC REPORT *Associate Professor*

High rise in carbonaceous aerosol during lockdown 2020: Our study revealed that the absence of vehicular emissions, production of NOx significantly decreased during lockdown 2020. This in turn enhanced the surface ozone favoring the photochemical oxidation of biogenic VOCs and produces huge amount of secondary organic aerosols.

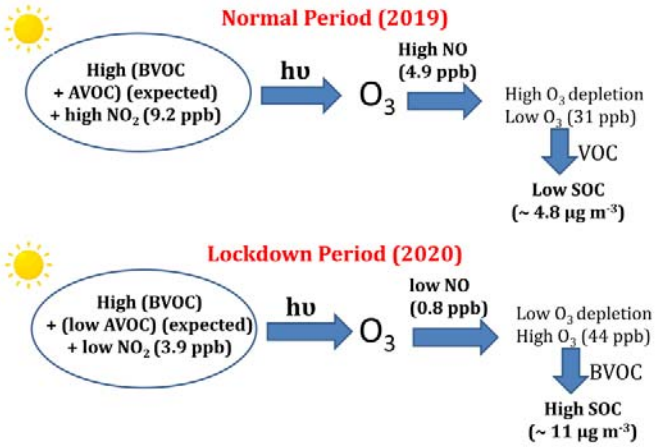


Fig 2: Formation of secondary organic aerosols over eastern Himalaya during lockdown 2020 and compared with normal period (2019)

Role of aerosol in cloud formation: We studied that when black carbon aerosols (though hydrophobic) get aged in the atmosphere and coated with several soluble species, then they act as good cloud condensation nuclei. But when sea-salt aerosols (though hydrophilic) get aged and interact with the polluted inorganic acids, then their potential to act as CCN decreases. Therefore, transported and aged soot particles are better CCN than the transported and aged sea-salt aerosols.

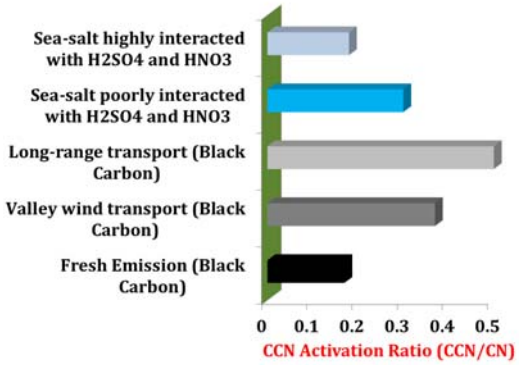


Fig 3: Ability of cloud droplet formation of different types of aerosols

DR. ABHIJIT CHATTERJEE

SCIENTIFIC REPORT *Associate Professor*

Brown Carbon aerosol chemistry: We have studied the chemical characterization and the light absorbing ability and warming potentials of Brown Carbon aerosols of different sizes over different atmospheric environments like high altitude Himalaya, tropical urban metropolis and Sundarban mangrove forest.

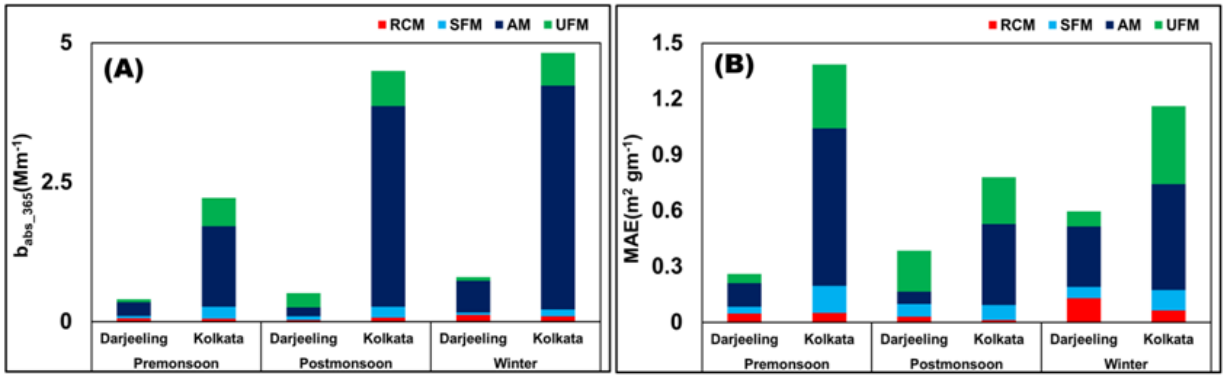


Fig 4: Absorption coefficient and mass absorption efficiency of Brown Carbon aerosols over Kolkata and Darjeeling at different sizes of aerosols

Impact of lockdown on India's air quality: We have studied the impact of lockdown 2020 on the air quality over different states in India. We observed that different states behaved differently and the long range transport played major roles for the loading of atmospheric aerosols in different states during lockdown.

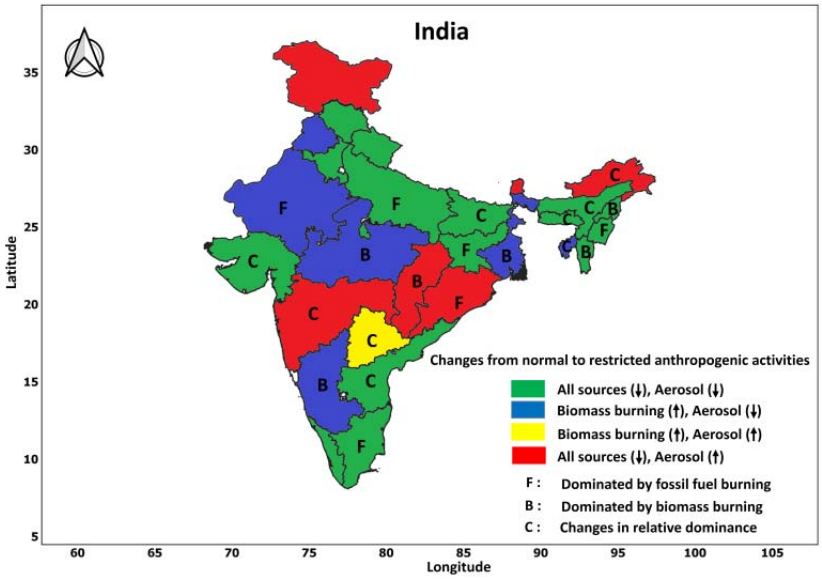


Fig 5: "Aerosol Source-Aerosol Loading" relationships for different Indian states during lockdown 2020

DR. ABHIJIT CHATTERJEE

SCIENTIFIC REPORT ***Associate Professor***

Impact of hypochlorite spraying during lockdown 2020: I studied the effect of excessive use of sodium hypochlorite solution/spray as surface disinfectant to stop spreading COVID-19 on the atmospheric chemistry and public health.

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	07	11	04	–	–	02

DR. SANAT KUMAR DAS

Associate Professor

Scientific Report

Background and Vision :

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

Summary of Research Work :

1. ***Investigation of airborne microbes over Indo-Gangetic Plain from the Himalayas to Coastal Bay of Bengal***

An integrated campaign covering wide region of Eastern India in winter starting from the Himalayas to coastal region of the 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. The microbial analysis is presently under process.

DR. SANAT KUMAR DAS

SCIENTIFIC REPORT *Associate Professor*

Fig. 1: Sample collection at middle of night at Darjeeling in a cold windy weather condition

2. Characterization of aerosol types by columnar optical properties analysis at a coastal site on eastern seaboard of India (Collaboration with Indian National Center for Ocean Information Services (INCOIS))

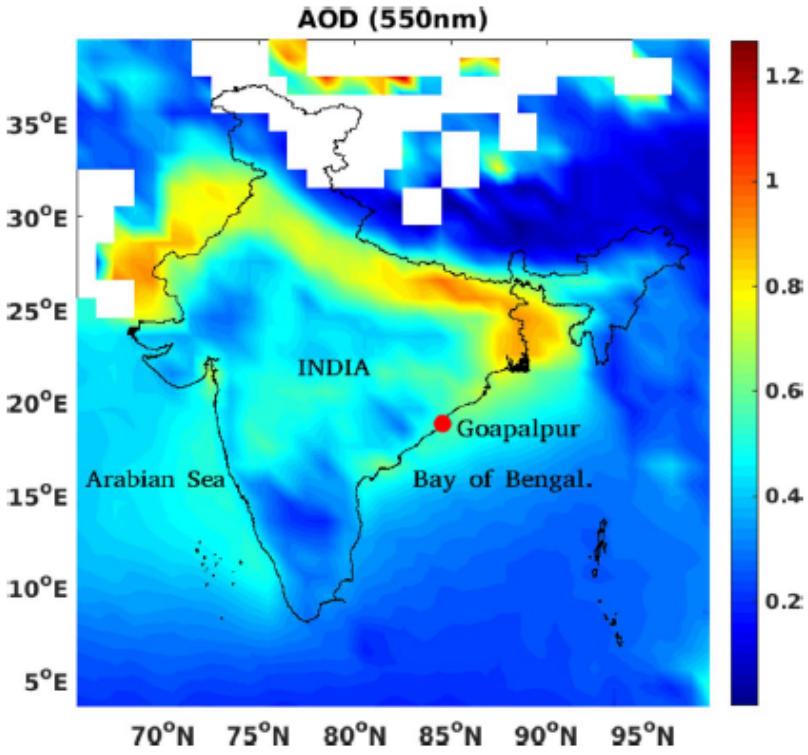


FIGURE 2: SPATIAL DISTRIBUTION OF AOD IN INDIA

DR. SANAT KUMAR DAS

SCIENTIFIC REPORT *Associate Professor*

The coastal stretch of the northwestern Bay of Bengal experiences mixture of aerosol types from variety of sources attributed to spatial heterogeneity. The present study aims to identify aerosol types from ground based spectral measurements of Aerosol Optical Depth (AOD) at Gopalpur (19.30°N, 84.88°E), a coastal site on the eastern seaboard of India. The spectral variation of AOD exhibits four distinct types. The seasonal variation of aerosol size characterization revealedthe prevalence of coarser mode particles during premonsoon (March - June) and monsoon (July - October) period. The coarser mode aerosols during premonsoon were attributed to transport of dust, minerals and local sea spray aerosols, whereas during monsoon due to wet removal of finer aerosol particles. In contrast, the dominance of fine mode particles was observed during postmonsoon (November - February) possibly due to strong local anthropogenic emission and advection of finer particles. In addition, AOD variations were strongly associated with daily fluctuations in wind speed. The relatively higher wind speed during premosnoon acts conducive for genesis of relatively larger aerosol particles such as sea-salt. The present study complements the information on daily and seasonal variability of aerosol size characteristics that could be critical in filling gaps for global level assessment. Additionally, this study strengthens the existing knowledge of the aerosol influence on the regional weather pattern, contributing to more comprehensive understanding of the regional climate system in response to anthropogenic forcing.

3. Impact of Lockdown created by COVID-19 pandemic on ground-based Airglow Image observations in India (Collaboration with The Indian Space Research Organisation (ISRO))

Aerosols are responsible for the scattering and absorption of any kind of visible radiation passing through the atmosphere. The lockdown situation during the present pandemic condition provides us the opportunity to estimate the contribution of lower atmospheric aerosols coming from various surface sources in the attenuation of signals generated from the upper atmosphere and observed them at the ground. Airglow emissions originating from mesospheric and thermospheric altitudes have been routinely being monitored from Kolhapur (16.8°N, 74.2°E) using Imagers under the ISRO. We notice that the observable amplitudes of very small-scale waves during April 2020 were significantly smaller than the regular

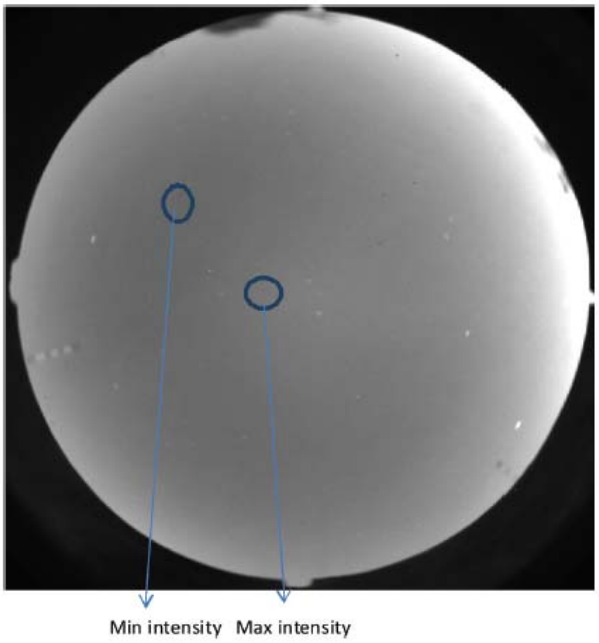


FIGURE 3:AIRGLOW IMAGE ON A CLEAR DAY

observations. We attempt to identify the reason for such low observable amplitudes. The improved contrast of the airglow imager is found to be the possible reason for such a drastic difference in the quality of measurements. We suggest that lockdown had important repercussion on the visibility through the improved air quality and thus the better viewing conditions of the instrument were reflected in observations carried out by airglow imager.

4. Investigation of Bioaerosols over Marine regions, scheduled for sampling:

Our recent study reports that a continental winter-time haze is moving out from Indo-Gangetic Plain to the Bay of Bengal. This continental haze contains large abundance of pollutants attached with airborne microbes, commonly known as bioaerosols, which needs to be investigated. To investigate the changes of the airborne microbial community due to long-range transportation of this continental haze over the marine regions from the Bay of Bengal to the Indian Ocean, I proposed to the Ministry of Earth Sciences (MoES) for providing cruises and the proposal has

been accepted for the periods given below solely dedicated for my research team. I am expecting to get good results from the future ship-borne experiments, given below.

Institute	Principle Investigator	Study Area	Period	Embarkation	Disembar-kation	Platform
Bose Institute	Dr.Sanat Kumar Das	Bay of Bengal-Indian Ocean	1-7 Oct, 2021	Chennai	Cochin	RV-Sagar Tara
Bose Institute	Dr.Sanat Kumar Das	Bay of Bengal-Indian Ocean	3-14 Feb, 2022	Cochin	Chennai	RV-Sagar Tara
Bose Institute	Dr.Sanat Kumar Das	Bay of Bengal	7-18 Feb, 2022	Chennai	Chennai	RV-SagarAnveshika

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	03	–	08

– SCIENTIFIC REPORT –

DEPARTMENT OF MICROBIOLOGY

BOSE INSTITUTE ANNUAL REPORT 2020-2021

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.

DEPARTMENT OF MICROBIOLOGY

- 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: Arindam Dutta, Shrestha Ghosh, Satamita Deb, 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. Debarun Acharya, Dr. Avijit Das, ***Women Scientist :*** Dr. Madhumita Roy, Dr. Shreya Sengupta.

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

PROF. SUJOY KR. DAS GUPTA

Professor

Group Members:

Dr. Shreya Sengupta, *DST Woman Scientist*
Shrestha Ghosh, *SRF*
Apurba Sarkar, *SRF*
Madhumanti Patra, *SRF*
Poulomi Ghosh, *SRF*
Anik Barman, *SRF*
Rahul Shaw, *SRF*

Scientific Report

Background and Vision:

TB is a significant disease worldwide, especially in India, a country that contributes about 20% towards the global TB burden. We investigate the molecular biology of *Mycobacterium tuberculosis*, the TB pathogen using mycobacteriophages. Our fundamental vision is that we may devise new methods to inactivate mycobacteria by understanding how mycobacteriophages infect and kill mycobacteria. We are mainly focused on a phage named D29 with which we have been experimenting for many years and therefore gathered considerable experience. We are also investigating aspects of mycobacterial metabolism using state-of-the-art tools such as CRISPR Cas and NGS analysis of RNA.

PROF. SUJOY KR. DAS GUPTA

SCIENTIFIC REPORT *Professor*

Aims and Objectives:

a. In the area of mycobacteriophage research our objective is to investigate the mechanism by which expression of genes belonging to theD29 genome is regulated in a temporal manner using proteomic and molecular tools

b. Investigate how D29 phageinactivates its mycobacterial host and use the information derived for the development of drugs against TB.

c. To study mycobacterial metabolism and mechanism of initiation of cell cycle under nutrient starved and nutrient rich conditions.

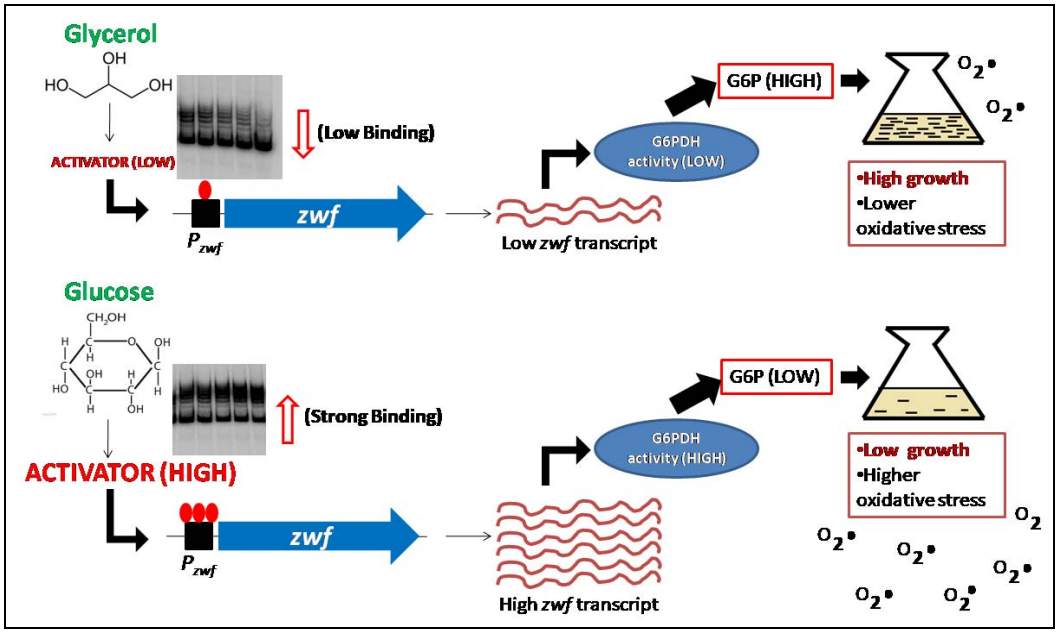
Work Achieved:

We have used the CRISPR cas technology to explore why mycobacteria prefer to use glycerol over glucose to grow. Using Mycobacterium smegmatis (Msm) as our model system, we have analyzed how glycerol and glucose influence central carbon metabolism. We have demonstrated that glycerol promotes the accumulation of the metabolite Glucose 6 phosphate (G6P), which helps Msm to fight against oxidative stress. Surprisingly, glucose does not favor the accumulation of G6P but does the opposite – it induces the disappearance of this metabolite by increasing the expression of the enzyme G6P dehydrogenase (G6PDH). A CRISPR block that results in the inhibition of the expression of *zwf*, the gene encoding G6P dehydrogenase, leads to a higher growth rate. We have found that the observed phenomenon is due to the presence of a transcription factor in glucose-grown cells responsible for activating the expression of the *zwf*gene. We are currently trying to identify this factor (refer to the cartoon below).

In another study, we are trying to understand the function of MSMEG_2295. MSMEG_2295 is a TetR family protein encoded by the first gene of an operon that expresses the gene for DinB2 (MSMEG_2294), a DNA repair enzyme that can function as a translesion DNA polymerase. DNA binding and functional assays revealed that MSMEG_2295 controls the expression of multiple genes, including dinB2. Several of these genes code for proteins that influence central carbon metabolism. The results obtained indicate that MSMEG_2295 is a global regulator that controls genes, the products of which are involved in carbon metabolism, DNA damage repair, and oxidative stress responses.

PROF. SUJOY KR. DAS GUPTA

SCIENTIFIC REPORT *Professor*



The cartoon shows the possible mechanism behind the decreased growth of *Mycobacterium smegmatis* (Msm) in the presence of glucose compared to glycerol. In glucose-grown cells, a transcriptional factor is present at a high level that binds to the upstream region of *zwf*. It activates its expression—the gene *zwf*codes for the enzyme glucose 6 phosphate dehydrogenase (G6PDH). The increase in G6PDH activity leads to the lowering of G6P, which is known to give protection to Msm against oxidative stress. In glucose, Msm is unable to reduce oxidative stress due to low G6P levels, so the cells are either killed or inactivated. In the presence of glycerol, the factor is less active, and thus the opposite happens. G6P levels are high in glycerol-grown cells. The net result is that in glycerol growth of Msm is far better than glucose

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	–	–

PROF. TAPAN K. DUTTA

Professor

Group Members:

Rinita Dhar, *JRF*
Suman Basu, *JRF*
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)*
Satamita Deb, *Project Associate II*
Arindam Dutta, *Project Assistant*

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

Scientific Report

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 eco-systems. 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 supposed to aid in the manipulation of the indigenous microbiota in order to promote the health of host.

Summary of Research Work:

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. Biochemical analysis of metabolic pathways in individual strains was evaluated using respirometric and spectrophotometric studies, besides LC-MS and GC-MS analyses. Based on the biochemical analysis of potential degraders, *de-novo* whole genome sequencing was conducted for a few of the isolates, which aided in identification of the involvement of putative genes/gene-clusters. Further, to understand differential expression of genes/operons, transcriptome analysis has been undertaken, which will furnish information in cloning and characterization of key catabolic enzyme(s) and also help to understand induction profiles of the degradative strains in order to develop biosensor strains of interest. 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 to analyze relevant genes/phage to reveal catabolic machineries and bacterial evolution including horizontal gene transfer mechanisms.

To address a different objective, biochemical and molecular approaches were undertaken to understand metabolic cross-talk between the catabolic pathways of the degradation of 2-, 3-, and 4-hydroxybenzonitriles (cyanophenols), in a naphthalene degrader *Burkholderia* sp. strain BC1 sharing common metabolic intermediates. This hypothesis is being evaluated by comparing induction profiles of respective catabolic pathway enzymes of individual pathways *vis-a-vis* substrate specificities, while genomic and transcriptomic approaches are underway to reveal the processes.

In pursuing other aspect of research, mangrove associate *Suaeda monoica* (Fig.1) was selected for study of novel bioactive compounds present in root, shoot and leaf of the plant (Fig. 2). In addition, both culture-dependent and culture-independent approached were undertaken to reveal

PROF. TAPAN K. DUTTA

SCIENTIFIC REPORT *Professor*

microbial profiles and their relationship within plant rhizosphere soil, non-rhizosphere 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 I *amyloliquefaciens* FZB42 and pksX in *B. subtili* metabolite producing gene clusters, RiPP, NR synthesis of tropane, piperidine, pyrimidine, alk cephalosporin etc.

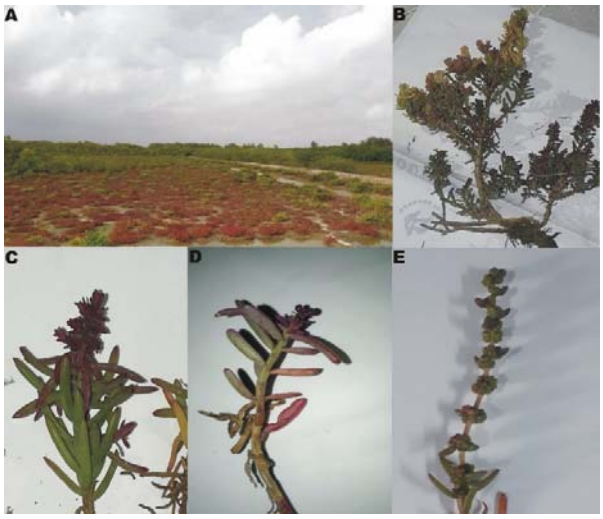


Fig. 1. Images of *Suaeda monoica*. (A) Sample collection site, (B) isolated plant, (C, D) Enlarged view of leaves and stems with emerging inflorescence, (E) Matured inflorescence.

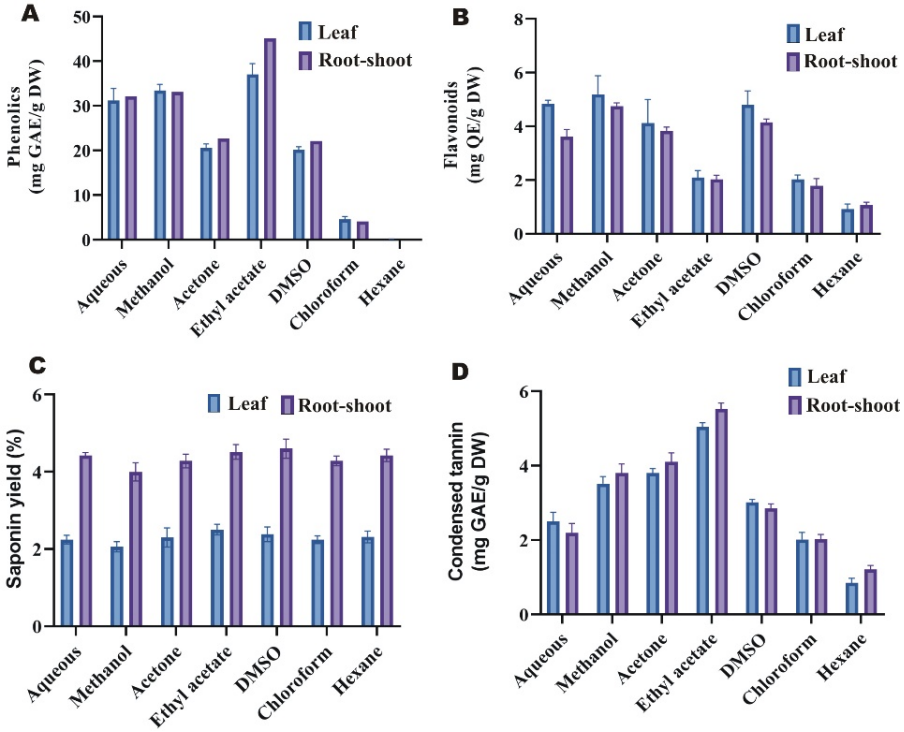


Fig. 2. Quantification of phenolics (A), flavonoids (B), saponins (C) and condensed tannins (D) in the leaf and root-shoot extracts of *Suaeda monoica*. Two-way ANOVA showed significant differences at p values < 0.0001 by Turkey's multiple range test.

DR. TAPAN K. DUTTA

SCIENTIFIC REPORT ***Professor***

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 2 kDa in size, is currently under investigation using MALDI-TOF analysis to correlate genomic data for further cloning and expression of the target antimicrobial peptide.

In another endeavour, Next-generation Sequencing (NGS) analysis was initiated 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, exploitation of metagenome data using various bioinformatics tools, which will facilitate functional characterization of various important enzymes and/or biosynthetic pathways of omega-3-fatty acids and flavors, are among the major future objectives.

In addition, studies on the host-pathogen interaction from molecular perspective using high-throughput intraspecific and interspecific protein-protein interaction network data from human and bacterial pathogens were deliberated. A comprehensive analysis revealed that these interactions are mainly mediated by hub proteins of bacteria which attack mainly human party hubs, affecting desired functional modules associated to pathogenicity. Moreover, both the high affinity domain-domain interactions as well as low affinity intrinsic disorder-mediated interactions play important role in human-bacteria protein-protein interactions. According to a recently published report based on this study, we explored the attributes of the human–bacteriaprotein–protein interaction (PPI) network from the available large-scale interspecific interactome data of three pathogenic bacterial species, *Bacillus anthracis, Francisella tularensis and Yersinia pestis*, for which large-scale high-throughput intraspecific and interspecific PPI data are available.

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	03	01	–	02	–	–

DR. WRIDDHIMAN GHOSH

Associate Professor

Group Members:
Nibendu Mondal, *SRF*
Jagannath Sarkar, *SRF*
Sumit Chatterjee, *JRF*
Subhajit Dutta, *JRF*

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

Scientific Report

Background and Vision:

Our Geomicrobiology Group explores the biosphere for novel molecular mechanisms (pathways) of the evolutionarily ancient metabolism called sulfur-chemolithotrophy, which supposedly originated in the high temperature, reducing environments of the early Earth.

Our laboratory also tries to reveal the *in situ* metabolisms, opportunities and constraints, and geochemical manifestations of the microorganisms of the Carbon-Sulfur-cycle within microbiomes that have active interfaces with the Earth's geological processes. Of the various microbiomes explored, the following biophysically-extreme habitats are under special attention.

- The geochemically-peculiar (neutral pH, silica-poor, but boron-, sulfide-, sulfate- and thiosulfate-rich) hot spring systems of the Trans-Himalayas (Eastern Ladakh, India), where our *in situ* studies have hypothesized that native geochemical and microbial factors can act as potent determinants of the high microbial habitability of these high temperature environments; this hypothesis is currently being tested on pure culture isolates.
- The hypoxic territories of the deep sea (namely, the perennial and seasonal oxygen minimum zones of the Arabian Sea), where we are specifically focused on the sedimentary microbiome, and its geological drivers and manifestations.

DR. WRIDDHIMAN GHOSH

SCIENTIFIC REPORT ***Associate Professor***

Summary of Research Work:

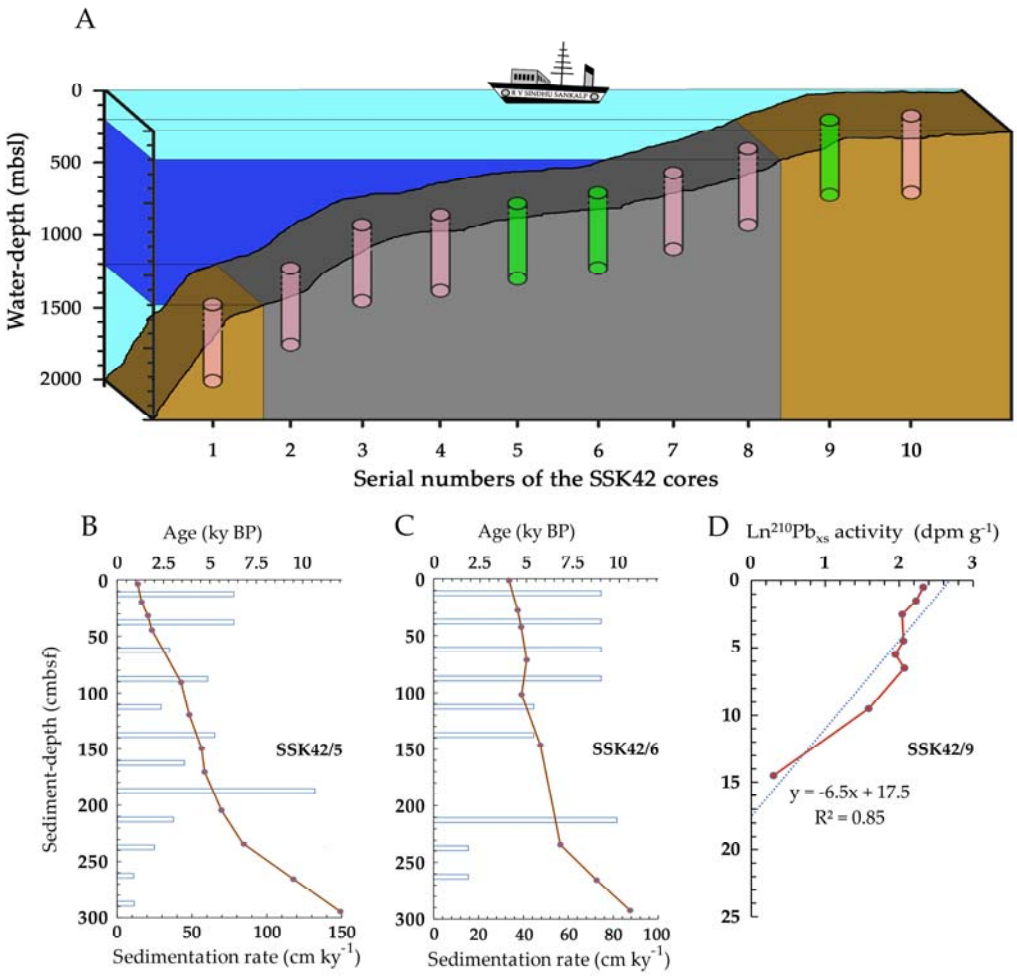
Working with an alphaproteobacterial mesophile isolated from a sulfur-borax hot spring of Puga Valley, Eastern Ladakh, we revealed the key roles of thermal conditioning, oligotrophic nutrition, and *in situ* geomicrobial factors such lithium, boron and glycine-betaine, in conferring thermal endurance to such microorganisms which are stochastically introduced into geothermal systems and no close taxonomic relative of which grows above 45°C *in vitro*. In the sedimentary biogeochemistry front of the Arabian Sea oxygen minimum zone, we discovered that sedimentation rate and organic matter dynamics shape microbiomes across a continental margin with little impact of bottom-water O_2 concentration. In a scientific social responsibility initiative, we the geomicrobiologists re-purposed our basic genomics expertise to discover that positive selection of non-synonymous mutations (dN/dS>1) occurred in most of the structural, but not the non-structural, genes of SARS-CoV-2 (until Nov '20): this implied that the virus had already harmonized its replication/transcription machineries with the host metabolism, while it was still redefining virulence/transmissibility strategies at the molecular level.

Distinct microbiome structures and functions were discovered, amidst comparable pore fluid chemistries, along 300 cm sediment horizons underlying the seasonal (shallow coastal) and perennial (deep sea) oxygen minimum zones (abbreviated as sOMZ and pOMZ respectively) of the Arabian Sea, situated across the western-Indian margin (water-depth of the sOMZ sediment horizon explored: 31 m; water-depths of the pOMZ sediment horizons explored: 530 m and 580 m). Along the perennial-, and seasonal-OMZ, sediment cores (designated as SSK42/5 and SSK42/6, and SSK42/9, respectively) microbial communities were dominated by *Gammaproteobacteria* and *Alphaproteobacteria*, and *Euryarchaeota* and *Firmicutes*, respectively.

As a perennial-OMZ signature, a cryptic methane production-consumption cycle was found to operate near the sediment-surface, within the sulfate reduction zone; overall diversity, as well as the relative abundances of simple-fatty-acids-requiring anaerobes (methanogens, anaerobic methane-oxidizers, sulfate-reducers and acetogens), peaked in the topmost sediment-layer and then declined via synchronized fluctuations until the sulfate-methane transition zone was reached. The microbiome profile was completely reverse in the seasonal-OMZ sediment horizon. In the perennial-OMZ sediments, organic carbon deposited was higher in concentration and rich in marine components that degrade readily to simple fatty acids; simultaneously, lower sedimentation rate afforded higher O_2 exposure time for organic matter degradation despite perennial hypoxia in the bottom-water; the resultant abundance of reduced carbon substrates eventually sustained multiple inter-competing microbial processes in the upper sediment-layers. The entire geomicrobial scenario was opposite in the sediments of the seasonal-OMZ. These findings create a microbiological baseline for understanding carbon-sulfur cycling in distinct depositional settings and water-column oxygenation regimes across the continental margins.

DR. WRIDDHIMAN GHOSH

SCIENTIFIC REPORT *Associate Professor*

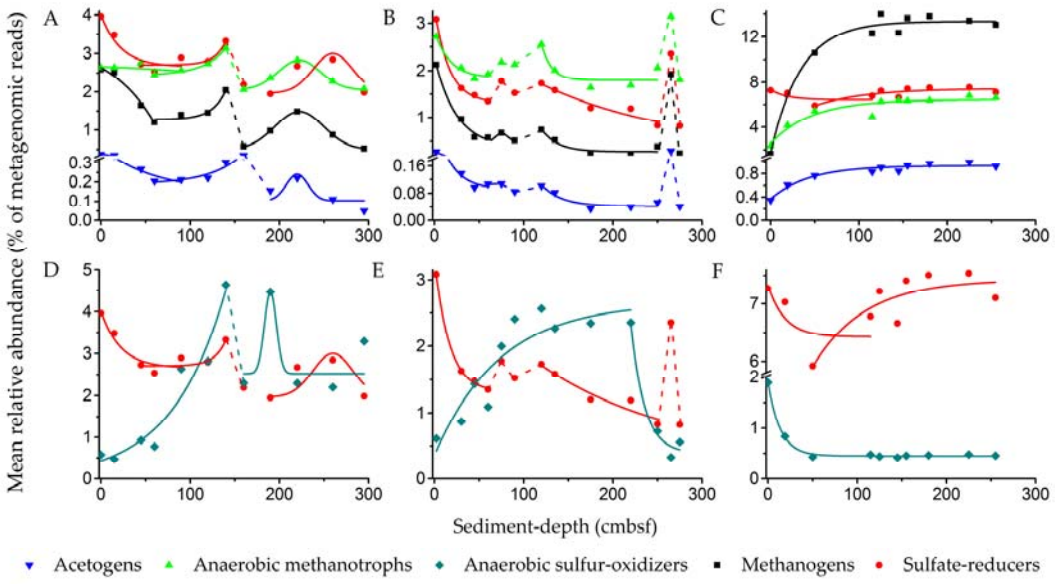


Geographical and geological context of the pOMZ and sOMZ sites explored. (A) Schematic diagram showing the position of SSK42/5, SSK42/6 and SSK42/9 (indicated by green color), relative to the other SSK42 cores (indicated by pink color) reported elsewhere (Fernandes et al. 2018, 2020). Water-depth is plotted to scale along the vertical axis of the diagram, while distances between the cores represented along the horizontal axis are not in scale. Within the oxygenated water mass (light turquoise shade) the mid-oceanic pOMZ is indicated by blue shade. Sediment horizons underlying the pOMZ are indicated by gray shade while those impinged by oxygenated water masses are indicated by brown shade. (B-D) Age versus depth models and sedimentation rates along (B) SSK42/5 (based on ^{14}C dates), (C) SSK42/6 (based on ^{14}C dates) and (D) SSK42/9 (based on $^{210}Pb_{xs}$ data).

Source of geological data: **Dr. Aninda Mazumdar,** *CSIR-National Institute of Oceanography, India*.

DR. WRIDDHIMAN GHOSH

SCIENTIFIC REPORT *Associate Professor*



Relative abundances of sulfate-reducers, methanogens, anaerobic methanotrophs, acetogens and anaerobic sulfur-oxidizers along (A and D) SSK42/5, (B and E) SSK42/6 and (C and F) SSK42/9. Variations in the relative abundances of sulfate-reducers, methanogens, anaerobic methanotrophs and acetogens are shown in panels A-C, whereas the variations in the relative abundance of anaerobic sulfur-oxidizers are shown (in comparison with sulfur-reducers) in panels D-F. Relative abundance values plotted for sulfate-reducers, methanogens, acetogens and sulfur-oxidizers are the percentages of metagenomic reads that matched genomic sequences from the genera considered as representing these metabolic-types. The theoretical lines in the same color code as the symbols represent the mathematical functions simulated for the distribution of the different metabolic-types: solid and dashed lines represent zones of mathematically defined and undefined distribution respectively.

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	06	03	–	–	–	02

Acharya Jagadis Chandra Bose demonstrating his self -designed instruments and experiments before Foreigners at Bose Institute (1928)

– SCIENTIFIC REPORT –

DIVISION OF MOLECULAR MEDICINE

BOSE INSTITUTE ANNUAL REPORT 2020-2021

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

DIVISION OF MOLECULAR MEDICINE

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

Professor

Group Members:

Arin Gucchait, *CSIR-SRF*
Tapasi Manna, *UGC-SRF*
Monalisa Kundu, *CSIR-SRF*
Pradip Shit, *CSIR-SRF*
Abhijit Rana, *CSIR-JRF*

Scientific Report

Background and Vision:

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

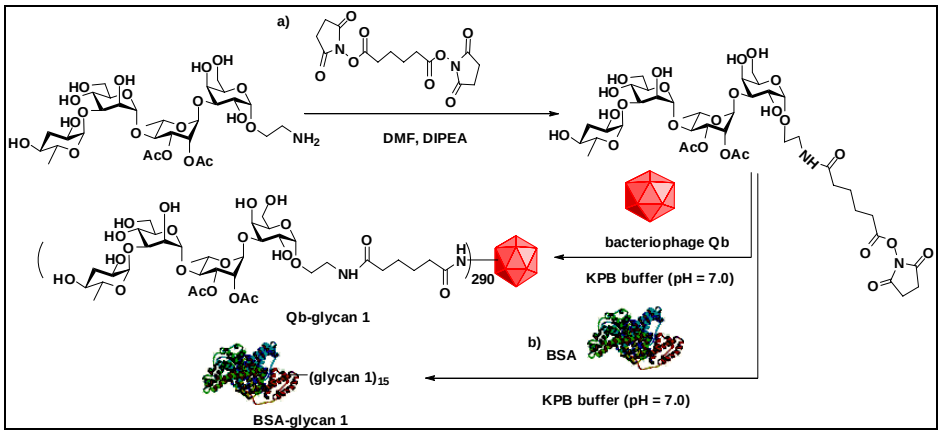
Aims and Objectives:

- Development of novel reaction methodologies for the stereoselective chemical glycosylations.
- Conjugation of oligosaccharides with suitable proteins to form glycoconjugates and their evaluation for possible antibacterial vaccine candidates.
- To develop natural products inspired small molecules having pharmaceutical potential.

PROF. ANUP KUMAR MISRA

SCIENTIFIC REPORT ***Professor***

Work Achieved:



- Stereoselective synthesis of a series of complex oligosaccharides corresponding to the pathogenic bacterial cell wall polysaccharides.
- Preparation of a number of glycoconjugate derivatives and their immunochemical studies towards the development of vaccine leads against *Salmonella* and *meningococcal* infections.
- Design and synthesis of natural products inspired small molecules having anti-cancer, anti-filarial and anti-inflammatory activities..

Future Research Plans:

- Unveiling the untold mysteries of stereoselective chemical glycosylations.
- Development of novel reaction methodologies relevant to the synthetic organic chemistry.

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	–	–	01	–	–

PROF. ATIN KUMAR MANDAL

Professor

Group Members:

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

Collaborators:

Dr. Anirban Bhunia, *Bose Institute, Kolkata*
Dr. Dhandapany Perundurai, *InStem, Bangalore*
Dr. Mohit Prasad, *IISER, Kolkata*

Scientific Report

Background and Vision:

Protein quality control (PQC) maintains homeostasis of proteome at physiological or stress condition. Molecular chaperones and degradation system are integral part of PQC machinery. Chaperones binds to non-native polypeptides to prevent aggregation and to facilitate the folding of proteins, and transfermisfolded proteins to degradation systems – the ubiquitin-proteasome and autophagy – to degrade abnormal or damaged proteins. These components of PQC system act in concert to prevent the accumulation of misfolded proteins and/or to facilitate their elimination which is critical for cell survival. However, the efficiency of the PQC system is often perturbed by environmental, cellular or genetic factors which generate stable toxic conformations having gain-of-function or aggregation prone cell toxic conformations. Generation of these toxic 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 proteins having gain-of-function activity or aggregation prone proteinsmisfolding of which accumulates as toxic aggregates inside the cell.

PROF. ATIN KUMAR MANDAL

Professor

SCIENTIFIC REPORT

Summary of Research Work:

Praja1 ubiquitin ligase facilitates degradation of polyQ proteins

Aggregation of expanded polyQ proteins causes late onset neurological diseases. Spinocerebellar ataxia-3 is developed due to the polyQ expansion of ataxin-3 protein. The cellular quality control system is altered in disease condition and modulation of the quality control system could be an effective way to remove the aggregates. Emphasized has been given to identify ubiquitin ligases those are responsible for removing SCA3 aggregates in early life and hence delayed disease manifestation. We have identified and characterized the function of RING finger ubiquitin ligase named, Praja1 which is highly expressed in brain tissue. We found that Praja1 level (mRNA/protein) is downregulated upon overexpression of polyQ proteins (Ataxin3/Huntintin) in mammalian cell (HEK293T/Neuro2A) resembling the disease condition. Praja1 interacts with polyQ proteins and co-localizes with their aggregates. Overexpression of Praja1 efficiently reduces the number of polyQ protein aggregates (ataxin-3 and huntingtin), but unable to do so when its RING domain is deleted suggesting involvement of its ubiquitin ligase activity. Praja1 reduces ataxin-3 protein level by facilitating ataxin-3 degradation via autophagy. Conversely, downregulation of Praja1 by siRNA/shRNA increases ataxin3/huntintin protein level and also their aggregates. We also found that overexpression of Praja1 reduces the toxicity of Ataxin-3 in yeast and transgenic *Drosophila* model.

Hsp70/Hsp90 organizing protein HOP regulates RAF1 kinase activity by recruiting Hsp90 during MAPK activation

We elucidated the function of HOP (Hsp70/Hsp90 organizing protein) a co-chaperone of Hsp90, in maintaining CRAF kinase activity. Our results suggest that HOP is essential for maintaining CRAF kinase activity, but in contrast to chaperones Hsp90 or Cdc37, it does not affect S621 phosphorylation of CRAF, necessary for CRAF stability and activity. We identified the critical domain of HOP responsible for its function. The functionality of HOP in regulating CRAF activity is mediated by its TPR2A-2B-DP2 domain. This domain of HOP enhances the interaction between Hsp90 and CRAF, and disruption of this interaction by site directed mutagenesisblocks activation of CRAF kinase, hence MAPK pathway. We also found that overexpression of HOP enhances recruitment of Hsp90 to CRAF which in turn regulates actin-dependent translocation of the kinase during MAPK signaling. Conversely, down-regulation of HOP by small interfering RNA (siRNA) reduces MAPK signaling mediated by CRAF kinase.

PROF. ATIN KUMAR MANDAL

Professor

SCIENTIFIC REPORT

Characterization of interaction between PDE8A and 14-3-3 protein in regulation of CRAF kinase

cAMP-specific phospdiesterases downregulate signalling through protein kinase A (PKA). 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 that PDE8A interacts with 14-3-3 protein and this interaction is enhanced by activation of PKA. 14-3-3 binds to the S359 residue of PDE8A. 14-3-3 mononer or dimer both interacts with PDE8A. We are currently addressing the underline reason behind it.

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	–	–

PROF. KAUSHIK BISWAS

Professor

Group Members:

Dr. (Mrs.) Dipanwita Chakraborty, *DBT RA*
Shibjyoti Debnath, *SRF-UGC Adhoc*
Abhisek Sarkar, *SRF-UGC Adhoc*
Elora Khamrui, *JRF-CSIR Adhoc*
Sounak Banerjee, *JRF-UGC Adhoc*
Subha Ray, *JRF-UGC Adhoc*

Scientific Report

Background and Vision:

Over-expression of glycosphingolipids are found to be associated with a large number of cancers. However, neither the precise role of these glycolipids in the process of tumorigenesis, or the underlying basis of their over-expression in many cancers is known. Detailed mechanistic studies aimed towards understanding their precise mode of action in modulating tumor growth, progression or metastasis are also lacking. Our laboratory is engaged in defining the functional role of some of these glycosphingolipids, particularly gangliosides in tumorigenesis, and identifying the mechanism by which they do so. On the other hand, our laboratory is also focused in understanding how some of these gangliosides are at all over-expressed in certain cancers.

Aims and Objectives:

a) The consequence of such an over-expression in tumors.

- Functional role of tumor derived gangliosides in inducing EMT leading to tumor growth, development and metastasis.
- Ganglioside induced modulation of miRNAs and its implication in tumorigenesis.

b) The basis of over-expression of select glycosphingolipids in cancer.

- Transcriptional regulation of ganglioside synthase genes.
- Mapping the proteome associated with the transcription start site (TSS) of ganglioside-synthase genes in cancer.

PROF. KAUSHIK BISWAS

SCIENTIFIC REPORT ***Professor***

Work Achieved:

a) Identification of a novel role of ganglioside GM2 in inducing EMT changes through modulation of HIPPO-YAP/TAZ transcriptional program.

b) Identified a possible role of ganglioside GM2 in regulating miR-615-5p function in controlling tumorigenesis.

c) Eriodictyol mediated selective targeting of the TNFR1/FADD/TRADD axis in cancer cells induce cancer cell apoptosis and inhibits tumor progression and metastasis.

d) Defined a novel role of ganglioside GM2 in inducing DNA damage response and repair pathways in cancer cells.

Future Research Plans:

a) Delineating the mechanism of GM2-mediated epithelial-mesenchymal transition (EMT) – understand the role of HIPPO-YAP/TAZ signaling axis in GM2-mediated EMT and metastasis.

b) Identification of the molecular machinery (proteome) involved in the epigenetic regulation of the GM2-synthase gene - extend the applicability of the genome editing tool, CRISPR, by using CRISPR-dCas9 for an "en-ChIP" assay which will help pull down the entire proteome associated with the TSS of the GM2-synthase gene.

c) Identifying how ganglioside GM2 modulates expression of tumor suppressor miR-615-5p, towards a pro-tumorigenic outcome.

d) Elucidation of the mechanism behind ganglioside GM2-mediated promotion of DNA damage response and repair, that may lead towards generation of chemo-resistance in cancer.

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	–	–

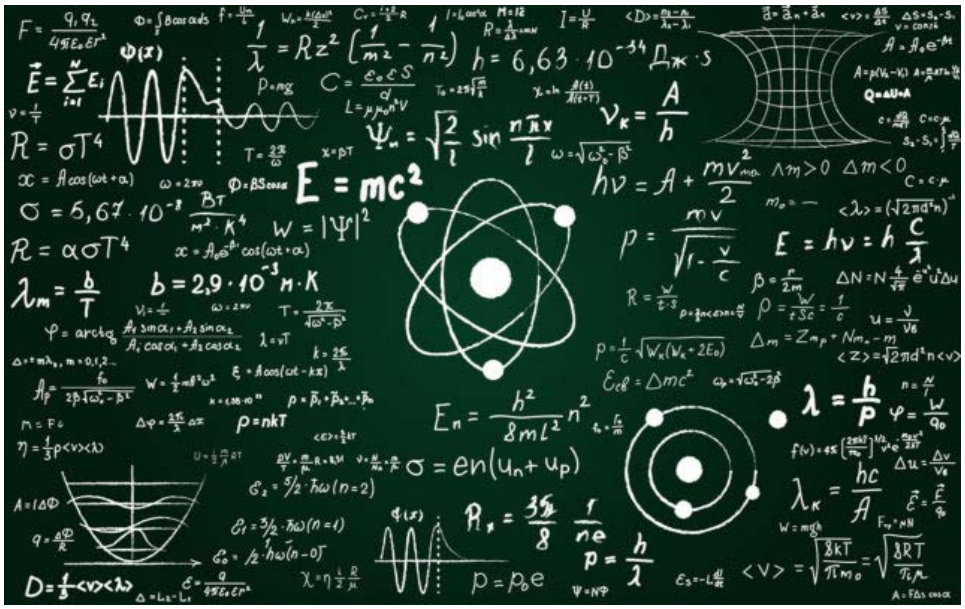
Instrument demonstration by Acharya Jagadis Chandra Bose
to his research fellows at Bose Institute in presence of
Lady Abala Bose (1928)

– SCIENTIFIC REPORT –

DEPARTMENT OF PHYSICS

BOSE INSTITUTE ANNUAL REPORT 2020-2021

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, Dr. Saikat Biswas, Prof. Achintya Singha, Prof. Soumen Roy, Dr. Sidharth Kr. Prasad.

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

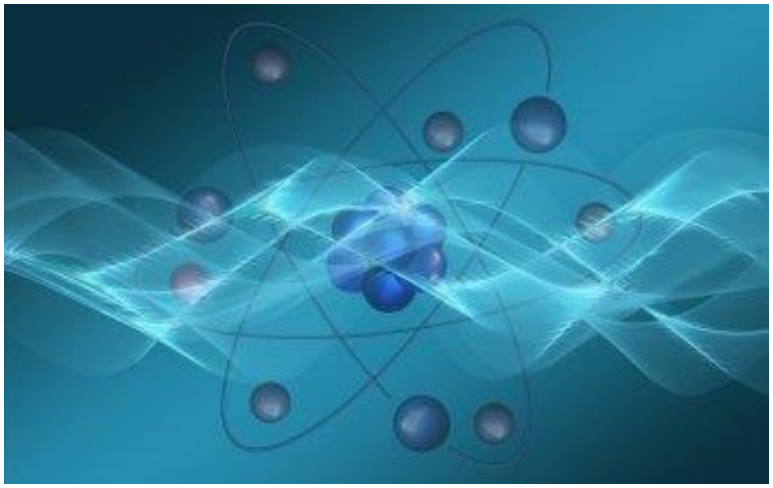
DEPARTMENT OF PHYSICS

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.

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, Ranjit Das.

PROF. SANJAY KR. GHOSH

Professor



Group Members:

Deeptak Biswas, *SRF*
Trishna Bhattacharyya, *SRF*

Scientific Report

Understanding the strongly interacting systems and atmospheric phenomena

Background and Vision:

- Unraveling the mysteries of neutron stars – looking for exotic components such as strange quark matter inside neutron stars - experiments and effective model studies
- Understanding of regional climatic variability – observation analysis and mode.

Summary of Research Work:

- The limiting mass is a significant characteristic for compact exotic stars. In the case of quark stars the limiting mass can be expressed in terms of fundamental constants and the bag constant. In the present paper, using bag model description, the maximum mass of a rotating quark star is found to depend on the rotational frequency apart from other fundamental parameters. The analytical results obtained agree with the results of several relevant numerical estimates as well as observational evidences.
- Micro rain radar (MRR-2) provides the measurement of the drop size distribution DSD with altitude and rain rates. In this paper, we show a new form of gamma drop size distribution (DSD) model. MRR-2 is based on the principle of Radar spectrum measurement of continuous-wave of frequency modulation. DSD measurements for the rain rates ~ 0–25 mm/h and the height from 150 to 2000 m during the south-west monsoon season for the period 2009 and 2010 are used in this study. From the variance of DSD (σ 2) and mass-weighted mean drop diameter as well as after the mathematical calculation, two parameters (Λ and μ) are obtained for the use of lower-order moments. Both the moments are utilized for

the best suitable of gamma DSD. Measured DSD for the different rain rates and different altitudes below the melting layer height (~ 2–3 km) compared among the exponential, lognormal and gamma DSD model over Darjeeling in the Eastern Himalaya. The correlation between best fit measured DSD and gamma distribution indicate that they correlate well for both lower and higher order moments for the heights 150 m and 1050 m. Whereas they correlated only for higher order moments for the 450 m, 1500 m and 1950 m. Thus, it is found that the observed pattern of DSD agrees well to the gamma DSD model.

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
–	08	–	–	01	–	–

PROF. SOMSHUBHRO BANDYOPADHYAY

Professor

Group members:
Prasenjit Deb,
Arkaprabha Ghosal

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

Scientific Report

Background and Vision:

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

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

PROF. SOMSHUBHRO BANDYOPADHYAY

SCIENTIFIC REPORT ***Professor***

Aims and Objectives:

Presently we are working on problems in the following areas:

- Quantum entanglement as a resource in local state discrimination problems.
- Quantum nonlocality.
- Quantum gravity induced entanglement of masses.

Achievements:

- Proved that the no-superposition theorem is related to other no-go theorems in quantum theory.
- Proved that entanglement cost is maximal for LOCC discrimination of sets of states that do not contain any maximally entangled state.
- Showed that quantum gravity can induce genuine many-body entanglement in symmetric configurations of test masses.

Future Plans:

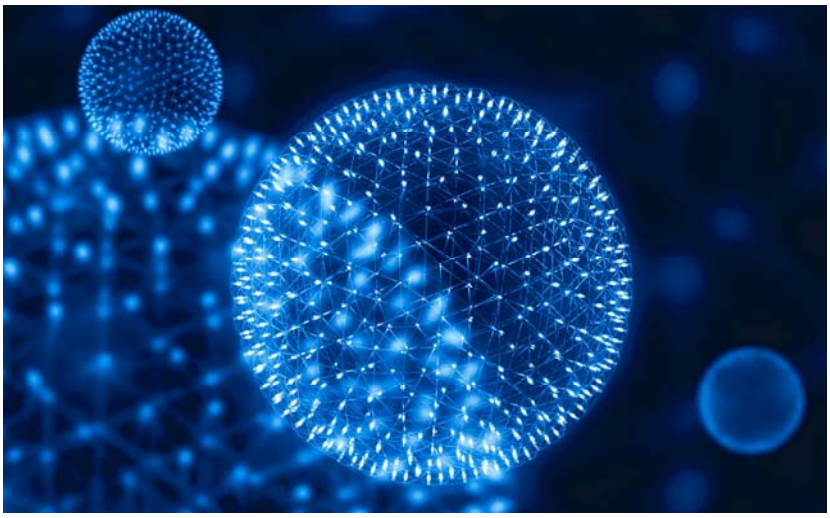
- To obtain the exact entanglement cost and the corresponding optimal resource states in discriminating orthogonal two-qubit bases using LOCC.
- To explore quantum gravity induced entanglement of masses in many-body systems where symmetry is absent.
- To develop a theory based on the techniques of quantum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

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	–	–	–	–	–

PROF. RAJARSHI RAY

Professor



Group Members:

Sumana Bhattacharyya, *SRF-CSIR*
Pracheta Singha, *SRF-INSPIRE*
Pratik Ghoshal, *SRF*

Scientific Report

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.

PROF. RAJARSHI RAY

SCIENTIFIC REPORT *Professor*

Summary of Research Work:

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.

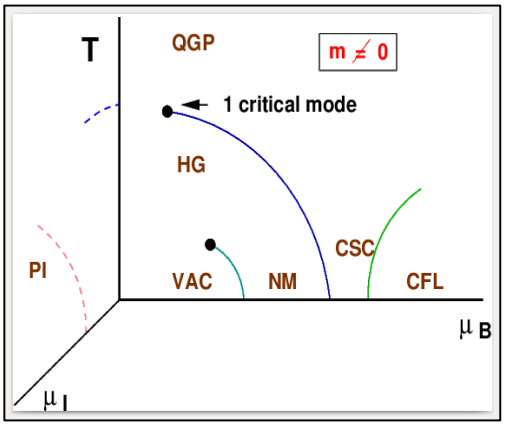


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Figure illustrating the essence of our research work

The figure illustrates the phase diagram of strongly interacting matter. T is the temperature axis and the other two are the baryon and isospin chemical potential axis respectively. The phase structure is quite rich with different phases and phase boundaries, crossover regions, critical end points as has been investigated in various models. Here HG denotes the hadron gas phase and QGP denotes the quark gluon plasma phase discussed previously.

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	–	–	–	–

PROF. DHRUBA GUPTA

Professor

Group Members:

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

Scientific Report

Background and Vision:

My area of research includes nuclear astrophysics, rare isotope beams and exotic nuclei. With sophisticated rare isotope accelerators worldwide, we can now study pressing problems in nuclear astrophysics, the nuclear force and the origin of elements in the universe. We encounter exotic structures like nuclear halos, nuclear skins and new magic numbers away from the line of β-stability. For a systematic study of light stable and unstable nuclei, experiments with the lithium and beryllium isotopic chains deserve special attention. The Big Bang Nucleosynthesis (BBN) theory is consistent with observation for the abundance of light nuclei except for ^{7}Li. Here, an anomaly by a factor of four is observed known as the Cosmological Lithium problem, unsolved for decades. Other interesting issues in this area of research, include radiative capture reactions in relation to the transit from Carbon-Nitrogen-Oxygen (CNO) cycle to the hot CNO cycle occurring in several astrophysical situations and also inhomogeneous nucleosynthesis. It is understood that research on exotic unstable/unbound nuclei would pervade nuclear physics in the coming years. Thus, it is also necessary to develop robust theoretical frameworks exclusively to study such nuclei, complementing experimental findings.

PROF. DHRUBA GUPTA

SCIENTIFIC REPORT *Professor*

Summary of Research Work:

The *cosmological lithium problem* delineating the ^{7}Li abundance anomaly is extensively studied till date but is yet unresolved. To study this problem, we continued the data analysis of the experiment that we carried out earlier with a 5 MeV/A ^{7}Be beam on a CD_2 target, at the HIE-ISOLDE radioactive beam facility of CERN. The experimental setup (Fig. 1) consisted of double sided silicon strip detectors in pentagon geometry (W1) as well as front annular (S3) and back angle detectors (BB7) covering 8^{o} - 170^{o}. Excitation energy spectrum of ^{8}Be* from triple coincidence of protons and two alpha particles in the ^{7}Be(d,p)^{8}Be* reaction have now been obtained (Fig. 2). The excitations of 16.63 MeV and higher have been studied for the first time using this reaction. The excited state angular distributions are underway. 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. The NPTool package is extensively used in simulations and analysis of the data. Two papers are in the final stages and would be communicated soon. We also continued our theoretical work using supersymmetric quantum mechanics (SQM) to study unstable and unbound exotic nuclei. In the context of the lithium problem, we already studied a high-lying resonance state in the ^{9}B nucleus at 16.84 MeV. We are also working on the properties of such resonances relevant to nuclear astrophysics.

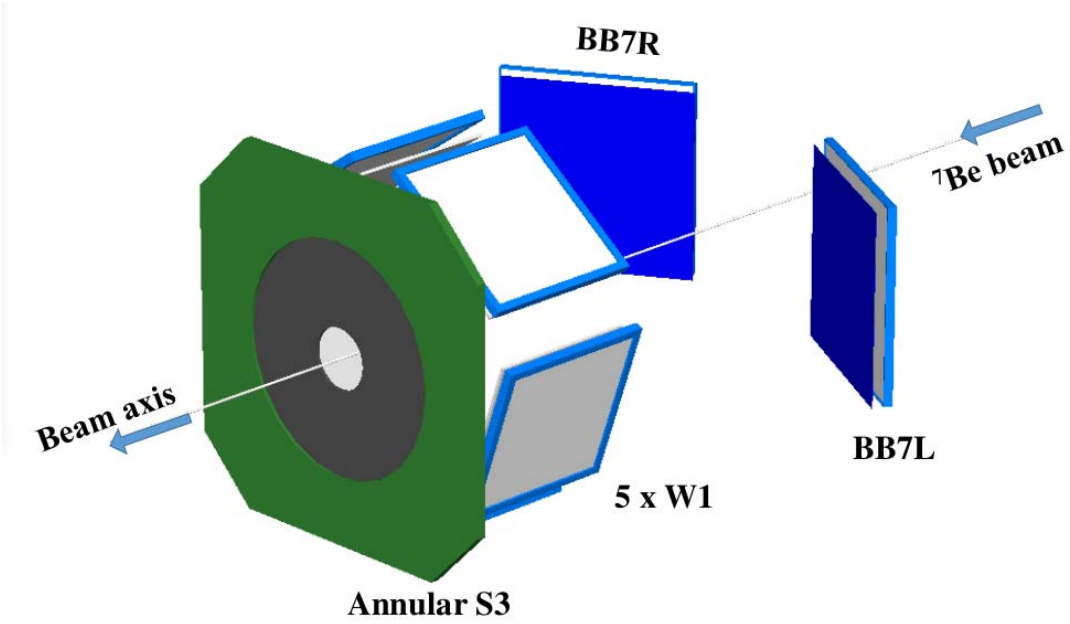

Fig. 1: The detector setup of the experiment with 5 MeV/A ^{7}Be beam on a CD_2 target.

PROF. DHRUBA GUPTA

SCIENTIFIC REPORT | ***Professor***

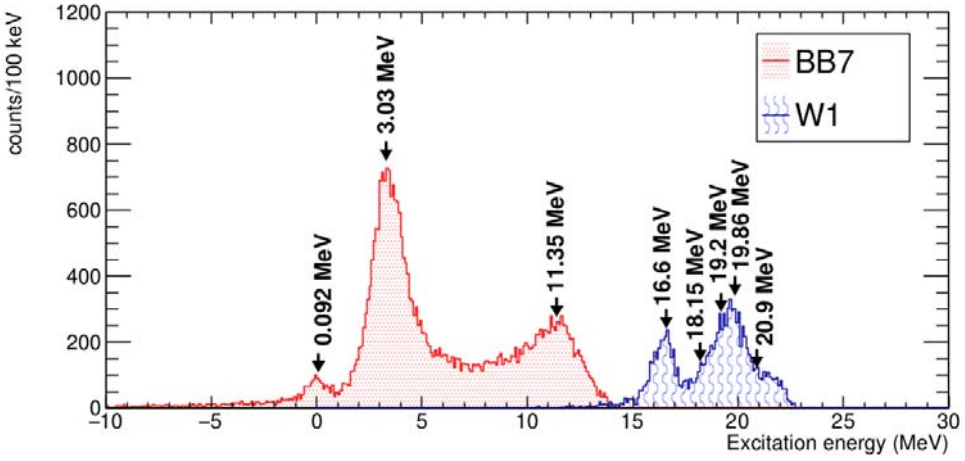

Fig. 2: Excitation energy spectrum of ^{8}Be* from triple coincidence of protons and two alpha particles in the ^{7}Be(d,p)^{8}Be* reaction, from the experiment at CERN-HIE-ISOLDE.

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	–	03	–	–	–

PROF. SUPRIYA DAS

Professor

Group Members:

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

Scientific Report

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 is another way of detecting them.

Aims and Objectives:

i) Characterize matter at extreme conditions using different probes.

ii) Development of new particle detectors to study matter at extreme conditions.

iii) Detect and study properties of cosmic ray air shower at mountain altitude.

PROF. SUPRIYA DAS

SCIENTIFIC REPORT *Professor*

Summary of Research Work:

a. Study of photon production in p-Pb collisions at the LHC:

We are analyzing the data from p-Pb collisions recorded by the Photon Multiplicity Detector at ALICE to study the multiplicity and pseudorapidity distributions of photons in the forward region. The results from this analysis are crucial in understanding the evolution of particle production mechanism from small system such as p+p to Pb+Pb. We plan to compare the results with those obtained from models such as HIJING and DPMJET and look for multiplicity fluctuation. Preliminary results on the uncorrected pseudorapidity distribution for photons have been obtained from simulation and two different correction methods have been studied.

The results from this analysis have been approved by the ALICE collaboration and presented in DAE HEP symposium 2020. The same will be published in Springer Proceedings.

Collaborators: Md. Asif Bhat, Abhi Modak, Sidharth K. Prasad

b. Study of secondary cosmic γ-ray flux during Solar Eclipse:

A study was carried out to find any possible variation in the secondary γ-ray flux in India during the Great American Total Solar Eclipse on August 21, 2017. The unique feature of this work is this was the first such measurement carried out at a place which was not covered within the path of the eclipse. A small NaI(Tl) scintillator detector was used for this work. The results show that there was a small decrement in the flux for γ–rays up to energy 1.5 MeV during the eclipse compared to the flux on normal days, but above that energy there was a significant increase in the same.

This work has been published in Astrophysics and Space Science (2020) 365:172

Collaborators: Shreya Roy, Saikat Biswas, Sanjay K. Ghosh and Sibaji Raha

c. Study of charging up effect in triple GEM detector:

In this work the charging up effect has been investigated in a double mask triple Gas Electron Multiplier (GEM) prototype detector with Ar/CO_2 in 70:30 gas mixture using radioactive Fe^{55} X-ray source. The significance of this work is to understand whether the accumulation of charges on the GEM foils due to continuous operation has any role to modify the performance of the detector. It was found that the gain of the detector increases slowly with time as an effect of charging up i.e. accumulation of charges on the polyimide foil. It was also seen that the time constant for the charging up effect increases with the increase in particle flux incident on the detector.

This work was reported in Journal of Instrumentation (2020), Vol 15: T09011

Collaborators: Sayak Chatterjee, Arindam Sen, Shreya Roy, Saikat Biswas; External Collaborators: Nivedita G, IISER, Thiruvananthapuram and Arushi Paul, University of Calcutta

d. Study of species-specific jet modification in heavy-ion collisions:

A work has been initiated to decipher the signal of quark and gluon jet modification in relativistic heavy-ion collisions using γ-tagged jets. Perturbative Quantum Chromodynamics (pQCD) inspired model Jet Evolution With Energy Loss (JEWEL) is used to sample the PbPb events at 5.02 TeV collision energy to calculate the fragmentation function and radial momentum distribution in case of gluon initiated and quark initiated jets.

The preliminary results from this work have been reported in the DAE HEP symposium 2020.

Collaborators: Rathijit Biswas, Sidharth K. Prasad; External Collaborator: Subikash Choudhury

e. 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 (m2 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.

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
–	32	–	02	02	–	–

PROF. ACHINTYA SINGHA

Professor

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*

Scientific Report

Background and Vision:

Today nanostructured material is one of the most active and exciting research areas in both basic sciences and a wide range of technological applications. At the fundamental level, nanomaterials act as a laboratory to study the fascinating phenomenon in the sub-micron regime. The basic research on low dimensional systems not only meets the desire of scientists but also generates the foundation for future technological applications. We aim to unravel the novel properties of nanostructured materials. We primarily try to probe the lattice vibrations, how they are coupled to various quasiparticles (e.g., electrons, magnons, etc.) and other properties like electronic and optical behaviors which are important to develop better materials for technological applications.

PROF. ACHINTYA SINGHA

SCIENTIFIC REPORT *Professor*

Summary of Research Work:

Study of piezoelectric effect in few-layered MoS_2 using Raman spectroscopy

Tunability of two-dimensional quantum materials (2DQM) through an external perturbation has strongly excited condensed matter research in recent years due to its possibility of applications.

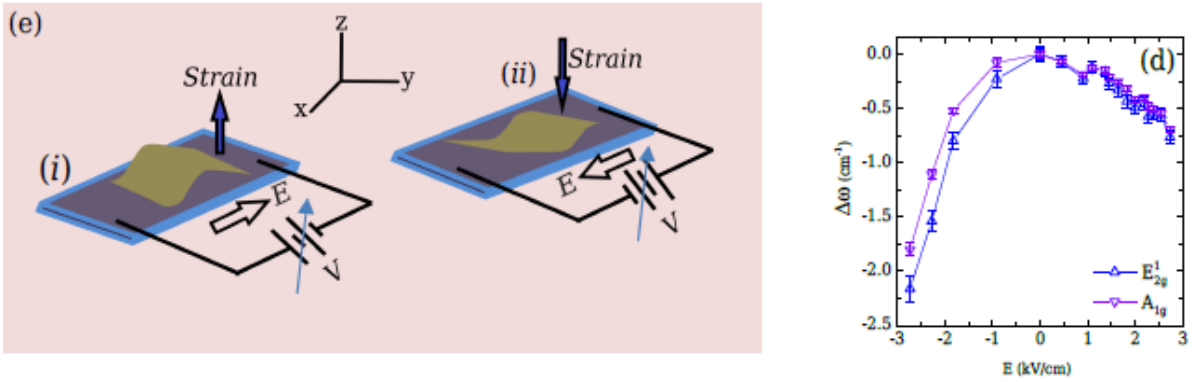

Fig. 1: Cartoon describing the experimental situation and the plot shows the shifts of the phonon mode frequency by reversing the direction of the applied electric field.

Here, we studied the electro-optical effect in MoS_2 using Raman Spectroscopy. Electric field dependent Raman data and first-principle density functional theory calculation probed the broken symmetry driven piezoelectricity in MoS_2. This optical probing of the electro-mechanical coupling may lead to applications as a non-extensive technique for electric field/strain sensors in the nanoelectronics devices **[S. Mitra *et al.*,npj 2D Materials and Applications 6, (2020)].**

Electric field enhancement and dipole and quadrupole resonance mode in non-plasmonic nanowire using Raman spectroscopy

Electric field enhancement in semiconductor nanostructures offers a possibility to find an alternative to the metallic particles which is well known for tuning the light–matter interaction due to its strong polarizability and size-dependent surface plasmon resonance energy. Raman spectroscopy is a powerful technique to monitor the electric field as its scattering depends on the electromagnetic eigenmode of the particle.

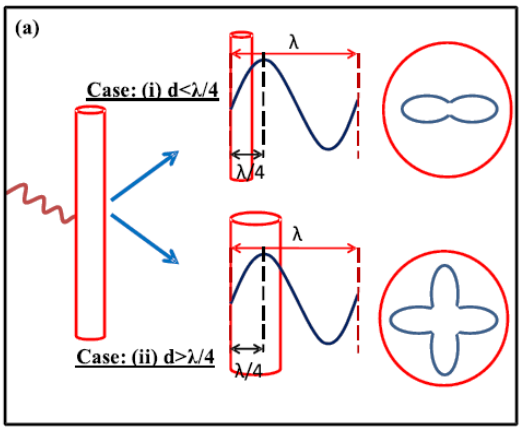

Fig.1: Schematic representation of the light matter interaction study in 2D-0D hybrid system

PROF. ACHINTYA SINGHA

SCIENTIFIC REPORT *Professor*

Here, we observed enhanced polarized Raman scattering from germanium nanowires of different diameters. The incident electromagnetic radiation creates a distribution of internal electric field inside the naowires which can be enhanced by manipulating the nanowire diameter, the incident electric field and its polarization. Furthermore, depending on the diameter of nanowire and wavelength of incident radiation, polarized Raman study shows dipolar (antenna effect) and quadrupolar resonances, which has never been observed in germanium nanowire. We attempt to understand this polarized Raman behavior using COMSOL Multiphysics simulation, which suggests that the pattern observed is due to photon confinement within the nanowires. **[S. Raha *et al.*, Nanotechnology 31, 425201 (6pp) (2020)].**

Thermal conductivity of a single Germanium nanowire measured by Opto-thermal Raman spectroscopy

We investigated temperature-dependent thermal conductivity κ(T) in a single Ge nanowire (NW) using opto-thermal Raman spectroscopy. The thermal conductivity of Ge NWs at around room temperature is observed to lie in the range 1.8–4.2 W/m K for diameters between 50 and 110 nm and it is found to follow a linear dependence on NW diameter. κ(T) shows approximately 1/T behavior which arises from the Umklapp processes

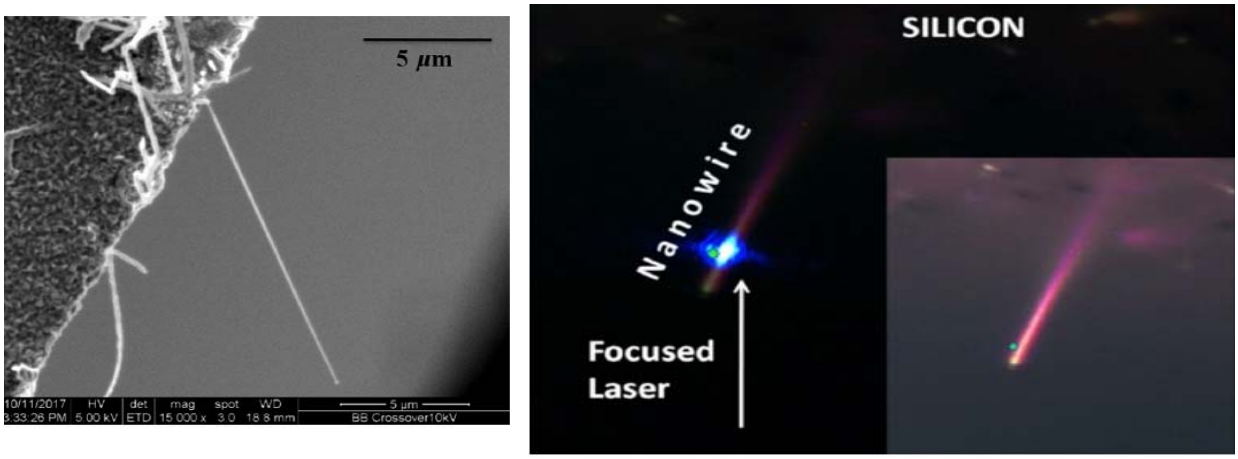

Fig. 3: SEM image of the suspended nanowire and an image during Raman measurement

We suggest a quick way to estimate approximately the thermal conductivity of NWs using Opto-thermal Raman spectroscopy **[S. Sett *et al*., Physical Review Applied, 13, 054008 (2020)].**

Lattice dynamics of the topological Dirac semimetal $LaAgSb_2$ with charge density wave ordering

$LaAgSb_2$ is a rare material that offers the opportunity to investigate the complex interplay between charge density wave (CDW) ordering and topology-protected electronic band structure. As both of these phenomena are governed by structural symmetries, a comprehensive study of the

PROF. ACHINTYA SINGHA

SCIENTIFIC REPORT *Professor*

lattice dynamics is highly desirable. Here, we present the results of temperature- and pressure-dependent Raman spectroscopy and x-ray diffraction in single crystalline $LaAgSb_2$ to probe the CDW-ordering phenomenon. The combined high-pressure Raman spectroscopy and synchrotron x-ray diffraction reveal multiple structural phase transitions through lowering of crystalline symmetries, which are also expected to lead to electronic topological transitions. [**R. Singha** *et al.,* **Physical Review B 102, 205103 (2020)].**

Mn doped MoS_2 nanoflowers based supercapacitor electrode material

Supercapacitor is one of the most efficient green energy storage devices in the field of electrical energy. In finding a promising material for high-performance supercapacitors electrodes, Mn incorporated MoS_2 nanoflowers (NFs)is synthesized using a simple one-step hydrothermal process. The supercapacitor electrode made of Mn doped MoS_2 exhibits maximum specific capacitance: 430 F g^{-1}; energy density: 48.9 W h kg^{-1} and power density: 5.0 kW kg^{-1} with excellent capacitance retention up to 5000 cycles at 10 A g^{-1}. The performance of the electrode is superior compared to other graphene or MoS_2 based compounds. The practical applicability of the electrode material has been examined by lightning four LED bulbs in series showing longer discharge time [**S.S. Singha et al., Electrochimica Acta, 338, 135818 (2020)].**

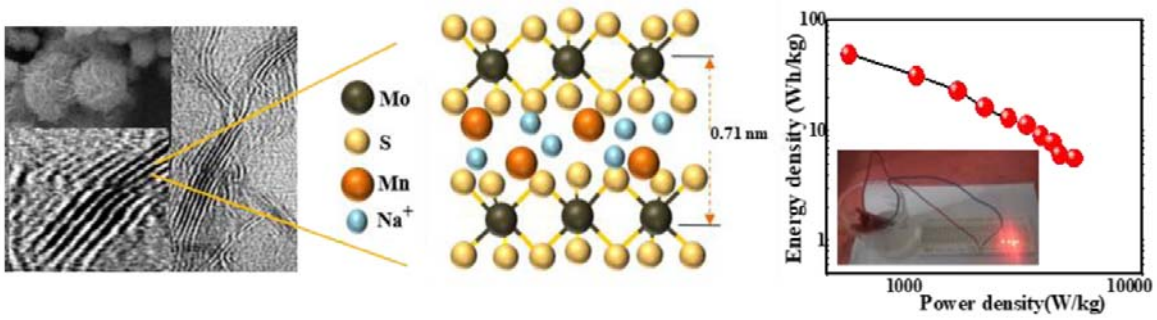

Fig 4: SEM and TEM images of Mn doped MoS_2 NFs, schematic of ion diffusion process and practical applicability of the electrode material.

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	–	05	02	–	01

PROF. SOUMEN ROY

Professor

Group Members:

Deep Nath, *SRF*
Sumana Gop, *SRF*

Scientific Report

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. Numerous 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, statistics, network science, computation and experiments. Non-linear dynamics and game theory are some other useful tools to study such systems. Almost all of our published work is based on empirical or experimental data.

Summary of Research Work:

(a) We present a rigorous yet general mathematical approach to mutagenesis bearing the potential to deliver systems-level perspectives. Such systems-level understanding of phage resistance is definitely appealing for phage–bacteria interactions and phage therapy research. Quite independently, the ability to distinguish between two graphs with a set of identical or common vertices and establish the repercussions thereof, is important in network theory. We propose a

measure called shortest path alteration fraction (SPAF) to compare any two networks by shortest paths, using set theory. When SPAF equals one, it can identify node pairs connected by at least one shortest path, which are present in either network but not both. SPAF equalling zero identifies identical shortest paths, which are simultaneously present in both networks between a given node pair. We study the importance of our measure in five diverse microbial species theoretically. We capture reported effects of well-studied mutations and predict new ones. We also scrutinize the effectiveness of our procedure through experimental and theoretical tests on *Mycobacterium smegmatis*mc^{2}155. We generate a mutant of mc^{2}155, which is resistant to mycobacteriophage D29. This mutant of mc^{2}155, which is resistant to D29 exhibits significant phenotypic alterations. Whole-genome sequencing identifies mutations, which cannot readily explain the observed phenotypes. We analyse exhaustively the protein–protein interaction network of the wild-type and mutant. For this we utilise the machinery of topological metrics and differential networks, which fails to present a clear picture. However, SPAF coherently identifies pairs of proteins at the end of a subset of shortest paths, from amongst hundreds of thousands of viable shortest paths in the networks. The protein pairs associated with the altered functions are strongly correlated with the observed phenotypes. This work has been published in Bioinformatics (Oxford).

(b) Evolutionary game theory attempts to understand the stability of cooperation in a population. Maintenance of cooperation is difficult, especially when spatial restrictions are absent. The area of games played on graphs has been thoroughly studied. It is well recognised that the outcome of such games could be significantly influenced by the underlying graph topology. Does the topology of the underlying structures on which the games are played possesses no role whatsoever in the determination of payoffs? We introduce the notion of a cooperator graph and defector graph as well as a form of game payoff, which is weakly dependent on the underlying network topology. Our approach is inspired by the well-known microbial phenomenon of quorum sensing. We show that even with such a weak dependence, the basic game dynamics and indeed the very nature of the game may get changed. Such alterations in the nature of a game have been well-reported in experimental and theoretical studies.This work has been published in The European Journal of Physics B: Condensed Matter and Complex Systems.

(c) We have introduced the machinery of Differential Networks to compare a pair of closely similar networks. Proteins having structures in two different states are an excellent venue for validating mathematical predictions to compare two different yet similar graphs. This can be achieved by application of the framework of Residue Interaction Graphs (RIG) or Protein Contact Networks (PCN). In signalling proteins, allosteric communication is the basis of signalling and information transfer. Collective interactions between amino acid residues, which are spatially distributed in the three dimensional structure of a protein molecule, form the basis of allosteric network. While the construction of RIG is based on static crystal structures of proteins, it is

important to extract information on protein dynamics to understand allostery. Therefore, quantitative analysis of RIG based on the framework of Differential Network (DN), is immensely helpful in identifying key amino acid residue interactions within such communication pathways. While the simultaneous availability of protein structures from two different states is essential for DN, there are additional challenges due to crystallographic artefacts. Therefore, experimental validation of predictions from the analyses of RIG is naturally scarce in literature. We study the photosensor domain of the signalling photoreceptor transcription factor, Aureochrome1, to understand light-driven signalling.

Our collaborators have performed direct experiments and verified our predictions from RIG using the machinery of DN. Our approaches are applicable far beyond the present case to the general scenario of any protein having structures in two different states. This work has been published in Proteins: Structure, Function, and Bioinformatics.

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	03	–	–	01	–	–

DR. SAIKAT BISWAS

Associate Professor

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

Scientific Report

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 physics.

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 of these experiments will use fast gaseous detectors, we are working on the R&D of these detectors in the High Energy Physics detector laboratory. This R&D program includes research on the Resistive Plate Chamber (RPC), Gas Electron Multiplier (GEM), Straw tube detector and Scintillation detector (for cosmic ray study).

Summary of Research Work:

Measurement of spark probability and study of charging up effect for GEM detector:
(With S. Chatterjee, A. Sen, S. Roy, S. Das, S. K. Ghosh; K. Nivedita G (IISER, Thiruvananthapuram); A. Paul (University of Calcutta); U. Frankenfeld, C. Garabatos, J. Hehner, T. Morhardt, C. J. Schmidt, A. Lymanets (GSI, Germany); H. R. Schmidt (Eberhard Karls Universität Tübingen, Germany))

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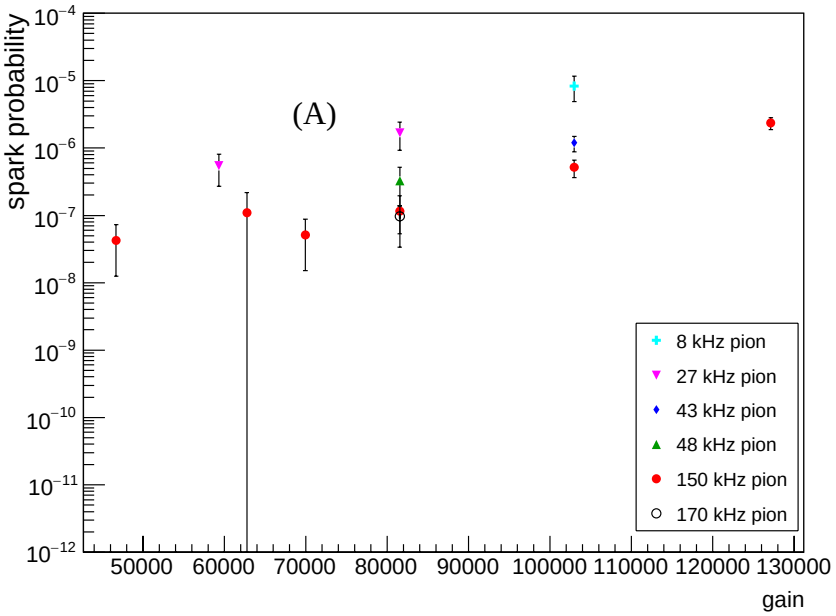
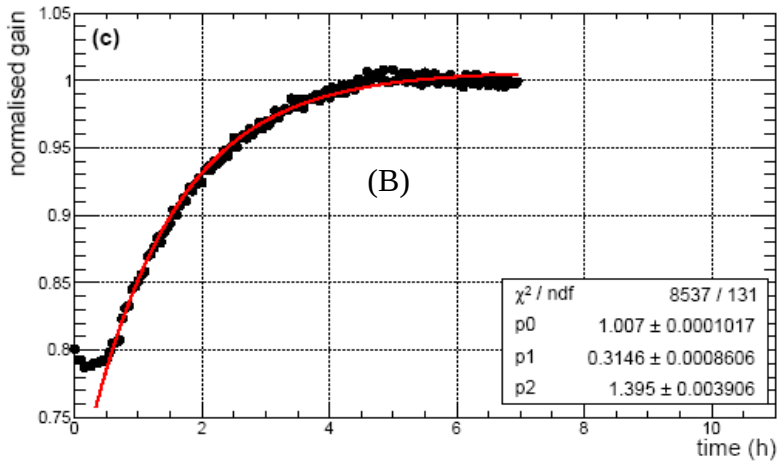
SCIENTIFIC REPORT *Associate Professor*

The spark probability of a single mask triple GEM detector is measured with mostly pure pion beamand also for a shower produced by pion beam with a 20 cm thick iron block at CERN SPS.The spark probability of the detector is found to be $\sim 10^{-7}$ for 150 GeV/c pion beam of rate 150 kHz with a gain between 40,000 to 80,000. No spark is observed for shower produced by pion beams of rates 120, 50 and 6 kHz after striking an iron slab of thickness 20 cm. In this measurement, the particle density per unit surface area of the GEM detector is much smaller for the secondary particles produced in shower than that for the pion beam.That is the probable reason for not getting any spark in the shower set-up.

The charging-up effect of a double mask triple GEM prototype is studied using different irradiation rates from an X-ray source. For 1 kHz, 10 kHz, and 90 kHz operations, the time constant of the charging-up effect is found to be 2.376 ± 0.02 hours, 1.524 ± 0.008 and 1.395 ± 0.004 hours respectively. It is concluded that the time constant of the charging up effect decreases with increasing particle flux.





(A) Spark probability of the GEM detector as a function of the gain. (B) Variation of the normalised gain of GEM detector as a function of time for 90 kHz X-rays irradiation rates falling on 28 mm^2 (3.2 kHz/mm^2) area of the GEM chamber. p2 is the time constant which is the figure of merit of the charging-up effect.

DR. SAIKAT BISWAS

SCIENTIFIC REPORT *Associate Professor*

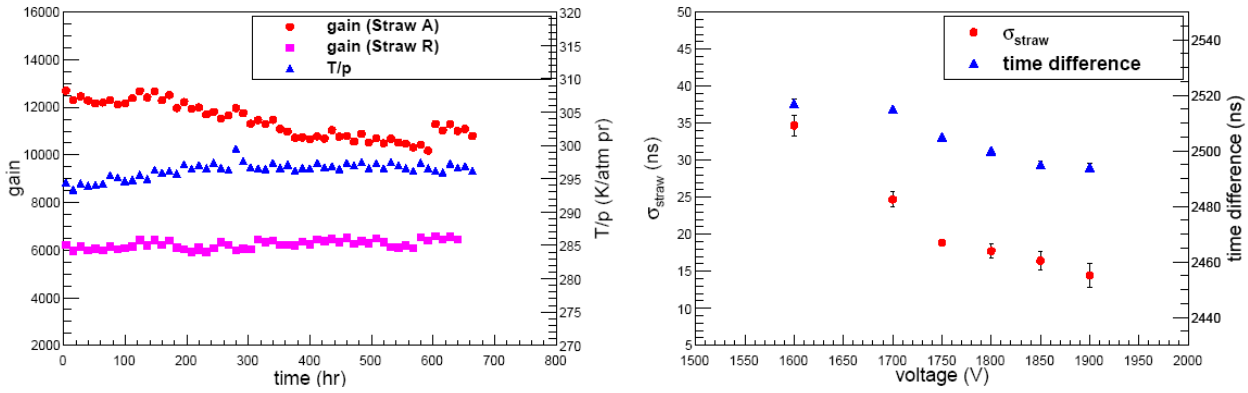
Stability study and time resolution measurement of straw tube detectors:

(With S Roy, S Jaiswal, S. Chatterjee, A Sen, S Das, S K Ghosh, S Raha; V M Lysan, G D Kekelidze, V VMyalkovsky (LHEP-JINR, Dubna, Russia))

R&D activity with a straw tube detector prototype is carried out. 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.

From the first experiment, it is concluded that the gain reduction by 9.6% per C/cm after a total charge accumulation of 0.6 C/cm on the straw wire might be due to the continuous and high radiation. The observed ageing rate is small but not negligible. In the second experiment, it is confirmed that the occurred ageing was due to the high radiation intensity and also drawn a conclusion on the dependence of this ageing rate on the gas flow rate. Another conclusion that can be drawn from our experiment is that the straw tubes can be safely operated at low radiation intensities (~0.1 kHz/mm) and at low gas flow rates (~0.02 l/h) (as no ageing is observed in a straw in experiment 2) and at high radiation intensities (~40 kHz/mm) at high gas flow rates (>3 l/h) (as slight gain reduction is observed even after 800 h of operation of the straws in experiment 1).

The time resolution of the straw tube detector is also measured with cosmic rays. The best achieved time resolution is found to be 14.4±1.6 ns at a biasing voltage of 1900 V.



(Left) Gain and T/p as a function of time of the straws A (Straw under test or ageing straw) and R (Reference straw) biased at 1550 V and 1450 V respectively. (Right) Time resolution (σ_{straw}) of the straw tube and time difference as a function of voltage

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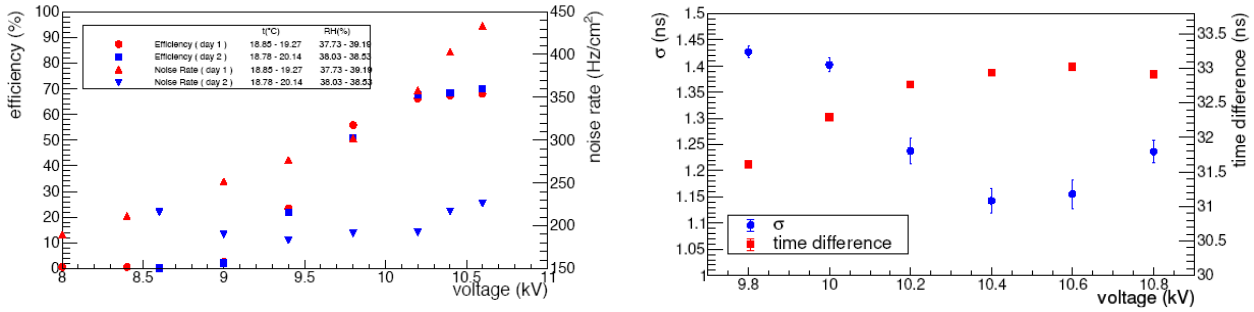
SCIENTIFIC REPORT *Associate Professor*

Characterization of an RPC prototype with moderate resistivity plates:
(With A. Sen, S. Chatterjee, S. Roy, S. Das)

Keeping in mind the requirements of high rate capable, cost effective, large area detectors to be used in the future high energy physics experiments, commercially available bakelite plates having moderate bulk resistivity (3×10^{10} Ω cm) are used to build an RPC module. The chamber is tested in the avalanche mode with 100% Tetrafluoroethane gas. With this prototype, an efficiency of~ 70% and time resolution of~1.2 ns (σ) are obtained from an applied voltage of 10.2 kV onwards. Investigation of the reason behind lower efficiency is going on. One probable reason for the limitation in the efficiency is the voltage drop on the electrodes because of high leakage current.



(Left) Efficiency and noise rate of RPC as a function of voltage. (Right) Time resolution and time difference of RPC signal and master trigger as a function of voltage.

Study of Cosmic ray:
(With S. Roy,A. Sen, S. Chatterjee, R. Biswas, S. Das, S.K. Ghosh, S. Raha)

We are developing plastic scintillation detectors for the detection of cosmic ray and also working on the inorganic scintillation detectors for cosmic gamma ray detection during solar and lunar eclipses. The data of the total solar eclipse of August 21, 2017 which was visible in most of the regions of North America during the day, whereas India, falling on the other half of the globe missed this particular eclipse, is analysed. The secondary cosmic gamma-ray flux is measured using a NaI(Tl) scintillator detector during this total solar eclipse. Our aim is to measure and examine if there are any variations in the secondary cosmic ray (SCR) flux at Kolkata, India due to the occurrence of the eclipse in America. We observe unexpected decrement and increment in SCR flux in certain energy regions.

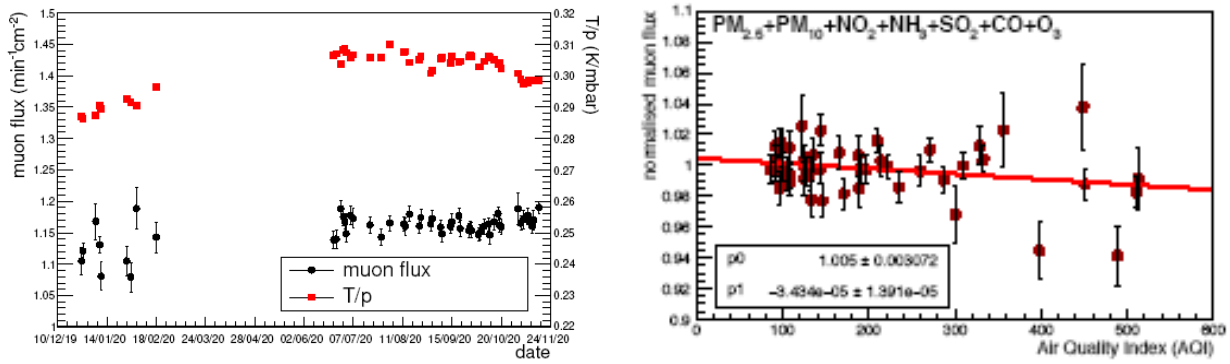
Cosmic ray muon flux is measured using the coincidence technique with plastic scintillation detectors. Torestrict the outbreak of COVID-19, Government of India imposed 67 days of nationwide complete lockdown in three phases. After that, the unlocking is declared in phases in different parts of India. Before the lockdown, we collected some cosmic ray flux data. After

DR. SAIKAT BISWAS

SCIENTIFIC REPORT *Associate Professor*

lockdown, the measurement is continued to compare with the flux measured before lockdown. In our measurement, it is found that the cosmic ray flux remained more or less unchanged before and after the lockdown. However, it is well known that atmospheric temperature and pressure affect the cosmic ray flux and we looked for any such possible correlation. A positive correlation is indeed observed between the muon flux and the ratio of atmospheric temperature and pressure.The cosmic muon flux is normalised by T/p value to eliminate the effects of atmospheric temperature and pressure.It is found that the mean normalised muon flux before and after the lockdown period are 0.982 with a standard deviation of 0.031 and 1.001 with a standard deviation of 0.012 respectively.

A lockdown such as the one implemented due to COVID-19 typically has significant influence on the atmospheric condition in terms of the presence of air pollutants. We wanted to study any possible correlation of measured cosmic ray muon flux with this.It is found that significant declination in the concentrations of the air pollutants due to the lockdown and tried to look for any correlation with the measured muon flux within the stipulated time window. The result shows a clear correlation as with decreasing concentrations of the air pollutants we observed an increasing trend of the normalised muon flux.



(Left) Cosmic ray muon flux and T/p as a function of date. (Right) Normalised muon flux as a function of AQI of seven most abundant air pollutants.

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
–	08	–	04	01	–	02

DR. SIDHARTH KUMAR PRASAD

Associate Professor

Group Members:

Abhi Modak, *SRF, Institute Fellow*
Prottoy Das, *SRF, Institute Fellow*
Debjani Banerjee, *SRF, DST Inspire Fellow*

Collaborations:

A Large Ion Collider Experiment (ALICE) at CERN, Geneva
Compressed Baryonic Matter (CBM) experiment at GSI, Germany

Scientific Report

Background and Vision:

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

DR. SIDHARTH KUMAR PRASAD

SCIENTIFIC REPORT ***Associate Professor***

Aims and Objectives :

- Characterization of a new state of matter QGP:
  - Performing experiments through the participation and contributions in the large international experimental collaborations such as ALICE at CERN, Geneva and CBM at FAIR, GSI.
  - Performing data analysis and Physics publications in scientific journals regarding characterization and understanding of QGP
- Development of in-house facilities and expertise for detector R&D, instrumentation and computational techniques for big data analysis.
- Physics publications in journals about understanding of heavy ion collisions through formation and characterization of QGP.

Work Achieved:

- Study of jet production and its properties in proton-proton and proton-lead collisions is being carried out using ALICE at LHC. Results are presented in national/international conferences.
- Investigation of jet-medium interactions using JEWEL and EPOS Monte Carlo models in Pb-Pb collisions at LHC energy is performed and published.
- Measurements of photon multiplicity and pseudorapidity distributions in proton-lead collisions at 5.02 TeV are being performed and preliminary results are presented in national/international conferences.
- The effect of magnetic field on estimation of jet transport coefficient is studied using a simplified quasi-particle model.
- Water based cooling system is developed for individual modules of CBM MUCH and used in the mini-CBM experiment at GSI, Germany.

DR. SIDHARTH KUMAR PRASAD

SCIENTIFIC REPORT ***Associate Professor***

Future Research Plans:

- Physics analyses and publications of the LHC data to explore the Physics of strongly interacting matter at extreme energy density through characterization of QGP properties.
- Production, tests and quality assessment of a Gas Electron Multiplier (GEM) based Muon Chamber (MUCH) detector for the CBM experiment at FAIR, GSI, Germany.
- R&D and commissioning of a cooling system for the full station of the MUCH detector in the CBM experiment.

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	–	11	01	–	06

Acharya Jagadis Chandra Bose with his students-(1928)
Back row- N.C. Nag, J.C. Ghosh, J.C. Bose, M.N. Saha, S. Dutta
Front row- N.R. Sen, J.N. Mukherjee, S.N. Bose, D.M. Bose

– SCIENTIFIC REPORT –

DIVISION OF PLANT BIOLOGY

BOSE INSTITUTE ANNUAL REPORT 2020-2021

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 totipotency - 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.

DIVISION OF PLANT BIOLOGY

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: Subal Basak, Arup Kumar Dey, Ashim Kumar Nath, Dr. Chaitali Roy, Jadab Kumar Ghosh, Kaberi Ghosh, Jayasish Ghosh, Sanjib Kumar Das, Nadiram Kayal, Birendra Kumar Bari, Siddhartha Roy, Moumita Mondal Basu Roy, Tapas Chakraborty.

PROF. SHUBHO CHAUDHURI

Professor

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

Scientific Report

Background and Vision:

The highly complex structure of chromatin imparts resistance to several nuclear processes. It is still an unsolved mystery as to how several genes whose sequence might be buried in the complex chromatin structure is accessed by nuclear factors during their expression in response to endogenous and exogenous cues. Post-translation modification of histones (epigenetic mark) as well as active chromatin remodelling guided by either ATP dependent chromatin remodeler or histone chaperones play an important regulatory role in activating or repressing gene expression by generating 'open' or 'closed' chromatin configuration inside the cell. Such dynamic changes in the chromatin organization are essential for almost all cellular events like transcription, replication, repair and DNA recombination. The focus of my lab is to study the mechanism of chromatin remodelling in plants to understand the transcription regulation of genes that are regulated by endogenous and exogenous cues.

The small architectural proteins which belongs to High Mobility Group super family is involved in changing the topology of DNA to provide appropriate structure for the binding of nuclear proteins, especially transcription machinery. We have been characterizing ARID-HMG group of proteins that are highly plant specific. Since plant genome does not code for HMGN type of proteins and HMG-box group is highly diverse in plants, we believe that this diversity of HMG-box compensate the role of HMGN and is involved in many developmental as well as environmental transcription for proper specio-temporal expression of genes.

PROF. SHUBHO CHAUDHURI

SCIENTIFIC REPORT ***Professor***

Objectives:

- Characterization of plant specific nuclear architectural proteins and investigating its role in plant development
- Investigating the role of epigenetic regulation during plant development and stress response

Major Achievements:

Investigating the role of nuclear architectural protein AtHMGB15 in pollen development

Knockout mutant of ARID/HMG protein AtHMG15 (Arabidopsis HMG15) shows mutant pollen morphology and retarded pollen tube germination. NGS-based analysis between flowers of wild-type and mutant plants about 757 genes are shown to be up-regulated and about 905 genes are down-regulated in athmgb15 which are involved in several biological processes like metabolism, cell organization and biosynthesis, transcription, transport, developmental and signal transduction pathways. Some of these genes are specifically responsible for floral development particularly the pollen development, organization, wall formation and pollen tube growth.

Analysis of RNA seq data shows that major pathways that were affected in pollen development in *athmgb15* mutant plants belongs to a) Jasmonic acid biosynthesis and signalling; b) Program cell death (PCD); c) Pollen development and d) Cell wall synthesis. These observations are the stepping stone to understand the role of AtHMGB15 regulated hormonal cross talk in pollen developmental process.

Comparative genome wide changes in Histone H3K27 modification and gene expression in rice during cold stress

Oryza sativa L. ssp. ***Indica*** being a tropical crop is highly sensitive to low-temperature stress leading to impaired growth and massive losses in grain productivityThis project involves the study of genome-wide changes in the epigenetic marks of Lysine 27 of Histone H3 and changes in the transcriptome, involved in stress response when rice plants are subjected to cold stress. 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 when present leads to repression of transcription. Previous transcriptome analysis indicated that Cold stress is associated with upregulation of stress responsive TFs, hydrophilic proteins and signaling molecules, whereas, the genes coding for cellular biosynthetic enzymes, cell cycle control and growth-related TFs are downregulated. Presently, the role of epigenetic modifications in the expression of these cold stress responsive genes were studies using whole-gene ChIP-seq data.

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	–	–

PROF. GAURAB GANGOPADHYAY

Professor

Group Members:

Debabrata Dutta, *SRF-UGC*
Soumili Pal, *SRF- INSPIRE*
Vivek Awon, *SRF-UGC*
Diptasree Kumar, *SRF-WBDBT project*
Sananda Bhattacharya , *PhD student (Collaborator Prof. S.K Datta)*
Shinjini Sengupta, *PhD student (Collaborator Prof. S.K Datta)*

Scientific Report

Background and Vision:

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

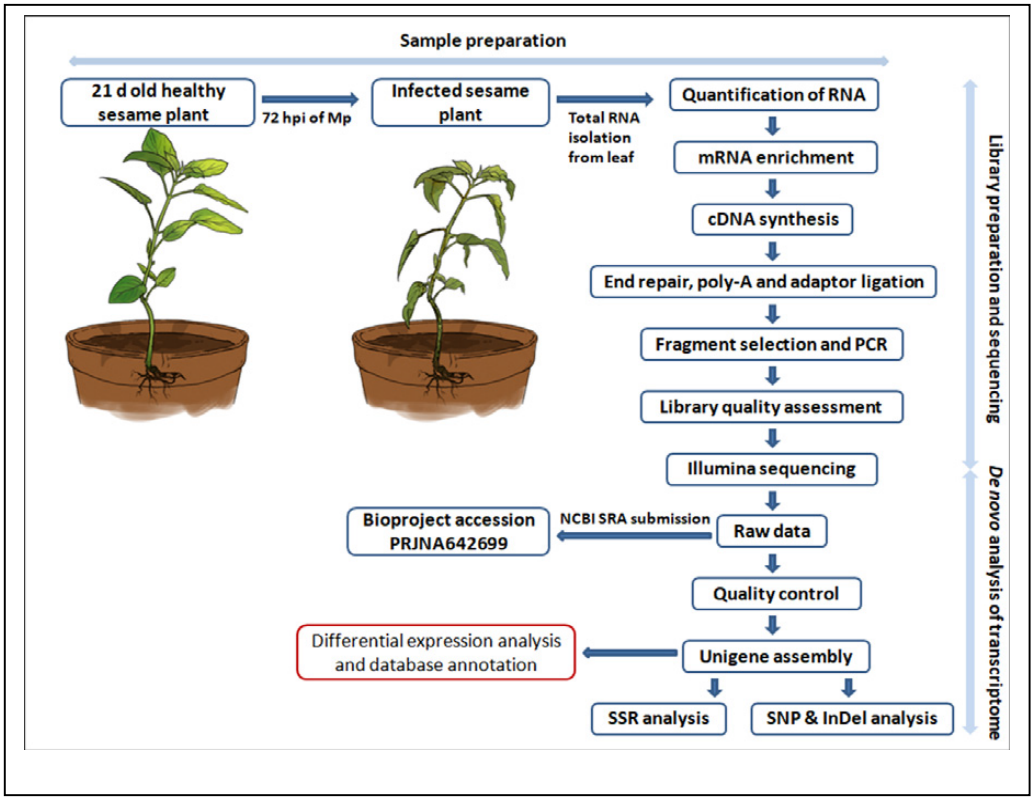
Summary of Research Work:

- We have generated a transcriptomic dataset of cultivated, wild, and inter-specific hybrid sesame in response to induced *Macrophomina phaseolina* infection. This destructive soil-borne fungus causes charcoal rot of sesame, leading to high yield loss. Most of the high-yielding sesame cultivars (*Sesamum indicum*) of India are susceptible to charcoal rot. Wild sesame, *Sesamum mulayanum* shows a high degree of tolerance against many pathogens. We have earlier developed an inter-specific hybrid between Indian cultivated sesame and *S. mulayanum*. The seedlings of the parents and a selected F_6 recombinant were infected with *M. phaseolina*. The data of the infected and control (mock-inoculated) transcriptome is reported in one of our recent publications (*DIB, 2020*). The RNA-seq by Illumina NovaSeq

PROF. GAURAB GANGOPADHYAY

SCIENTIFIC REPORT *Professor*

6000 technology generated 2.9 × 10^8 paired-end reads. We deposited the data in NCBI sequence read archive (SRA) with accession number PRJNA642699. The *de novo* assembly of clean reads generated 106,295 unigenes with an average length of 1,342 bp covering 1.42 ×10^8 nucleotides. The screening of 106,295 unigenes with MISA and SAMtools software resulted in the identification of 26,880 simple sequence repeats (SSRs), 90,181 single nucleotide polymorphisms (SNPs), and 25,063 insertion deletions (InDels). Apart from mono-base repeats, di-nucleotides repeats (42.51%) were found to be the most abundant, followed by tri-nucleotides (14.28%) among the SSRs. Subsequently, we have designed 22,494 pairs of primers based on the perfect di and tri-nucleotide SSRs. Transitions (Ts, 60%) were the most abundant substitution type among the SNPs followed by transversions type (Tv, 40%), with a Ts/Tv ratio of 1.48. The development of genic-SSR markers and SNP information will pave the way for molecular marker-assisted breeding of sesame for tolerance against charcoal rot.

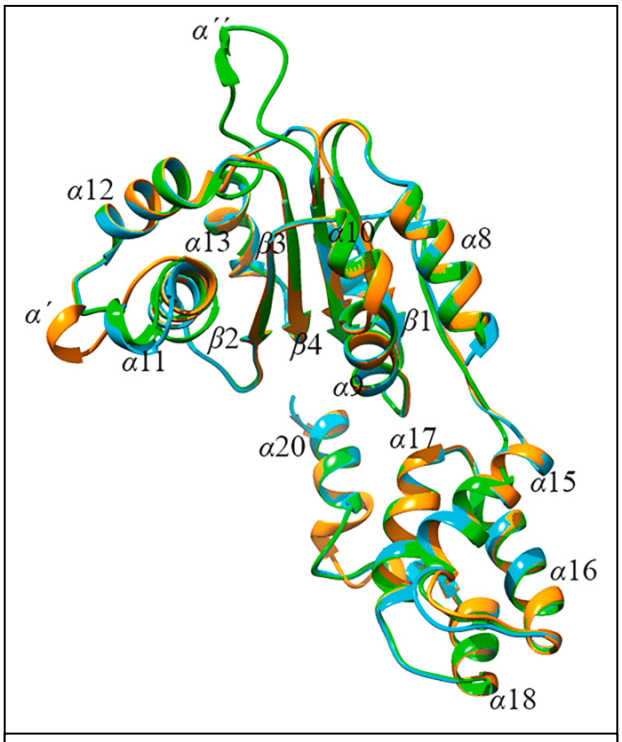


Schematic work flow used for transcriptome analysis of control and infected (Mp) sesame

PROF. GAURAB GANGOPADHYAY

SCIENTIFIC REPORT ***Professor***

- The Resistant (R) proteins play a fundamental role in the innate immunity of plants. Most of these R-proteins have centrally located NB-ARC domain, which regulates the R-protein by NTPase activity. Though the effect of amino acid substitution in RNBS, MHD motifs of the NB-ARC domain has been studied in detail, the *P*-loop motif remains still less explored. With the help of *in-silico* analysis of a hypothetical R-protein (Hyp-R) in sesame, we tested the hypothesis that how amino acid substitution in the conserved *P*-loop motif can affect the interaction between ligand and NB-ARC domain. We have reported I188G, I188V, T192P substitution in *P*-loop motif and V356S adjacent to GLPL motif in three different sesame genotypes in one of our recent publications (*PMPP, 2021*). Docking results and atomic interaction analysis revealed a cumulative effect of these substitutions on the hydrogen bond interactions, which in turn impart effects on ligand binding affinity in *Sesamum indicum* (-6.6 kcal/mol), *S. mulayanum* (-7.3 kcal/mol) and recombinant line (- 7.5 kcal/mol). We correlated the expression of the R-gene encoding Hyp-R protein in sesame after inoculating with *Macrophomina phaseolina*. This study suggests that amino acid substitution in *P*-loop and adjacent to GLPL motif have an immense effect on ligand binding affinity.



Superimposed image of NB-ARC domain of the Hyp-R protein of *S. indicum* (orange), recombinant (green), and *S. mulayanum* (cyan)

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	Awards / Honours / Memberships
01	03	–	09	01	–	–

PROF. PALLOB KUNDU

Professor

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*

Scientific Report

Background and Vision:

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

Emphases are on understanding the major processes of gene regulatory mechanisms such as, regulation of initiation of transcription by transcription factors (TFs) and post transcriptional regulation by miRNAs during stress. We are also interested in understanding the biology of plant specific membrane-bound NACs, namely, NACMTFs as they may serve as direct sensor of stress on cellular membrane. Using tomato plant and various pathogens, and utilizing genomics, molecular biological and plant biotechnological tools my current research programmes are:

- **Mechanisms of regulation of stress-responsive microRNA expression and significance of specific miRNA-mRNA interactions in disease-biology.**

PROF. PALLOB KUNDU

SCIENTIFIC REPORT ***Professor***

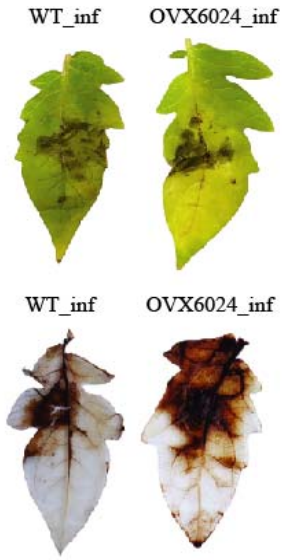
- **Role of mediators of cell death, such as NB-LRRs and metacaspases, in disease development.**
- **Mechanisms of regulation of expression and biological functions of membrane bound NAC transcription factors in tomato (NAC MTFs).**
- **Generation of stress resilient crops of the future by biotechnological 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 Work:

Heightened miR6024-NLR interactions facilitate necrotrophic pathogenesis in tomato

Small RNA-based regulation of Nucleotide-binding leucine-rich repeat, ***NLR,*** genes likely serve as a damper mechanism to spurious defense signaling activation. The exact role of the *NLR*-targeting miRNA and *NLR*-derived small RNAs in disease biology is poorly understood; specifically, limited information is available about their function in necrotrophic pathogenesis. miR6024, which mainly targets NLRs in tomato and potato species, showed varied regulation with varying phytopathogenic stresses, which led to cognate regulation of its target NLRs in tomato, as seen in this study. The 22nt mature miRNA could also potentiate the generation of secondary phased siRNA from a particular target transcript during the necrotrophic ***A. solani*** induced Early blight disease. The miR6024 overexpressing transgenic plants showed constitutive downregulation of its target NLRs. Perturbation of defense-transcriptome in overexpressing leaf tissues was also evident. In *A. solani* infection, these plants exhibited aggravated disease phenotype with enhanced lesion, greater ROS generation and hypersusceptibility, thus establishing an antagonistic role of miR6024 in plant immunity. With the elucidation of the disease-synergistic role played by miR6024, it becomes a potent candidate for identifying and targeting for generating ***A. solani*** resistant tomato plants.

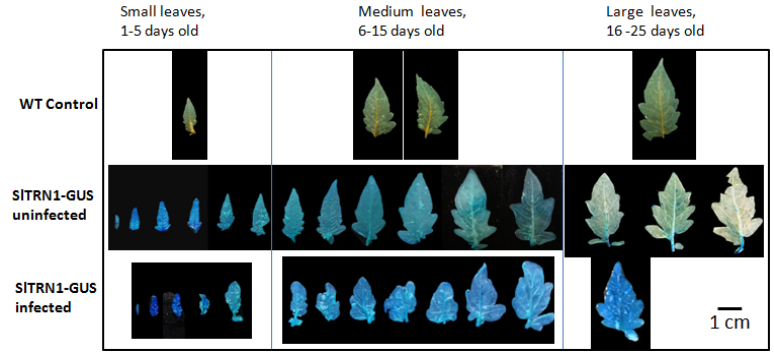


miR6024 overexpressing transgenics show greater susceptibility towards the necrotrophic A. solani fungus infection, than the wild type tomato plants.

PROF. PALLOB KUNDU

SCIENTIFIC REPORT *Professor*

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



Enhancement of tomato TORNADO1 promoter activity during ToLCNDV infection. GUS staining of different growth stages of wild type, promoter TRN1-GUS transgenic uninfected and transgenic infected tomato leaves showing enhanced activity in mature leaves.

Leaf curl disease of tomato caused by Tomato Leaf Curl New Delhi Virus (ToLCNDV) inflicts huge economical loss. Disease symptoms resemble leaf developmental defects including abnormal vein architecture. Leaf vein patterning related ***TORNADO*** gene's (***SlTRN1***) transcript level is augmented in virus-infected leaves. To elucidate the molecular mechanism of the upregulation of ***SlTRN1*** in vivo we have deployed ***SlTRN1*** promoter-reporter transgenic tomato plants and investigated the gene's dynamic expression pattern in leaf growth stages and infection. Expression of the gene was delimited in the vascular tissues and oppressed in growing leaves. Methylation-sensitive PCR analyses confirmed the accumulation of CHH methylation at multiple locations in the ***SlTRN1*** promoter in older leaves. However, ToLCNDV infection reverses the methylation status and restores expression level in the leaf vascular bundle. The virus dampens the level of key maintenance and *de novo* DNA methyltransferases *SlDRM5*, *SlMET1*, *SlCMT2* with concomitant augmentation of two DNA demethylases, *SlDML1* and *SlDML2* levels in ***SlTRN1*** promoter-reporter transgenics. Transient overexpression of *SlDML2* mimics the virus-induced hypomethylation state of the ***SlTRN1*** promoter in mature leaves. Further, in line with the previous studies, we confirm the crucial role of viral suppressors of RNA silencing AC1 and AC4 proteins in promoting DNA demethylation and directing it to reinstate activated transcription of ***SlTRN1*** in silenced tissues for possible modification of leaf venation architecture, leaf curling and easy vector acquisition of viral particles.

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	Awards / Honours / Memberships
–	01	–	–	03	–	–

DR. ANUPAMA GHOSH

Associate Professor

Group Members:

Rahul Datta, *SRF, Institute Fellow*
Dibya Mukherjee, *SRF, Institute Fellow*
Udita Acharya, *SRF, Institute Fellow*
Subhasish Mukherjee, *SRF, UGC Adhoc*
Aroni Mitra, *DBT-SRF*
Anisha Roy, *DBT-SRF*
Alka Kumari, *CSIR-RA*

Scientific Report

Background and Vision:

Our research involves identifying the molecular mechanism of communication between a host and a pathogen/beneficial microbe within a plant microbe interaction system. As a model biotrophic plant pathogen we are studying the corn smut fungus *Ustilago maydis*. We are currently investigating the biological function of a number of secreted proteins including ribonucleases, proteases and lipases from *Ustilago maydis* in connection to disease establishment by the pathogen. In addition, role of small heat shock proteins in the pathogenic development of the fungus is also studied. Besides, identifying the defense response by the host plant *Zea mays* is another major research area that is also being explored. However, our primary focus is on the host pathogen interface that is represented by the apoplast of the infected plant. We are also studying the response of maize towards colonization with beneficial microbes isolated from various environments.

DR. ANUPAMA GHOSH

SCIENTIFIC REPORT ***Associate Professor***

Summary of Research Work:

- A set of two secreted ribonucleases, Nuc1 and Nuc2 have been demonstrated to help in scavenging of extracellular RNA in *Ustilago maydis*.
- Existence of extracellular vesicles containing secreted virulence proteins like Nuc1 and Lip1 in the axenic culture of *Ustilago maydis* is established.
- Involvement of a small heat shock protein HSP20 in the sporidia to filament transition of *Ustilago maydis is* detected.
- Role of a secreted aspartyl protease in the sporulation of *U. maydis* is shown.

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	–	–

– SCIENTIFIC REPORT –

SENIOR SCIENTISTS

BOSE INSTITUTE ANNUAL REPORT 2020-2021

PROF. A.N.LAHIRI MAJUMDER

INSA Senior Scientist

Scientific Report

Abiotic Stress Tolerance in Plants : Regulation of metabolic events involving inositol, phosphoinositides and other processes.

(a) Characterization of myo inositol oxygenase (OsMIOX) from rice : Role in different indica rice cultivars under osmotic stress

Myo inositol oxygenase (MIOX), the only catabolic enzyme of the inositol pathway, catalyzes conversion of *myo*-inositol to D-GlcA (glucuronic acid). The present work undertakes a bioinformatic analysis of plant *MIOX* gene(s), with emphasis on the rice gene (*OsMIOX*) and biochemical characterization of MIOX enzyme derived from its' cloned gene from *indica* rice. The study emphasizes on the phylogenetic analysis of *MIOX* gene across lower groups, plants and animals with special reference to rice (*Oryza sativa*). Comparative motif analysis of the *MIOX* gene(s) suggested the existence of abiotic- stress related *cis*-acting elements such as CRE, DRE, MYB, MYC, STRE, MeJa etc. A single isoform of *MIOX* gene is located in chromosome 6 of *indica* rice (*Oryza sativa*). cDNA from the four rice cultivars were found to be identical with an open reading frame of 938bp coding for 308 amino acids producing a protein of ~35 kDa. Secondary structure prediction of the protein gave the predicted number of 144 alpha helices and 154 random coils. The three-dimensional structure suggested it to be a monomeric protein with a single domain. Bacterial overexpression of the protein, purification and enzyme assay showed optimal catalytic activity at pH 7.5-8 at an optimal temperature of 37˚C with Michaelis constant of 40.92 mM. The range of Km was determined as (40.92-54.1) mM and the range of Vmax was calculated as (0.003123-0.003461) mM/min respectively from Lineweaver Burk double reciprocal plot and curve-fitting Michaelis-Menten equation. Four rice cultivars (salt-tolerant and salt-sensitive) displayed differential gene expression of *OsMIOX* at different time points in different tissues under salinity and drought stress observed from qRT-PCR, microarray results and protein expression profile in immunoblot analysis. Gel volumetric analysis confirmed a very high expression of MIOX in roots and leaves on 7th day following germination. Microarray data showed high expression of *MIOX* at all developmental stages including seedling growth and reproduction. These data suggest that OsMIOX has a definite role in rice abiotic stress responses mediated through the *myo*-inositol oxidation pathway.

(b) Phosphoinositides in stress tolerance

Cloning and molecular studies of the four PLC genes from IR64 indica rice and their expression pattern under drought and salt stress has been studied. Suitable expression vector constructs have

PROF. A.N.LAHIRI MAJUMDER

INSA Senior Scientist

been made and transformation of IR64 rice with the most effective PLC genes (PLC1 and PLC 3) has been worked out . At present raising of homozygous T2/ T3 rice lines is underway . Determination of copy number, site of integration and physiological studies with respect to drought/salt stress of the homozygous rice lines are envisioned .

(c) Induction of multi-stress tolerance and improved photosynthesis to indica rice by introgression of a salt-tolerant chloroplastic FBPase from Oryza coarctata

C3 photosynthesis in rice is dependent on regeneration of Ribulose 1,5-bisphosphate (RuBP), the CO2 acceptor which is largely determined by the Fructose 1,6-bisphosphatase (FBPase) function in the chloroplast. Abiotic stress afects this function negatively impacting the decline in the photosynthetic potential of crop plants. In the present work the PcCFR gene, coding for a salt-tolerant chloroplasticFBPase, from Oryza coarctata (Roxb.) Tateoka, was introduced into the cultivated rice (*Oryza sativa* var. indica IR64). The homozygous transgenic PcCFR plants performed better than the untransformed lines in terms of overall plant growth, photosynthetic performances and grain yield under normal as well as under salt and diferent abiotic stress conditions. Under salinity, drought and cold stress PcCFR lines showed tolerance through emergence of new leaves, improved photosynthetic performance and overall growth rate. The cumulative results suggested that the overexpression of salt-tolerant FBPase (PcCFR) protein in the transgenic rice helps to keep the photosynthetic cycle by unabated generation of RuBP that retains better light harvesting capacity of the leaves under stress. It is presumed that this will provide an insight into the growth and development during abiotic stress by inducing an interaction among diferent sugars derived from photosynthetic carbon metabolism as well

(d) Enhancement of nutritional quality of rice through genetic manipulation : A review

Food with higher nutritional value is always desired for human health. Rice is the prime staple food in more than thirty developing countries, providing at least 20% of dietary protein, 3% of dietary fat and other essential nutrients. Several factors influence the nutrient content of rice which includes agricultural practices, post-harvest processing, cultivar type as well as manipulations followed by selection through breeding and genetic means. In addition to mutation breeding, genetic engineering approach also contributed significantly for the generation of nutrition added varieties of rice in the last decade or so. In the present review, we summarize the research update on improving the nutritional characteristics of rice by using genetic engineering and mutation breeding approach. We also compare the conventional breeding techniques of rice with modern molecular breeding techniques toward the generation of nutritionally improved rice

variety as compared to other cereals in areas of micronutrients and availability of essential nutrients such as folate and iron. In addition to biofortification, our focus will be on the efforts to generate low phytate in seeds, increase in essential fatty acids or addition of vitamins (as in golden rice) all leading to the achievements in rice nutrition science. The superiority of biotechnology over conventional breeding being already established, it is essential to ascertain that there are no serious negative agronomic consequences for consumers with any difference in grain size or color or texture, when a nutritionally improved variety of rice is generated through genetic engineering technology.

Publications:

1. Das, P , Adak S, and Majumder A L (2020) Genetic Manipulation for Improved Nutritional Quality in *Rice Front. Genet.*, Https://Doi.Org/10.3389/Fgene.2020.00776

2. Mukherjee S, Mukherjee A, Das P, Bandyopadhyay S, Chattopadhyay D, Chatterjee J and Majumder A L (2021) A salt□tolerant chloroplastic FBPase from *Oryza coarctata*confers improved photosynthesis with higher yield and multi stress tolerance to *indica* rice *Plant Cell, Tissue and Organ Culture* (PCTOC) https://doi.org/10.1007/s11240-021-02026-1

PROF. JOYOTI BASU

J. C. Bose National Fellow

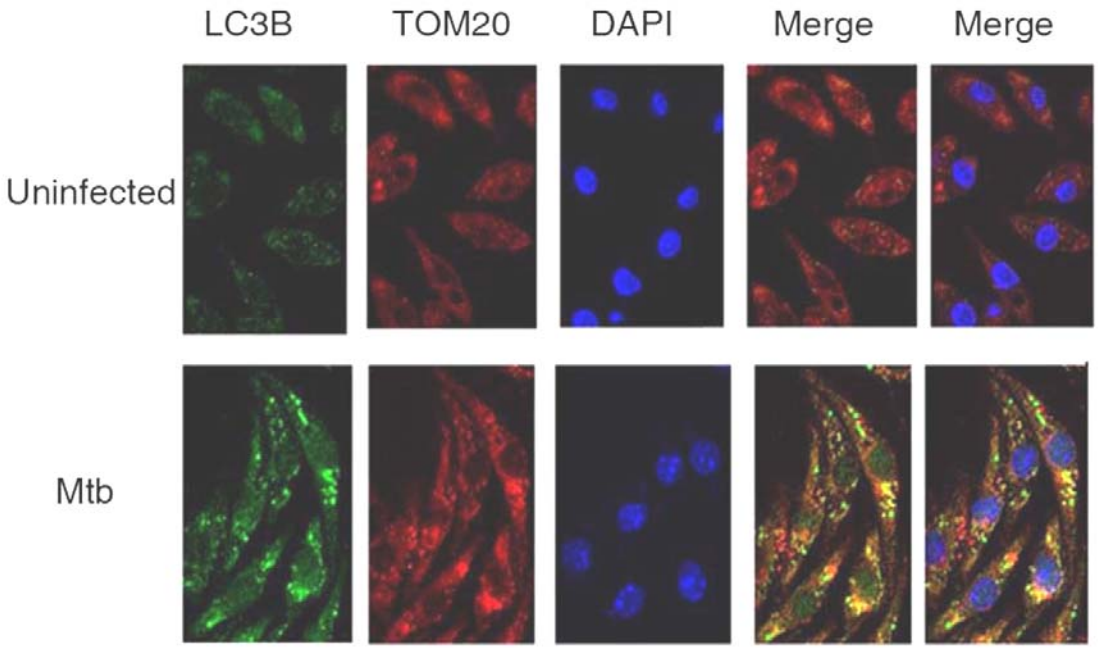
Scientific Report

The role of mitophagy in the immune response of macrophages to *Mycobacterium tuberculosis* infection (*in collaboration with Prof. ManikuntalaKundu*)

Energy metabolism plays a pivotal role in the regulation of immunity. The mitochondrion is the source of energy in cells. It generates NADH and ATP through the TCA cycle and oxidative phosphorylation to maintain energy supply. Recent studies suggest that the mitochondria play an important role in innate immunity. Damaged mitochondria lead to excessive ROS production and the release of mitochondrial DNA into the cytosol. Damaged mitochondria are engulfed by autophagosomes and then fused to lysosomes, and finally removed selectively from the system by a process termed mitophagy. During canonical mitophagy, PARK2/Parkin, an E3 ubiquitin ligase is phosphorylated by the kinase PINK1 and translocates to the mitochondria. We have tested the role of mitophagy in macrophages infected with *Mycobacterium tuberculosis*. We have established that during *M. tuberculosis* infection, mitophagy in macrophages occurs in a Parkin-dependent manner. LC3 associates with the mitochondrial marker TOM20, confirming that mitophagy is occurring during infection. Fission protein Dynamin related protein (Drp) 1 generally resides in the cytosol and translocates to the mitochondria during fission and mitophagy. We show by immune fluorescence microscopy that Drp1 localizes to the mitochondria during *M. tuberculosis* infection, and that knock down of Drp1 or its inhibition by Mdivi, leads to an inhibition of *M. tuberculosis*-triggered mitophagy. This suggests that mitophagy is likely preceded by mitochondrial fission. The importance of mitophagy in innate immunity to *M. tuberculosis* infection, was tested by studying the role of Parkin on glycolysis during infection. A number of glycolytic genes are induced in macrophages upon *M. tuberculosis* infection. Knock down of Parkin attenuated the expression of the glycolysis-associated genes *GLUT1*, *PKM2*, *MCT4* and *PFKFB3* during infection, suggesting a role of Parkin in regulating *M. tuberculosis*–induced mitophagy, and glycolysis in macrophages. Our observations bring to light a hitherto unexplored role of Parkin in regulating metabolism during *M. tuberculosis* infection of macrophages.

PROF. JOYOTI BASU

J. C. Bose National Fellow



Murine Bone Marrow Derived Macrophages were infected with *Mycobacterium tuberculosis* (Mtb) at an MOI 10, or left uninfected. After 6 h of infection, cells were immunostained with LC3 and TOM20 antibody, followed by visualisation by confocal microscopy. Nuclei were stained with DAPI.

Publications:

1. Subuddhi A, Kumar M, Majumder D, Sarkar A, Ghosh Z, Vasudevan M, Kundu M and Basu J (2020) Unraveling the role of H3K4 trimethylation and lncRNA HOTAIR in SATB1 and DUSP4-dependent survival of virulent *Mycobacterium tuberculosis* in macrophages. *Tuberculosis* 120:101897. doi: 10.1016/j.tube.2019.101897.
2. Mazumder S, Verma R, Saha A, Bhattacharyya P, Maji P, Surjit M, Kundu M, Basu J and Saha S (2021) Perspectives about modulating host immune system in targeting SARS-CoV-2 in India. *Front Genet*. 12:637362. doi: 10.3389/fgene.2021.637362.
3. Kundu M and Basu J (2021) Applications of transcriptomics and proteomics for understanding dormancy and resuscitation in *Mycobacterium tuberculosis*. *Front Microbiol*. 64,2487. doi: 10.3389/fmicb.2021.642487.
4. Mahatha A C, Mal S, Mazumder D, Saha S, Ghosh A, Basu J and Kundu M (2020) RegX3 activates *whiB3* under acid stress and subverts lysosomal trafficking of *Mycobacterium tuberculosis* in a WhiB3-dependent manner, *Front Microbiol.* vol. 11:572433. doi: 10.3389/fmicb.2020.572433.

PROF. MANIKUNTALA KUNDU

CSIR Emeritus Scientist

Scientific Report

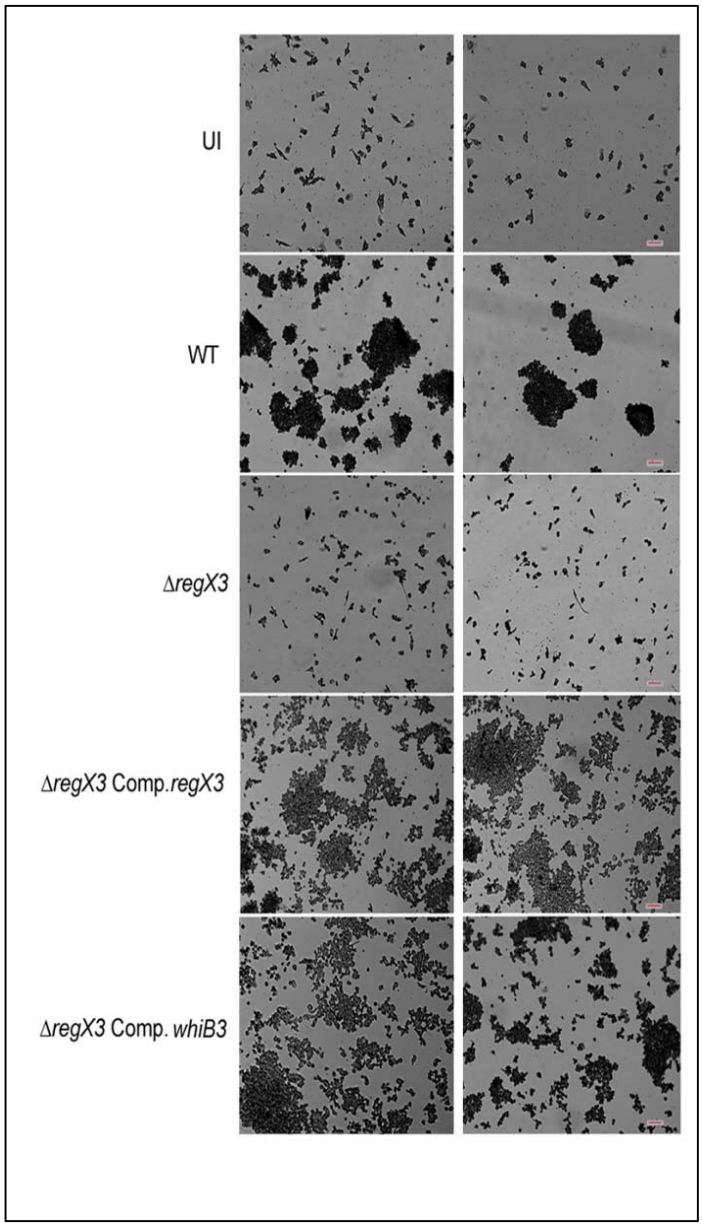
RegX3 dependent activation of WhiB3 favors formation of granuloma and subversion of lysosomal trafficking of *Mycobacterium tuberculosis* in macrophages

Intracellular trafficking to lysosomes reduces mycobacterial burden in macrophages, and virulent mycobacteria have the ability to evade trafficking to macrophages. We now show that *ΔregX3* is compromised for survival in macrophages compared to the wild type We therefore tested whether the ability of *M. tuberculosis* to evade trafficking to lysosomes is compromised in the absence of *regX3*. Following infection, the colocalization of FITC-labeled *M. tuberculosis* with the lysosomal marker LAMP1 was higher in the absence of *RegX3* as enumerated by fluorescence microscopy. This was partly reversed by complementation with either *regX3* or *whiB3*, suggesting that *RegX3* subverts the trafficking of *M. tuberculosis* to lysosomes in a WhiB3-dependent manner.

We also tested the role of *RegX3* in granuloma formation in vitro. Peripheral blood mononuclear cells (PBMCs) were infected with *M. tuberculosis*. Aggregates of PBMCs (>100 µm) representative of in vitro granuloma formation, were observed in the case of infection with the wild type bacterium but were absent when PBMCs were infected with *ΔregX3*. Complementation of *ΔregX3* with *regX3* (*ΔregX3* Comp. *regX3)* or *whiB3*(*ΔregX3* Comp. *whiB3*) restored the ability of the bacterium to elicit aggregation, suggesting that the role of *RegX3* in granuloma formation is dependent on WhiB3.

PROF. MANIKUNTALA KUNDU

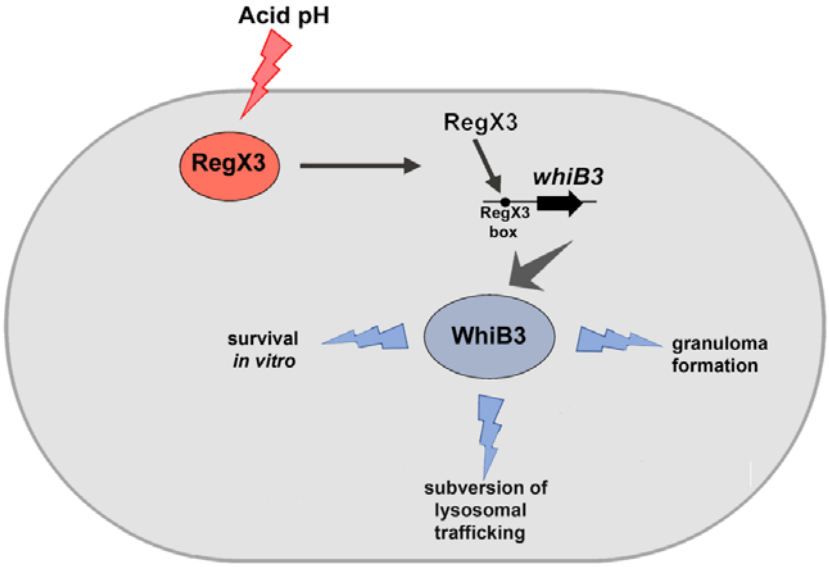
CSIR Emeritus Scientist



In vitro granuloma formation after infection of PBMCs with different strains of *M. tuberculosis.* One million human PBMCs were infected with different strains of *M. tuberculosis* at an MOI of 0.01; or were left uninfected (UI) and stained with MaygrünwaldGiemsa stain at day 9 post-infection. Images were taken at 10x magnification

PROF. MANIKUNTALA KUNDU

CSIR Emeritus Scientist



Publications:

1. Subuddhi A, Kumar M, Majumder D, Sarkar A, Ghosh Z, Vasudevan M, Kundu M and Basu J (2020) Unraveling the role of H3K4 trimethylation and lncRNA HOTAIR in SATB1 and DUSP4-dependent survival of virulent *Mycobacterium tuberculosis* in macrophages. *Tuberculosis* 120:101897. doi: 10.1016/j.tube.2019.101897.
2. Mazumder S, Verma R, Saha A, Bhattacharyya P, Maji P, Surjit M, Kundu M, Basu J and Saha S (2021) Perspectives about modulating host immune system in targeting SARS-CoV-2 in India. *Front Genet*. 12:637362. doi: 10.3389/fgene.2021.637362.
3. Kundu M and Basu J (2021) Applications of transcriptomics and proteomics for understanding dormancy and resuscitation in *Mycobacterium tuberculosis*. *Front Microbiol.* 64,2487. doi: 10.3389/fmicb.2021.642487.
4. Mahatha A C, Mal S, Mazumder D, Saha S, Ghosh A, Basu J and Kundu M (2020) *RegX3* activates *whiB3* under acid stress and subverts lysosomal trafficking of *Mycobacterium tuberculosis* in a WhiB3-dependent manner, *Front Microbiol.* vol. 11:572433. doi: 10.3389/fmicb.2020.572433.

PROF. SAMPA DAS

INSA Senior Scientist

Scientific Report

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

Previous investigations in relation to chickpea and wilt causing pathogen, *Fusarium oxysporum* interaction identified differentially up and down regulation of various transcription factors (TFs) including few members of WRKY and MYB transcription families.

Upon challenging resistant and susceptible chickpea genotypes with *Fusarium oxysporum* through the present project detected multiple layers of complex signalling mechanism of WRKY70 TF. WRKY70 plays unique role in transcriptional regulation of down stream signalling of defense related genes, modulating ROS homeostasis and Salicylic acid biosynthesis which actually determine the susceptibility and or resistance response of the host plant. Infection induced expression patterns of *CaWRKY 70* mediated immune signaling elements threw new insight to the understanding of chickpea-Fusarium interplay (BMC Plant Biology, 2020). Likewise, some members of MYB TF were also detected to be differentially expressed in chickpea in Fusarium infection. Among them CaMYB78 was found to be significantly upregulated in resistant chickpea genotype during *Fusarium oxysporum* infection. CaMYB78 was also explicitly induced during osmotic and salinity stress which is indicating its role in multiple stresses. Chimeric CaMYB78 gene was overexpressed both in tobacco and chickpea. Transgenic tobacco lines demonstrated increased insensitivity towards salinity and drought stresses during seed germination. CaMYB78- overexpressing seedlings had longer primary root length, increased biomass with higher efficiency to scavenge reactive oxygen species. CaMYB78 overexpresing chickpea plants showed enhanced level of expression of different abiotic stress related genes. These findings suggest that CaMYB78 plays and regulates abiotic stress tolerance and can be utilised in economically important crop management programmes.

PROF. SAMPA DAS

INSA Senior Scientist

Group Members:

Ms. Surbhi Shriti, UGC SRF,

Dr. Akansha Jain has been working as **DST Women Scientist** (SR/WOS-A/LS-377/2018) on a project entitled "Seed priming with Allium sativum leaf agglutinin (ASAL) for increasing *Bacillus subtilis* rhizospheric colonization and enhancing resistance against *Rhizoctonia solani*, the sheath blight pathogen of rice."

Rhizoctonia solani is a severely damaging pathogen affecting many important crops including rice on which it causes deadly disease of Sheath Blight. A particular *Bacillus* strain isolated from rhizospheric soil treated with Allium sativum leaf agglutinin was found to form strong biofilm and protect the crop from fungal attack.

Dr. Sathi Paul is continuing as CSIR Associate (since 01.05.18) on a project entitled **"**Efficacy of monomeric mutant variant of *Allium sativum* leaf agglutinin (mASAL) against wilt causing root pathogen *Fusarium oxysporum* f. sp. *ciceri* (Foc) of chickpea (*Cicer arietinum* L.)"

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. Their association with nitrogen fixation phenomenon was characterized and whole genome sequencing of above two bacterial species has been accomplished.

Publications:

1. Chakrobarty J, Jain A and Das S (2020) Inhibition of multiple defense responsive pathways by CaWRKY70 transcription factor promotes susceptibility in chickpea under *Fusarium oxysporum* stress condition. BMC Plant Biology 20(1): 319. DOI: 10.1186/s12870-020-02527-9.

2. Jain A, Chatterjee A, and Das S (2020) Synergistic consortium of beneficial microorganisms in rice rhizosphere promotes host defense to blight-causing *Xanthomonas oryzae* pv. *oryzae*. *Planta* 252:106. DOI: 10.1007/s00425-020-03515-x.

3. Jain A, Singh HB, and Das S (2021) Deciphering plant-microbe crosstalk through proteomics studies. *Microbiological Research.* 242 (126590) https:// doi. org10.1016/j micres. 2020.126590.

PROF. SAMPA DAS

INSA Senior Scientist

4. Paul S and Das S (2021) Natural insecticidal proteins, the promising bio-control compounds for future crop protection. *The Nucleus.* 64: 7–20 https://doi.org/10.1007/s13237-020-00316-1

5, Bhar A, Jain A. and Das S (2021) Soil pathogen, *Fusarium oxysporum* induced wilt disease in chickpea: a review on its dynamicity and possible control strategies. *Proc.Indian Natl. Sci. Acad.* https://doi.org/10.1007/s43538-021-00030-9

Book Chapters:

1. Jain A and Das S (2020) *Trichoderma* Proteome: Multifunctional Role in Plant Defense In: Trichoderma: Agricultural Applications and Beyond. Soil Biology Manoharachary C., Singh H.B., Varma A. (eds), *Springer Cham* vol 61: Pp 311-323. https://doi.org/10.1007/978-3-030-54758-5_14
2. Jain A and Das S (2021) Regulatory requirements for nanopesticides and nanofertilizers. In Advances in Nano-Fertilizers and Nano-Pesticides in Agriculture.: Jogaiah S, Singh, HB, Fraceto LF, de Lima R (eds.) In Wood head Publishing Series in *Food Science, Technology and Nutrition.* Pp 145-152. https://doi.org/10.1016/B978-0-12-820092-6.00006-9.
3. Jain A, Bhar A, Das S (2021) Improving Biotic and Abiotic Stress Tolerance in Plants: A CRISPR-Cas Approach. In: Sarmah B.K., Borah B.K. (eds) Genome Engineering for Crop Improvement. Concepts and Strategies in Plant Sciences. *Springer, Cham.* https://doi.org/10.1007/978-3-030-63372-1_9.

PROF. SUSHANTA DATTAGUPTA, *FNA*

INSA Senior Scientist

Scientific Report

During the year under consideration, I carried on research in the area of Quantum Effects in Solids, with particular attention to Nano-Science. Some of the research work have already been published during this period (with details given below) while others are being either submitted or being written up.

Publications:

A. Published (in Physics Journals)

1. Kumar N, Wadhera N, Tomar R, Singh Y, Dattagupta S and Chakraverty S (2020) Observation of Shubnikov-de Haas oscillation, non-trivial Berry phase, planar Hall and anisotropic magneto resistance at the conducting interface of EuO-$KTaO_3$, *Advanced Quantum Technology* 4, pp 2000081.
2. Dattagupta S (2020) Anderson and Line Shapes, *Resonance*.
3. Bandyopadhyay M, Dattagupta S and Dubey A (2020) Effect of noise on quantum transport of a charged particle in a tight-binding lattice, *Physical Review B* 101, 184308.
4. Dattagupta S (2020) On Interdisciplinary Science, Guest Editorial, *Current Science*.
5. Dattagupta S (2020) Can Graphene be used to Teach Quantum Mechanics? *Current Science*.
6. Dattagupta S (2020) Some Stray Thoughts on Doing Science under the Lockdown and the State of Physics of the Quantum Theory of Solids, *Proceedings of the Indian National Science Academy*, 86, 1291.

B. Published (0f general interest)

1. Tagore on Education, S. Dattagupta, in Magic of Learning, ed. Subha Das Mollick, Bichitra Pathshala, Kolkata.

SERVICE DEPARTMENTS / SECTIONS

BOSE INSTITUTE ANNUAL REPORT 2020-2021

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

CENTRAL INSTRUMENT FACILITY (CIF)

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. Sujoy Kumar Das Gupta, In-charge CIF (CB), Prof. Jayanta Mukhopadhyay, In-charge CIF (MC), Dr. Abhijit Chatterjee, Dr. Abhrajyoti Ghosh, Prof. Achintya Singha, Prof. Ajit Bikram Datta, Prof. Anirban Bhunia, Prof. Atin Kumar Mandal, Prof. Gaurisankar Sa, Prof. Gautam Basu, 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 : Tanima Modak Dhar, 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).

CENTRE FOR ASTROPARTICLE PHYSICS & SPACE SCIENCE

- 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.

FALTA EXPERIMENTAL FARM

In-charge : Prof. Pallob Kundu

Overview

Both scientific and outreach activities are conducted at the Falta Experimental Farm (FEF) of Bose Institute. The farm is situated at Falta village of South 24 Parganas, which is about 80 km away from Bose Institute Main campus. Utilizing the modern cultivation technologies and proper planning we harvest multiple crops in this small farm each year. The excess produces obtained from the farm are disbursed at a reasonable cost. This year, we have cultivated rice, maize, cucumber, broccoli, bean, okra, spine gourd, carrot, knolkhol. Additionally, coconut, green coconut, and mango from multiple trees were collected and sold.

Edible fish such as Rohu, Katla, Bata etc. are cultivated in all 4 ponds of the farm. All staff members in the farm also participated in the production and rearing of Rohu and Katla fish spawn via artificial breeding. Small scale color fish cultivation has been initiated recently.

Other activities include medium scale production of mushroom spawn for in house cultivation and supply to enthusiastic farmers, apiculture for honey collection, and vermicomposting. We have been successful in cultivation of earthworm along with the vermicompost units, which ensured enough supply for in house production of vermicompost as well as to enthusiastic farmers. It is worth mentioning that vermicompost produced at the farm is hugely popular among all members of Bose Institute. New initiative such as production of seasonal flowering plants and supplying it to all interested members of Bose Institute is proven successful. All these activities led to significant amount of revenue generation.

FALTA EXPERIMENTAL FARM (FEF)

Rural Biotechnology Training programme at Falta Experimental Farm:

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, which is one of the key areas in which the Father of the Nation, Mahatma Gandhi showed active interest. Bose Institute has adopted a holistic approach to train SC/ST/weaker sections in generating alternative modes of livelihood using biotechnology based programmes. 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.

Rural Biotechnology based 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:** Dr. Pallob Kundu; **Co-PI:** Dr. Gaurab Gangopadhyay; **Co-PI:** Dr. Shubho Chaudhuri, Division of Plant Biology, has been sanctioned under Tribal Sub Plan of DST SEED programme. 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 programme 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.

FALTA EXPERIMENTAL FARM (FEF)

Broccoli cultivation at the Falta Experimental farm.

Annual tree-plantation at the FEF

Prof. Uday Bandyopadhayay along with the faculties, staff members of Bose Institute and trainees of the hands-on training programme held at the Falta Experimental Farm.

Prof. Uday Bandyopadhayay (rear most) is attending one of the training sessions at the Falta Experimental Farm.

Color fish cultivation at the Falta Experimental Farm.

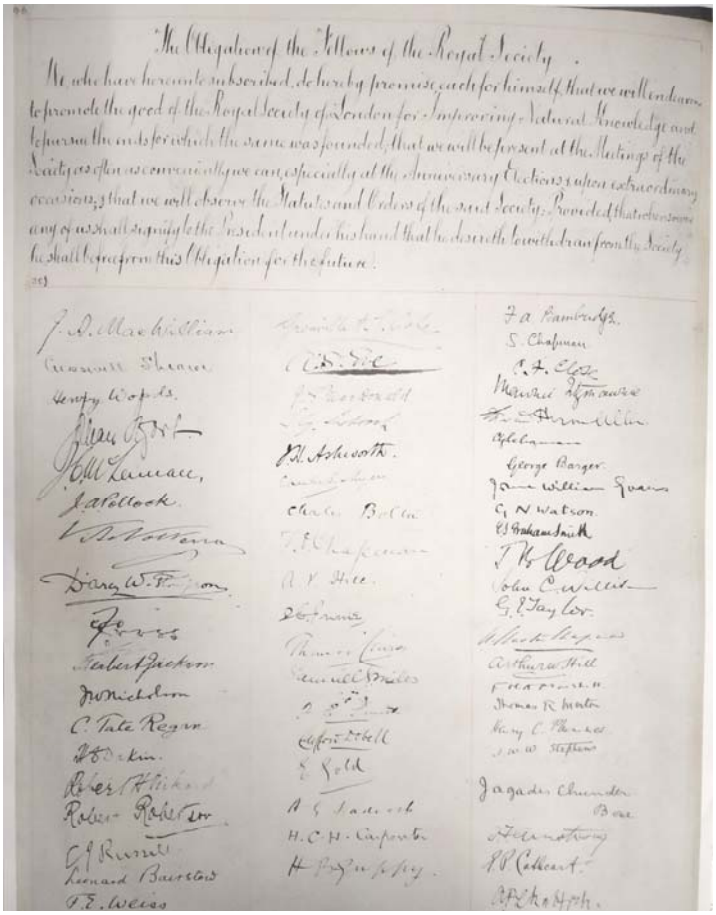
Trainees of the hands-on training programme.

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. In the year 2020, two major archival documents were procured from the archives of Royal Society of London- J.C. Bose's Election certificate in the Royal Society (1920) and the Page from Charter Book of Royal Society bearing Bose's signature during the ceremony admitting him in as a Fellow in the Royal Society of London.

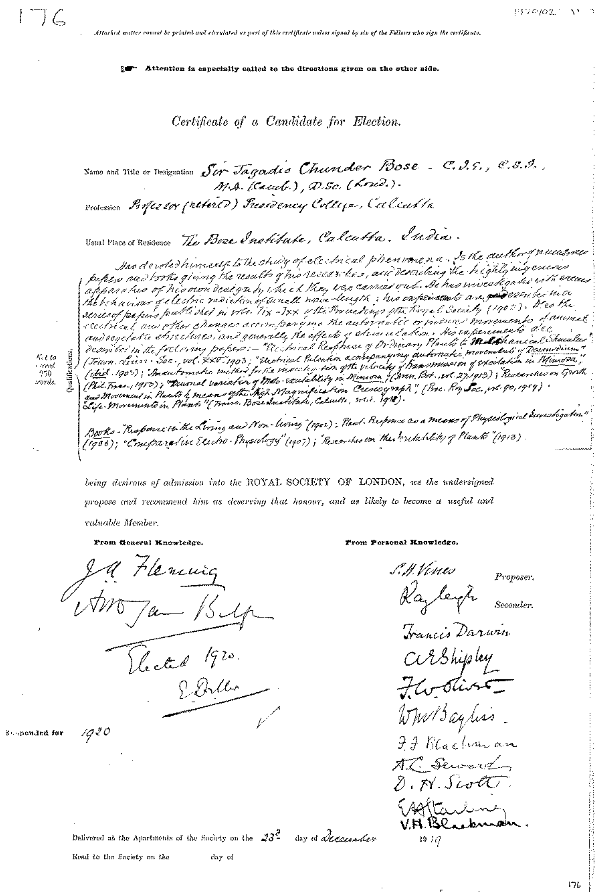
J. C. BOSE CENTRE
(PUBLICATION AND MUSEUM)



Facsimile of the Page from the Charter Book of Royal Society bearing the signature of J.C. Bose (1920)

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; Bose

J. C. BOSE CENTRE
(PUBLICATION AND MUSEUM)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Attached matter cannot be printed and circulated as part of this certificate unless signed by six of the Fellows who sign the certificate.

Attention is especially called to the directions given on the other side.

Certificate of a Candidate for Election.

Name and Title or Designation: Sir Jagadis Chunder Bose – C.I.E., C.S.I., M.A. (Camb.), D.Sc. (Lond.).

Profession: Professor (retired) Presidency College, Calcutta.

Usual Place of Residence: The Bose Institute, Calcutta. India.

Qualifications (Not to exceed 250 words): Has devoted himself to the study of electrical phenomena. Is the author of numerous papers and books giving the results of his researches, and describing the highly ingenious apparatus of his own design by which they were carried out. He has investigated with success the behaviour of electric radiation of small wave-length; his experiments are described in a series of papers published in vols. lix–lxx of the Proceedings of the Royal Society (1902). Also the electrical and other changes accompanying the automatic or induced movements of animal and vegetable structures, and generally the effects of stimulation. His experiments are described in the following papers:– "Electrical Response of Ordinary Plants to Mechanical Stimulus" (Journ. Linn. Soc., vol. XXV, 1903; "Electrical Pulsation accompanying automatic movements of Desmodium" (ibid. 1903); "An automatic method for the investigation of the velocity of transmission of excitation in Mimosa" (Ann. Bot., vol. 27, 1913); "Researches on Growth and Movement in Plants by means of the High Magnification Crescograph" (Proc. Roy. Soc., vol. 90, 1919). "Life Movements in Plants" (Trans. Bose Institute, Calcutta, vol. I, 1918).

Books – "Response in the Living and Non-living" (1902); "Plant Response as a means of Physiological Investigation" (1906); "Comparative Electro-Physiology" (1907); "Researches on the Irritability of Plants" (1913).

being desirous of admission into the ROYAL SOCIETY OF LONDON, we the undersigned propose and recommend him as deserving that honour, and as likely to become a useful and valuable Member.

From General Knowledge.
J.A. Fleming
Arthur J. Balfour
Elected 1920.

From Personal Knowledge.
S.H. Vines, Proposer.
Rayleigh, Seconder.
Francis Darwin
A.E. Shipley
F.W. Oliver
W.M. Bayliss
F.F. Blackman
A.C. Seward
D.H. Scott
E.H. Starling
V.H. Blackman

Suspended for 1920

Delivered at the Apartments of the Society on the 23rd day of December 1919

Read to the Society on the day of

Facsimile of the prestigious Certificate of J.C. Bose for being elected as a *Fellow of the Royal Society of London* (1920)

Institute-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.

LIST OF MEMBERS

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

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.

MADHYAMGRAM EXPERIMENTAL FARM (MEF)

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

CB 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

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 the latest information to the BI faculty, researchers, staff members, and students of the Integrated M.Sc.-Ph.D. programme on Life Sciences and Physical Sciences. The 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.

BOSE INSTITUTE LIBRARY

Library aims to

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

The total library collection of reading materials is 45110 as of 31.03.2020 and subscribed to more than 5000+ online journal 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. The Library is also having an ancient 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
- 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

Library resources are accessible for the Institute's faculty/scholar from all campuses of Bose Institute. Library also provides Off-Campus Access to its resources to Institute faculty members. Library uses open source 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).

BOSE INSTITUTE 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.
- The Arabidopsis Information Resource (TAIR): a database of genetic and molecular biology data

BOSE INSTITUTE LIBRARY

E. Scientific Softwares services by Library:

Sl. No.	Software	Publishers
1.	ENDNOTE X8 Multi-User Download-Research Software	Clarivate Analytics
2.	MatInspector and MatBase 1-year	Genomatix-Precigen Bioinformatics Germany GmbH
3.	QIAGEN CLC Genomics Workbench.	QIAGEN India Pvt. Ltd. **(New-2020)**
4.	IPA(Ingenuity® Pathway Analysis) Software	QIAGEN India Pvt. Ltd.
5.	Upgradation of Sigmaplot 11 Software to Sigmaplot version 14	Starcom Information Technology Limited
6.	Grammarly Writing Support	Bridge people
7.	iThenticate- Anti-plagiarism Software	Turnitin
8.	Adobe Acrobat Professional.	Adobe
9.	Adobe Photoshop	Adobe

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

The 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 consortia, faculty members/scholars of this Institute can access more than 5000+ online resources, SciFinder of ACS, Web of Science, Patent databases, etc. The 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 even other institutes in India.

G. New Addition(s) in 2019-2020:

- Book(s) added in 2019-2020 **:** 43 nos.
- Thesis a

BOSE INSTITUTE LIBRARY

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.
Inter-Library Loan Service	The Library provides 'Inter-Library Loan' facility to the users of other libraries, mostly research institutes who have Inter-Library Loan arrangement(s) with Bose Institute Library. Library also get the book through an inter-library book loan. Library provides article request service to BI faculty/scholars. Library also provides article services to faculty members/scholars across India.
Institutional Membership	The Library used to have a membership of various National and International organization(s) –(i) Biomed Central (BMC) up to March 2020(ii) Public Library of Science (PLoS), (iii) *International Federation of Library Associations* and Institutions (*IFLA), (iv) Indian Association Of Special Libraries And Information Centres (IASLIC), (v) Indian Science Congress Association (ISCA) Membership etc.*
e - Journals Access	The Library provides access to electronic journals subscribed by Library as well as subscribed through National Knowledge Resource Consortia (NKRC).

BOSE INSTITUTE LIBRARY

User Awareness Programme	The Library conducts user orientation programmes time to time for the benefit of users and optimal utilization of subscribed resources. The user orientation programme also includes "Reference management" for publications, citing references in the thesis, using databases, citation reports, 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. Library also provides 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.
Scientific 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	The Library has created an 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	The Library has become the participating Library in the NDL (National Digital Library) project, initiated by MHRD, Govt of India. The Library has also taken other initiatives for implementing RFID (radio-frequency identification) tagging for its collection.

BOSE INSTITUTE LIBRARY

Further Academic Activities:

Library also provides training to library school students like the 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.

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	–	22	–	–	–

SHYAMNAGAR EXPERIMENTAL FARM

Shymanagar 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. Except the above this unit also deals with the breakdown problems and execution of new project in other five nos. campuses.

The remarkable jobs as well as other maintenance job of Workshop in the year 2020-21:-

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 completed within the stipulated time frame.

Monitoring of the Electrical Installations of the seven campuses

LIST OF PERSONNEL

Staff Members : Raju Chandra Paul ,Workshop Superintendent.

Main Campus: Bholanath Saren (Superannuated on 30.09.2020), Abdul Rahaman Molla, Sk. Md. Farruck (Superannuated on 28.02.2021), Pranab Banerjee, Subrata Basak (Superannuated on 31.12.2020), Sanjoy Santra, Kodan Das.

Centenary Campus: Baidya Nath Murm.

Acharya Jagadis Chandra Bose at Iowa University with
members of Hindusthan Sabha - (1914)

OUTREACH AND MAN POWER DEVELOPMENT

BOSE INSTITUTE ANNUAL REPORT 2020-2021

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.

STATEMENT OF ACCOUNTS FOR THE YEAR 2020-21

BOSE INSTITUTE ANNUAL REPORT 2020-2021

STATEMENT OF ACCOUNTS FOR THE YEAR 2020-21

INDEPENDENT AUDITOR'S REPORT

To the Members of the Council

Qualified Opinion

We have audited the accompanying financial statements of **BOSE INSTITUTE** (the Institute), which comprise the Balance Sheet at March 31st 2021, and the Income & Expenditure account, Receipts & Payment Account for the year then ended, and notes to the financial statements, including a summary of significant accounting policies and other explanatory information. In our opinion and to the best of our information and according to the explanations given to us, except for the effect of the matter described in the *Basis for Qualified Opinion* section of our report, the accompanying financial statements give a true and fair view of the financial position of the Institute as at March 31st, 2021, and of its financial performance for the year then ended.

Basis for Qualified Opinion

1. The Institute has accounted for expenses on cash basis in the financial statements in few cases which is contrary to the Schedule 24 point 4.2 of the "Significant Accounting Policies and Notes to Accounts" as well as the fundamental accounting assumptions as per AS 1, notified by the Institute of Chartered Accountants of India. The Expenditure for the FY 2020-21 has been booked in the FY 2021-22. Thus, short booking of Expenditure found in 32 instances total amounting to Rs. 136.98 Lakh.

   Similarly, Expenditure of earlier period was booked in the FY 2020-21. The prior period Expenditure so booked is found in 7 instances amounting to Rs. 35.28 Lakh.

2. As per Schedule 24 Clause 17 of Notes on Accounts the excess payment as per Due Drawn statement has not been considered in Accounts. Thus, the Establishment Expenses for this year and also the same for the earlier period have not been adjusted. The extent of expenditure to be rectified and the recoverable amount to be shown in Balance Sheet are not quantified.

3. In Union Bank (A/C 3355) the unidentified receipt Rs. 1.94 Lakh during the FY 2020-21 has been shown in "Grant-in-aid unallocated". The total unidentified Receipts stands as on date Rs. 10.33 Lakh. Further Rs. 2.88 Lakh received during FY 2018-19 but remained unidentified and not accounted for till date.

4. No Fixed Asset register was available. Being informed that Fixed Asset register has been updated till 31st March, 2017 and the same for the period 1st April, 2017 to onwards will be started soon. Details related to location of asset, description of asset, life of asset and asset coding is yet to be prepared. Periodic physical verification of fixed assets and impairment testing are not performed. In view of this it is not possible to opine on correctness or otherwise of fixed assets.

STATEMENT OF ACCOUNTS FOR THE YEAR 2020-21

5. Intangible assets in the form of books and journals are not amortised over the licence period and are being carried forward and depreciated even after expiry of their licence period which is not in accordance with the requirement of AS 26 notified by the Institute of Chartered Accountants of India. The amount of such expired licences is presently not ascertainable.

6. Refer Schedule 3 of Balance Sheet Liability under "Earmarked / endowment Fund - Development Fund (Planning commission) closing balance as on 31.03.2021 Rs. 856.05 Lakh and corresponding Assets Schedule 10 "Investment from Earmarked / Endowment Fund Asset acquired under for development and modernization fund amounting to Rs. 666.57 Lakh have been held under "Investment and under earmarked fund" and has not been capitalized thereby understating the fixed assets to that extent. Consequent impact on depreciation and current year's profit is not ascertainable.

7. The practice of obtaining balance confirmation for receivable and payable accounts is not followed by the Institute. Party wise details along with the ageing analysis in relation to Sundry Creditors (Rs. 11.86 Lakh Credit), Adhoc Advance having a credit balance (Rs. 19.95 Lakh Credit) and Sundry Creditors for Goods and Services (Rs. 56.09 Lakh) and Liability (Rs. 37.52 Lakh Credit) as on 31st March 2021 have not been made available to us. No Party wise sub ledger is maintained in Books of Accounts (Tally). In Adhoc Advance, an amount advanced to a party Rs. 30.00 Lakh but the same account was credited by Rs. 50.00 Lakh. Thus, Adhoc Advance has a Credit balance. Consequential impact on the books of accounts is not ascertained.

8. Capital WIP to the tune of Rs. 21.12 Lakh have no movement since long. Current status of work and consequential impact on the books of accounts is not ascertainable.

9. We could not verify brought forward balances of 16 items of Current Assets total amounting to Rs. 77.15 Lakh, and 14 items of Current Liabilities total amounting to Rs/ 75.73 Lakh. Consequential impact on the year's revenue and the net current asset position as at the end of the year is not ascertainable.

10. Liability towards gratuity and leave encashment is not ascertained as per actuarial valuation and the same are accounted on cash basis contrary to the requirement of AS-15 notified by the Institute of Chartered Accountants of India. The impact on current year Financial Statement is not ascertained.

11. Out of Current liability of Payable to Pensioner of Rs. 6.31 Lakh, appearing in Pension Fund Accounts for FY 2020-21, Rs. 3.66 Lakh is a long outstanding amount the details of which were not made available to us. Hence the effect of the same on books of accounts cannot be determined.

STATEMENT OF ACCOUNTS FOR THE YEAR 2020-21

12. With respect to Contributory Provident Fund Account for FY 2020-21 details in relation to Payable to staff (Rs. 2.02 Lakh Credit), Receivable from Bose Institute (Out of Cl. Rs. 7.07 Lakh Debit, Rs. 7.02 Lakh), Receivable from GPF (Rs. 2.64 Lakh Debit) and respective contra entry in GPF Accounts as on 31.03.2020 are long outstanding amount the details of which were not made available to us. Consequential impact on the books of accounts is not ascertainable at this stage.

13. There are some TDS entries found in Form 26AS but not booked in books of Accounts. The Interest earned is Rs. 4.5 Lakh and TDS thereon being Rs. 0.31 Lakh, Vice Versa, some TDS entries are appearing in the Bank Certificate but not reflecting in Form 26AS. The interest earned Rs. 3.09 Lakh and TDS thereon being Rs. 0.23 Lakh. No reconciliation is done with the concerned deductor. Consequential impact on the books of accounts is not ascertainable at this stage.

14. There are 4 items of TCS entries found in Form 26AS where amount debited Rs. 28.45 Lakh and Tax collected Rs. 0.13 Lakh but the same is not accounted for due to want of Debit Note / Invoice. No reconciliation is done with the concerned collector. Consequential impact on the books of accounts is not ascertainable at this stage.

15. In Books of Accounts we found debit balance in Payable accounts (6 items total amounting to Rs. 48.12 Lakh) and Vice Versa credit balance in Receivable accounts (8 items total amounting to Rs. 40.25 Lakh). Instead of segregating the same to show in proper head, wrongly clubbed in the payable and receivable account respectively. As a result, both the receivable and payable are understated by Rs. 88.37 Lakh).

16. Refer Schedule 24 Clause 11 of notes of Accounts; the Institute has not identified any contingent Liability. No information of Suit filed / Court cases by / against the Institute is provided to us. The extent of contingent liability and whether any provision creation is necessary on the same cannot be ascertained.

Observation Projects for FY 2020-21:

17. Unspent balance is Rs. 888.28 Lakh (Out of 65 projects, 20 projects for FY 2020-21 Rs. 535.98 Lakh) has not been surrendered to competent authority.

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

STATEMENT OF ACCOUNTS FOR THE YEAR 2020-21

Emphasis of Matter:

We draw attention to the following matters:

1. Refer Schedule 24 Clause 16 of Notes on Accounts, The Institute has capitalized the asset on the basis of information received from RITES (the Project Management Consultant). No review and reconciliation of the amount certified by RITES is done before finalizing the capitalization amount. The cost is considered excluding GST. Segregation of assets under different category like Electrical installation, Equipment and Apparatus etc. is not done. Due approval for use of the land for Research work instead of residential purpose is yet to be obtained.
2. Non realization of refund of Service Tax amounting to Rs. 202.83 Lakh.
3. As per Accounting Policy and Notes of Accounts, Schedule 24 clause 3.2, the Institute has charged full depreciation on Written down Value Method as per prescribed rates *irrespective of dates* of putting the same to use.
4. Matters relating to Statutory compliance:
    a. As per GST Portal the Name of Proprietor / Director(s) / Partner(s) / Promoter(s) is not updated and is still showing the name of the former Registrar who has left the Institute. Being informed, the same is under process.
    b. There has been a delay in the payment of Professional Tax and filing of return in 12 instances during the year under audit.
    c. There are pending demands / defaults with respect to Income Tax for the FY 2020-21 (AY 2021-22) amounting to Rs. 7.97 Lakh.
    d. TDS on GST amounting to Rs. 0.16 Lakh has not been deducted from 2 vendors whose contract value exceeds the threshold limit of Rs. 2.50 Lakh, while making payment to them.
    e. Wrong deduction of Income Tax TDS u/s 194J @10% instead of u/s 194C @1.5% from 3 different vendors whose total excess tax deduction is Rs. 0.26 Lakh.
5. FD register is not properly maintained and closing balances are not inked. A difference in Opening Balance amounting to Rs. 28.08 Lakh is coming from earlier period.
6. Matters related to Terminated and Ongoing Projects:.
    a. Expenditure and Closing Balance between books of accounts (Tally) vis-à-vis Reports like Utilisation Certificate (UC) is subject to reconciliation.
    b. Audited UC/(SOE) for the FY 2020-2021 has not been submitted for 18 projects comprising of terminated projects as well as ongoing projects as on 31.03.2021.

STATEMENT OF ACCOUNTS FOR THE YEAR 2020-21

c. Grant received for 14 new projects during the FY-2020-21 but no project work has been commenced against the said grant received.

There is no submission of Project Completion Reports in respect of 55 projects. Out of this, 20 projects are terminated in FY 2020-21 and 35 projects where terminated during the period 2016-2020.

Our opinion is not modified in respect of these matters

Key Audit Matters

Key audit matters are those matters that, in our professional judgment, were of most significance in our audit of the Financial Statements of the current period. These matters were addressed in the context of our audit of Financial Statements as a whole, and in forming our opinion thereon, and we do not provide a separate opinion on these matters. In addition to the matters described in the Basis for Qualified Opinion and Emphasis of Matter sections, we have determined the matters described below to be the key audit matters to be communicated in our report:

Key Audit Matter	Auditors' response to Key Audit Matter
Funded Projects : The Institute receives and utilises Funds for various projects and needs to comply the terms and conditions of the relevant order and has to submit certificates and documents time to time to the concerned authority.	We performed an understanding and evaluation of system of internal control over the receipt and utilisation of Fund and accounting thereof as per terms and conditions of the sanctioned order of respective Grants and the compliances laid down the in the terms of the Grant.
Fixed Assets (including Capital Work in Progress): The carrying amount of Fixed Assets of the Institute is Rs 21700.08 Lakh, which represents about 46.12 % of the total assets of the Institute. Due to the significance of the value of the Fixed Assets, we have considered the same to be significant to our overall audit strategy and planning.	We assessed the controls in place, evaluated the appropriateness of capitalization process, performed tests of details on costs capitalized, the timeliness of the capitalization of assets and the derecognition criteria for assets retired from active use. We reviewed the judgments made by management including the nature of underlying costs capitalized; determination of realizable value of the assets retired from active use; the appropriateness of asset life applied in the calculation of depreciation; useful lives of assets as per the technical assessment of the management.

STATEMENT OF ACCOUNTS FOR THE YEAR 2020-21

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

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

Auditor's Responsibilities for the Audit of the Financial Statements

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

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

Place: Kolkata

Date: 31.08.2021

For SPAN & Associates
Chartered Accountants
FRN: 302192E

CA Amlan Kusum Mandal
Membership No: 064631
UDIN: 21064631AAAACA1567

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BOSE INSTITUTE
BALANCE SHEET AS ON 31st MARCH 2021

Corpus /Capital fund and liabilities	Schedule	2020-21 (₹)	2019-20 (₹)
Corpus /Capital fund	**1**	3,05,71,82,151.70	2,95,78,18,095.66
Reserves and surplus	**2**		
Earmarked/Endowment funds	**3**	56,46,31,841.99	55,18,41,128.61
Secured loans and borrowings	**4**		
Unsecured loans and borrowings	**5**		
Deferred credit liabilities	**6**		
Current liabilities and provisions	**7**	1,08,28,87,960.02	1,28,07,36,363.51
Total		**4,70,47,01,953.71**	**4,79,03,95,587.78**
Assets			
Fixed Assets	**8**	2,17,00,08,129.51	85,68,29,796.87
Investments-others	**9**	36,58,98,910.72	35,65,80,569.72
Investments -from earmarked/endowment Funds	**10**	13,93,89,108.60	13,51,35,214.80
Current assets, loans, advances etc.	**11**	2,02,94,05,804.88	3,44,18,50,006.39
Miscellaneous expenditure (to the extent not written off or adjusted)			
Total		**4,70,47,01,953.71**	**4,79,03,95,587.78**
Significant accounting policies	**24**		
Contingent liabilities and notes on accounts	**25**		

Place : Kolkata
Date : 31.08.2021

Signed in terms of our separate Report of even date.
For SPAN & Associates
Chartered Accountants
Firm Registration No. 302192E
Amlan Kusum Mandal
Partner
Membership No. 064631

Sd/-
Shaubhik Ghosh
UDC

Sd/-
Kamal Sing
Accountant (Cash)

Sd/-
Vikash Kumar
Audit & Finance Officer

Sd/-
Achintya Mukherjee
Accounts Officer

Sd/-
Prof. Rajarshi Ray
Registrar(O)

Sd/-
Prof. (Dr.) Uday Bandyopadyay
Director

BOSE INSTITUTE
INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31.03.2021

	Schedule	2020-21	2019-20
		Rs.	Rs.
INCOME	**12**	40,33,088.19	73,97,904.43
Income from Sales and Services			
Grants/Subsidies	**13**	97,42,00,000.00	1,17,48,44,000.00
Fees/Subscriptions	**15**		
Income from Investments (Income on Investment, from earmarked /endowment Funds transferred to Funds)	**14**	4,06,68,676.15	4,02,67,427.65
Income from royalty, publication etc .	**16**		
Interest Earned	**17**		
Other Income	**18**	47,51,167.04	63,45,186.01
Increase/ (decrease) in stock of Finished goods and work-in-progress	**19**		
Total (A)		**1,02,36,52,931.38**	**1,22,88,54,518.09**
EXPENDITURE			
Establishment Expenses	**20**	48,67,42,330.99	48,41,93,241.00
Other Administrative Expenses	**21**	20,69,38,435.42	24,82,54,854.65
Expenditure on Grant, Subsidies etc.	**22**	-	-
Interest	**23**	3,33,58,574.00	30,00,000.00
Fund for capital Expenditure	**23A**	9,88,75,054.04	1,09,01,254.00
Depreciation (Net Total at the year end corresponding to Schedule 8)		6,11,75,961.06	5,54,21,949.28
Depreciation for UAC	**8A**	39,08,11,882.35	
Total (B)		**1,27,79,02,237.86**	**80,17,71,298.93**
Balance being excess of Income over Expenditure (A-B)		-25,42,49,306.48	42,70,83,219.16
Transfer to Special Reserve (Specify each)			
Prior Period Items		-39,72,963.60	
Last Year Unspent Balance /overspent balance		**33,12,48,271.00**	**-9,58,34,948.16**
Balance of Unspent Balance After Adjustment		32,72,75,307.40	9,58,34,948.16
Balance being Surplus/(deficit) carried to corpus/capital fund		**7,30,26,000.93**	**33,12,48,271.00**
Significant accounting policies	24		
Contingent liabilities and notes on accounts	25		

Place : Kolkata
Date : 31.08.2021

Signed in terms of our separate Report of even date.
For SPAN & Associates
Chartered Accountants
Firm Registration No. 302192E
Amlan Kusum Mandal
Partner
Membership No. 064631

Sd/-
Shaubhik Ghosh
UDC

Sd/-
Kamal Sing
Accountant (Cash)

Sd/-
Vikash Kumar
Audit & Finance Officer

Sd/-
Achintya Mukherjee
Accounts Officer

Sd/-
Prof. Rajarshi Ray
Registrar(O)

Sd/-
Prof. (Dr.) Uday Bandyopadyay
Director

BOSE INSTITUTE
RECEIPTS & PAYMENT ACCOUNTS FOR YEAR ENDED 31st MARCH 2021 (COUNCIL A/C)

Receipts	Sch. No.	Amount (Rs.)	Payments	Sch. No.	Amount (Rs.)
Opening Balance	1	22,22,21,478.72			
Receipt against Establishment Expenses	2	2,31,535.01	Establishment Expenses	2	45,68,47,866.00
Receipt against Laboratory Expenses	3	21,59,711.00	Laboratory Expenses	3	7,86,05,611.33
			Other Administrative Expenses	4	12,93,82,240.05
Receipt Against Other Administrative Expenses	4	43,74,936.00			
			Payments for the current assets	5	3,00,03,572.00
Receipt from Indirect Income	9	2,03,97,887.08	Payments for the Other Assets	6	10,12,60,497.90
Receipt from other Assets	6	19,62,828.00			
Receipt from Current Assets	5	3,95,19,837.75			
Receipts from Statutory Liabilities	7	7,50,04,803.60			
			Payment for Current Liabilities & Statutory Liabilities	7	7,40,60,649.00
Receipts from Current Liabilities & other Liabilities	8	60,24,037.00			
			Payment for other Liabilities	8	8,06,63,750.00
			Payment from earmarked fund		
			Payment for other income	9	29,83,113.00
Inter Unit Account			**Inter Unit Account**		
			FAIR		59,000.00
			Scheme/Project Grant-in-aid		
Scheme/Project		-	Scheme/Project		20,68,554.00
Scheme/Project Grant-in-aid		1,36,71,90,000.00	ST-Rural		1,32,574.00
ST-Rural		2,02,843.00	Governing Body		5,900.00
Governing Body		-	Closing Balance	1	78,32,16,569.88
		1,73,92,89,897.16			**1,73,92,89,897.16**

Place : Kolkata
Date : 31.08.2021

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For SPAN & Associates
Chartered Accountants
Firm Registration No. 302192E
Amlan Kusum Mandal
Partner
Membership No. 064631

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

BOSE INSTITUTE
RECEIPTS & PAYMENT ACCOUNTS FOR YEAR ENDED 31st MARCH 2021 (PROJECTS)

RECEIPTS	Sch. No.	Amount Rs	PAYMENTS	Sch. No.	Amount Rs
OPENING BALANCE		**1,46,99,48,479.93**	Payment from Projects	2	18,47,86,894.35
Receipt from projects	2	34,91,93,734.00	Payment from Adhoc/RA/PDF	3	1,96,79,844.18
Receipt from projects from Adhoc /RA / PDF	3	2,23,54,647.00	Payment for other than Project	4	2,10,74,350.19
Receipts from Other Than Scheme / Projects	4	83,45,862.19			
Receipts from IFCC	5	4,20,76,125.00	Payment of IFCC	6	7,11,35,598.00
Fixed Deposit(IFCC)			Payment of ST-Rural	8	3,90,022.70
Receipts from St Rural	7	21,96,421.00			
			Receivable From Scholars'		302.00
Receivable From Scholars'		–	TDS Receivable		43,500.00
Branch /Inter Unit			**Branch /Inter Unit**		
Bose Institute		1,01,08,52,703.24	Bose Institute		1,48,70,27,890.00
IFCC			IFCC		
Interest on FD			Bank Charges		
Interest on SB 3355		–	AUTOSWEEP NO 416603350009396		
Pick Up Service		–	AUTOSWEEP NO 416603350009413		
AUTOSWEEP NO 416603350009396		–			
AUTOSWEEP NO 416603350009413		–			
Bank Charges		–			
			CLOSING BALANCE		1,12,08,29,570.94
		2,90,49,67,972.36			**2,90,49,67,972.36**

Place : Kolkata
Date : 31.08.2021

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Chartered Accountants
Firm Registration No. 302192E
Amlan Kusum Mandal
Partner
Membership No. 064631

Sd/-
Sukanta Chakraborty
UDC

Sd/-
Vikash Kumar
Audit & Finance Officer

Sd/-
Achintya Mukherjee
Accounts Officer

Sd/-
Prof. Rajarshi Ray
Registrar(O)

Sd/-
Prof. (Dr.) Uday Bandyopadyay
Director

Bose Institute Employees' Pension Fund
Income & Expenditure Account
For the year ended 31st March 2021

For the year ended 31st March 2020	Expenditure	For the year ended 31st March 2021	For the year ended 31st March 2020	Income	For the year ended 31st March 2021
(Rs.)		(Rs.)	(Rs.)		(Rs.)
15,43,44,567.00	To Pension Account	15,97,17,019.00	15,82,55,000.00	By Contribution from Bose Institute	19,06,86,734.00
68,37,497.00	To Gratuity Account	87,52,949.00			
-	TO DEATH GRATUITY	21,80,295.00		By Contribution from Other Organisation	
1,62,23,104.00	To Pension Commutation	84,21,402.00		For Pension & Gratuity	
	TO ARREAR PENSION	4,37,786.00		By Interest	
-	To Bank Charges	-	57,78,894.44	Fixed Deposit with Bank	77,04,776.00
-	To Loss on Fixed deposit	-	39,050.00	Savings Bank Account	1,42,460.00
-Rs.1,33,32,223.56	To Excess of Income over Expenditure	**1,90,24,519.00**			
Rs.16,40,72,944.44		**19,85,33,970.00**	**Rs.16,40,72,944.44**		**19,85,33,970.00**

Place : Kolkata
Date : 31.08.2021

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Amlan Kusum Mandal
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Membership No. 064631

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Accountant (Cash)

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Vikash Kumar
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Achintya Mukherjee
Accounts Officer

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Prof. Rajarshi Ray
Registrar(O)

Sd/-
Prof. (Dr.) Uday Bandyopadyay
Director

Bose Institute Employees' Pension Fund
BALANCE SHEET
For the year ended 31st March 2021

As at 31st March 2020	Liabilities	As at 31st March 2021	As at 31st March 2020	Assets	As at 31st March 2021
(Rs.)		(Rs.)	(Rs.)		(Rs.)
14,92,87,868.61	Balance As per last Account	13,59,55,645.05			
-Rs.1,33,32,223.56	Add: Excess of Income over Expenditure	1,90,24,519.00	13,00,02,738.00	Fixed Deposit	14,39,67,031.00
			9,22,818.00	Accrued Interest on FD	13,37,887.00
3,66,830.00	Payable to Pensioner	6,31,628.00	1,09,510.19	Bank Balance With S.B.I Savings bank Account	1,71,58,605.19
			1,57,70,253.86	Receivable from Bose Institute Council	1,75,47,018.86
Rs.0.00	tds pension	-	(47,358.00)	RECEIVABLE FROM EMPLOYEES	(47,358.00)
			16,000.00	TDS PENSION	2,34,443.00
(2,00,949.00)	Payable to BOSE INSTITUTE	10,87,595.00			
Rs.0.00	Provision for Deduction of Excess Payment	50,26,372.00			
2,50,000.00	Payable to Staff	3,12,088.00			
1,04,02,436.00	Liability towards 30% 7CPC	1,81,59,780.00			
Rs.14,67,73,962.05		**18,01,97,627.05**	**Rs.14,67,73,962.05**		**18,01,97,627.05**

Place : Kolkata
Date : 31.08.2021

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Vikash Kumar
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Achintya Mukherjee
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Prof. Rajarshi Ray
Registrar(O)

Sd/-
Prof. (Dr.) Uday Bandyopadyay
Director

Bose Institute Employees' General Provident Fund
INCOME AND EXPENDITURE
For the year ended 31st March 2021

31-03-2020 Amount in Rs.	Expenditure	31-03-2021 Amount in Rs.	31-03-2020 Amount in Rs.	Income	31-03-2021 Amount in Rs.
1,32,61,153.00	Interest Paid to Members	1,09,98,961.00	1,46,43,656.00	Interest on Fixed Deposit	1,18,58,841.00
-	Loss on Fixed Deposit	-			
-	Bank Charges	37,838.00	11,545.00	Interest on savings Bank Accounts	51,513.00
13,94,048.00	Excess of Income Over Expenditure	8,73,555.00			
1,46,55,201.00		**1,19,10,354.00**	**1,46,55,201.00**		**1,19,10,354.00**
				Excess of Income over Expenditure	
			1,78,48,508.94	Brought forward from previous year	1,92,42,556.94
1,92,42,556.94	Excess of Income over Expenditure transferred to Balance Sheet	2,01,16,111.94			
			13,94,048.00	Excess of Income over Expenditure	
				Brought forward from current year	8,73,555.00
1,92,42,556.94		**2,01,16,111.94**	**1,92,42,556.94**		**2,01,16,111.94**

Place : Kolkata
Date : 31.08.2021

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Prof. Rajarshi Ray
Registrar(O)

Sd/-
Prof. (Dr.) Uday Bandyopadyay
Director

Bose Institute Employees' General Provident Fund
BALANCE SHEET
For the year ended 31st March 2021

31-03-2020 Amount in Rs.	Liabilities	31-03-2021 Amount in Rs.	31-03-2020 Amount in Rs.	Assets	31-03-2021 Amount in Rs.
16,80,11,563.31	GPF Accumulation Capital Fund Balance Brought Forward	17,14,96,383.31	19,72,98,315.00	Fixed Deposit with State Bank of India	17,09,38,153.00
				Investment	-
	Add: Refund of Advance Adjusted with Accumulated profit		11,90,505.00	Advance Outstanding from Members	8,45,968.00
-		-	-	Add: Refund of Advance Adjusted with Accumulated profit	-
2,27,87,280.00	Add: Subscription by members during the year	1,75,55,869.00	11,90,505.00		8,45,968.00
1,32,61,153.00	Add: Interest Paid to members	1,09,98,961.00	13,11,201.00	Interest Accrued but not received from on Fixed Deposit	12,59,263.00
20,40,59,996.31		20,00,51,213.31			
			1,08,472.25	Bank Balance with SBI	20,83,845.25
3,25,63,613.00	Less: Withdrawal	5,17,31,256.00			
17,14,96,383.31		14,83,19,957.31	60,10,591.00	Receivable from Bose Institute	85,87,635.00
1,92,42,556.94	Add: Excess of Income over Expenditure transferred from Income Expenditure Account	2,01,16,111.94		Receivable from Staff	40,000.00
1,49,15,844.00	Payable to Bose Institute	1,50,54,495.00			
2,64,300.00	Payable to CPF	2,64,300.00			
20,59,19,084.25		**18,37,54,864.25**	**20,59,19,084.25**		**18,37,54,864.25**

Place : Kolkata
Date : 31.08.2021

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Firm Registration No. 302192E
Amlan Kusum Mandal
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Prof. Rajarshi Ray
Registrar(O)

Sd/-
Prof. (Dr.) Uday Bandyopadyay
Director

Bose Institute Employees' Contributory Pension Fund
INCOME AND EXPENDITURE
For the year ended 31st March 2021

31-3-2020 Amount in Rs.	Expenditure	31-3-2021 Amount in Rs.	31-3-2020 Amount in Rs.	Income	31-3-2021 Amount in Rs.
1,09,846.00	Interest credited to Members:	-	2,37,746.00	Interest earned on Investment CPF	60,140.00
1,27,900.00	Balance	60,140.00			
2,37,746.00		60,140.00	2,37,746.00		60,140.00
			1,27,900.00	Balance c/f	60,140.00
9,07,971.00	Profit & Loss	9,68,111.00	7,80,071.00	Excess of Income over Expenditure	9,07,971.00
9,07,971.00		**9,68,111.00**	**9,07,971.00**		**9,68,111.00**

Place : Kolkata
Date : 31.08.2021

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For SPAN & Associates
Chartered Accountants
Firm Registration No. 302192E
Amlan Kusum Mandal
Partner
Membership No. 064631

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Registrar(O)

Sd/-
Prof. (Dr.) Uday Bandyopadyay
Director

Bose Institute Employees' Contributory Pension Fund
BALANCE SHEET
For the year ended 31st March 2021

Previous Year Amount in Rs.	Liability	Current Year Amount in Rs.	Previous Year Amount in Rs.	Assets	Current Year Amount in Rs.
29,07,491.75	Capital Fund	30,17,337.75	26,00,000.00	Fixed Deposit	3,55,742.00
1,09,846.00	Add: Interest to members	-			
3,55,469.00	Less : Final Withdrawal	23,56,713.00			
26,61,868.75		6,60,624.75			
9,07,971.00	Profit & Loss as per Income & Expenditure	9,68,111.00	3,00,241.75	Bank Balance at SBI	6,05,983.75
2,02,160.00	Payable to staff	2,02,160.00	14,244.00	Accrued Interest	7,278.00
1,09,482.00	Loans	1,09,482.00	7,02,696.00	Receivable from Bose Institute	7,07,074.00
			2,64,300.00	Receivable from GPF	2,64,300.00
38,81,481.75		**19,40,377.75**	**38,81,481.75**		**19,40,377.75**

Place : Kolkata
Date : 31.08.2021

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Director

Schedule 24

SIGNIFICANT ACCOUNTING POLICIES & NOTES TO ACCOUNTS

1.0 Change in Accounting Policy:

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

2.0 Fixed Assets:

2. 1 Land at Madhyamgram

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

2. 2 Fixed Asset Register

The Institute has taken up initiatives to prepare a comprehensive Fixed Asset Register with the help of an agency. But the process gets halted due to shifting operation of the Unified Academic Campus (UAC) and will be resumed soon after the shifting process is over. This initiative will also cover the assets acquired in the year 1991-92 from “Institute Development and Modernisation Fund” (provided by Planning Commission). When the Fixed Asset Register will become ready, then the nomenclatures and order mentioned in Schedule 8 (old form schedule 4) will be taken into account.

2.3 Work-in-Progress

The particulars of fixed assets, under construction/installation are given in Schedule 8 (old form schedule 4).

2.4 Import in Progress

Import in Progress has been amounted for on the basis of bank advice on the date of actual payment.

SIGNIFICANT ACCOUNTING POLICIES & NOTES TO ACCOUNTS

2. 5 Valuation of assets

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

b. The assets related to terminated projects have been identified up to 2005-06. Further identification of the assets relating to the years 2006-07 to 2019-20 is in progress and will be included in the Fixed Asset Register.

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

3.0 Depreciation:

3.1 As per the requirement of new format depreciation for the year 2020-21 and is charged to Income & Expenditure Account.

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

1. Building – 10%
2. Equipment – 15%
3. Books & Journals – 10%
4. Furniture – 10%
5. Vehicles – 15%
6. Air Conditioner – 10%
7. Electric Installation – 10%
8. Computer & Internet Peripherals – 60%

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

4.0 Revenue Recognition & Grant in Aid:

4.1 During financial year 2020-21, Grant-in-Aid for Council has been received under the head General, Salaries and Capital. Grant-in-Aid under General and Salaries have been treated as revenue grant. All incomes other than Government Grant and Bank Interest are accounted for on cash basis. Govt. Grants are accounted for on accrual basis provided the order sanctioning the Grant is received before the end of the financial year.

4.2 The Institute has a system of accounting in respect of expenses for items like Salary, Stipend payable to Research Scholars under Sponsored Project Account, Gratuity, Leave Salary, Rates & Taxes etc. on cash basis. Liabilities for amount payable to suppliers for materials, services and other expenses are accounted for on accrual basis.

4.3 Consumable Stores are charged to expenditure for purchases.

SIGNIFICANT ACCOUNTING POLICIES & NOTES TO ACCOUNTS

4.4 Revenue expenditure on Scheme/Project and on specific grant are recognised in the accounting period in which the corresponding expenditure and grant arise. Net excess of receipts over expenditure of grants-in-aid schemes, sponsored by various agencies are represented in bank balances.

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

5.0 Retirement/Post Retirement and Staff Benefits:

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

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

5.3 Leave encashment, Gratuity, Provident Fund Contribution and Pension are accounted for on cash basis.

6.0 System of Fund Accounts

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

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

7.0 Earmarked Funds:

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

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

SIGNIFICANT ACCOUNTING POLICIES & NOTES TO ACCOUNTS

8.0 Foreign Currency Transactions:

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

9.0 Research and Development Costs:

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

10.0 Advances:

A sum is included under "Advance Council" is shown in the Balance Sheet under the head Advances (Schedule-11) which include a sum of pending recovery/adjustment prior to 2018-19 amounting to Rs. 10,90,480.00.

11.0 Contingent Liability:

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

12.0 Previous year's Figures:

The previous year's figures have been re-grouped and re-arranged in conformity with the figures of current year. Expenses incurred in connection with the Scheduled Tribe Specific Rural Biotechnology Programme and IRHPA Project for the Accounting Year 2013-14 and 2014-15 has been shown separately in Income and Expenditure Account is now adjusted with the Income and Expenditure Account balance 2015-16 of Bose Institute Council Account.

13.0 General Provident Fund:

GPF figures have been reconciled and properly incorporated in accounts having discussion with Statutory Auditor.

14.0 Long Un-Reconciled Balance:

This is well known that Bose Institute is a century old organisation so as its accounts. After a long and good deal of deliberation manual accounts were replaced by computerised accounting system in 2010-11, but still there are lot of unreconciled balances appearing in the accounts. All-out efforts are given to reconcile all old and pending balances and make the Balance Sheet more lucid and presentable. It is expected that during 2021-22, all pending items will be reconciled.

15.0 Interest on unspent balance of EMR projects:

The interest on unspent balance held with Bose Institute for some EMR projects are shown on 1st April 2021. Total amount of such interest is Rs. 3,28,229.00.

SIGNIFICANT ACCOUNTING POLICIES & NOTES TO ACCOUNTS

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

Bose Institute has constructed its Unified Academic campus (UAC) at Plot No. 80, Block EN, Sector V, Salt Lake City, Kolkata 700091. M/s. DCPL was appointed as the architect of the project. Underground piling work has been completed by M/s. Macintosh & Burn Limited. M/s RITES Limited was engaged as Project Management Consultant (PMC). They have supervised the entire construction work and had appointed various contractors for entire construction package wise. The construction costs arrived at are as follows as per the certification of M/s. RITES Limited:

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

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

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

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

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

A DO letter was issued by Head AI division, DST, GoI, vide No. AI/5/1/2019, dated 07.02.2019 mentioning that as per Department of Expenditure OM No. 1/1/2016-E-III(A), dated: 13.01.2017 "where the categories of employees whose pattern of emoluments structure i.e. pay scales and allowances and conditions of service are not similar to that of the Central Government employees, a separate "Group of Officers" (GoO) in respect of each Autonomous Bodies may be constituted in the respective Ministry/Department." Accordingly the "Group of Officers" were constituted for Bose Institute and informed through the OM No. AI/5/1/2019, dated: 5th March 2019 to ensure that the final package of benefits extended to the employees of BI is not more beneficial than that admissible to the corresponding categories of the Central Government employees. The final package recommended by the "Group of Officers" will be submitted to AS&FA for further concurrence of the Ministry of Finance."

After several meetings of GoO with Bose Institute authorities and officers and exchange of several documents and correspondences it was concluded that Bose Institute was following time scale promotion for its Non-Academic employees (both technical and administrative) on the basis of BI OM No. R/82/08/1699, dated: 08.04.2008 & R/82/08/1799, dated: 15.04.2008, which is more beneficial compared to the corresponding categories of the Central Government employees. In its report No. AI/1/40/BI/2019, dated: 16th Oct 2019 the GoO recommended that the above BI OMs No. R/82/08/1699, dated: 08.04.2008 & R/82/08/1799, dated: 15.04.2008, "were illegal, arbitrary and without approval of the competent authority and hence shall be made null and void."

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

encashment payments shall be brought out separately for appropriate direction of M/o Finance."

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

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

The detailed calculation is submitted to DST for its necessary action for placing the same to Ministry of Finance for waiver of recovery of the excess payments as mentioned above and the matter is pending till date. From the month of May 2020 the salary of 137 numbers of existing employees has been revised and given effect in the monthly pay bill preparation. The above mentioned amount is subject to verification and audit.

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

INDEPENDENT AUDITORS REPORT
To the Member of Council

Opinion

We have audited the accompanying financial statement of **BOSE INSTITUTE**, **Indo-Fair coordination centre** (entity), which comprises the Balance sheet as at MARCH 31st 2021 & Statement of expenditure for the year ended on 31st March, 2021 and notes to the financial statement, including a summary of significant accounting policies and other explanatory information. In our opinion and to the best of our information and according to the explanations given to us, the accompanying financial statement give true and fair view of the financial position of the entity as at march 31st, 2021 and of its financial performance for the year then ended.

BASIS FOR OPINION

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

Key Audit Matters

Key audit matters are those matters that, in our professional judgment, were of most significance in our audit of the Financial Statements of the current period. These matters were addressed in the context of our audit of Financial Statements as a whole, and in forming our opinion thereon, and we do not provide a separate opinion on these matters. In addition to the matters described in the Basis for Qualified Opinion, we have determined the matters described below to be the key audit matters to be communicated in our report:

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

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

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

INDEPENDENT AUDITORS REPORT
To the Member of Council

Auditor's responsibilities for the audit of the financial statements

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

Place: Kolkata

Date: 31.08.2021

For SPAN & Associates
Chartered Accountants
FRN: 302192E

CA Amlan Kusum Mandal
Membership No: 064631
UDIN: 21064631AAAACB7741

BOSE INSTITUTE (IFCC)
NOTES ON ACCOUNTS

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

   A joint declaration was signed on 07.02.2007 by the Minister for Science & Technology and Earth Sciences, Govt. of India and the Federal Minister for Education & Research, Federal Republic of Germany concerning the participation in construction and operation of the international facility for Anti-porton and Ion research. A joint statement was issued by the Chancellor of Republic of Germany and Prime Minister of India on 30.10.2007 in this regard. On 04.10.2021, the international agreement on the construction of FAIR was signed by nine countries, namely Germany, Finland, France, India, Poland, Romania, Russia, Slovenia and Sweden. Latter on United Kingdom also joined as a partner. India's contribution to the FAIR consortium has been estimated at 42.79 million Euro at July 2010 prices which is equivalent to Rs. 260.00 Crore (Approximately). According to the MoU between DAE & DST, the overall cost of Rs. 260.00 Crore is to be borne equally by DAE & DST.

   Bose Institute, Kolkata has been designated as the Indian shareholder in the FAIR Company and the Nodal India Institution for management of the FAIR programme in India. The assets created from Indian participation will not come under the purview of Bose Institute and they will also not be shown in its Balance Sheet. Keeping in mind all the above accounting of FAIR project is unique and it is maintained in the old format a before, without changing in format for Central Autonomous Institutes.

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

BOSE INSTITUTE (IFCC)
BALANCE SHEET
For the year ended 31st March 2021

As at 31st March 2020 (₹)	Liabilities	As at 31st March 2021 (₹)	As at 31st March 2020 (₹)	Assets	As at 31st March 2021 (₹)
3,26,946.00	Fund for Creation of Asset	3,40,988.00	54,732.00	Shares in FAIR GmbH	54,732.00
			2,72,214.00	Office Equipment Furniture : ₹ 98,530.00 Equipment : ₹1,87,726.00	2,86,256.00
	Unspent Grant				
10,38,49,326.77	Grant from Department of Science and Technology (**Schedule-1**)	8,55,53,196.77	-	Advance	-
22,03,45,771.47	Grant from Department of Atomic Energy (**Schedule-2**)	21,64,40,031.47	-	Receivable From Bose Institute	-
2,46,59,804.00	Interest Earned (**Schedule-3**)	1,77,39,841.00	10,336.00	**Cash Balance** Cash in Hand	-
				Bank Balances	
59,000.00	Audit Fees Payable	59,000.00	33,94,940.24	Union Bank of India S.B. A/c -	10,65,239.24
35,850.00	Payable to Bose Institute	98,210.00	34,55,44,476.00	Fixed Deposits	31,88,25,040.00
34,92,76,698.24		**32,02,31,267.24**	**34,92,76,698.24**		**32,02,31,267.24**

Place : Kolkata
Date : 31.08.2021

Signed in terms of our separate Report of even date.
For SPAN & Associates
Chartered Accountants
Firm Registration No. 302192E
Amlan Kusum Mandal
Partner
Membership No. 064631

Sd/-
Kamal Sing
Accountant (Cash)

Sd/-
Vikash Kumar
Audit & Finance Officer

Sd/-
Achintya Mukherjee
Accounts Officer

Sd/-
Prof. Rajarshi Ray
Registrar(O)

Sd/-
In-charge Fair Project

Sd/-
Prof. (Dr.) Uday Bandyopadyay
Director

BOSE INSTITUTE (IFCC)
INCOME AND EXPENDITURE
For the year ended 31st March 2021

For the year ended on 31st March, 2020 (₹)	Particulars	For the year ended on 31st March, 2021 (₹)
-	Advertisement Expenses	-
-	Ad-hoc Bonus	-
59,000.00	Audit Fees	59,000.00
-1.23	Bank Charges	-
40,844.00	Contingency Expenses	7,604.00
94,911.00	Meeting Expenses - IFCC	-
-	Fellowship (JRF)	-
6,24,600.00	Salary	6,24,600.00
3,79,276.00	Student Support	-
10,01,861.37	Travelling Expenses	-
-	Overhead Charges	-
7,95,160.00	Workshop	1,59,718.00
29,95,651.14		**8,50,922.00**

Place : Kolkata
Date : 31.08.2021

Signed in terms of our separate Report of even date.
For SPAN & Associates
Chartered Accountants
Firm Registration No. 302192E
Amlan Kusum Mandal
Partner
Membership No. 064631

Sd/-
Kamal Sing
Accountant (Cash)

Sd/-
Vikash Kumar
Audit & Finance Officer

Sd/-
Achintya Mukherjee
Accounts Officer

Sd/-
Prof. Rajarshi Ray
Registrar(O)

Sd/-
In-charge Fair Project

Sd/-
Prof. (Dr.) Uday Bandyopadyay
Director

BOSE INSTITUTE (IFCC)
RECEIPT & PAYMENT
For the year ended 31st March 2021

Particulars	Amount (₹)	Particulars	Amount (₹)
Opening Balance			
Cash in Hand	10,336.00		
SB A/c Union Bank of India	33,94,940.24		
Fixed Deposits	34,55,44,476.00		
GRANT FROM DST	-		
GRANT FROM DAE	-		
GRANT FROM DST (IFCC Exp.)	-		
Interest on SB A/c	1,65,693.00		
Interest on FD (Term Deposits)	1,75,74,148.00		
Advance	7,000.00	Advance	7,000.00
Profession Tax	3,360.00	Profession Tax	3,360.00
TDS (Salary: ₹ 20004.00 + Party:₹ 652411.00)	6,72,415.00	TDS (Salary: ₹ 20004.00 + Party: ₹ 652411.00)	6,72,415.00
TDS on GST (IGST)	14,87,365.00	TDS on GST (IGST)	14,87,365.00
Workshop	-	Workshop	1,59,718.00
		Travelling Expenses	-
		Bank Charges	-
		Meeting Expenses - IFCC	-
		Audit Fees	59,000.00
		Contingency Expenses	7,604.00
		Overhead Charges	-
		Salary	6,24,600.00
		Student Support	-
		Advertisement Expenses	-
		Office Equipment	14,042.00
		Power Converter (In-Kind)	3,57,27,296.00
		Detector (FAIR Experiment)	-
		Vacuum Chamber (In-Kind)	-
		Beam Stopper (In-Kind)	-
		GRANT FROM DST (IFCC Exp.) (Return of Bank Interest for the Year 2019-20)	4,58,922.00
		GRANT FROM DST (For FAIR) (Return of Bank Interest for the Year 2019-20)	98,10,492.00
Inter Unit Account		**Inter Unit Account**	
Bose Institute (Council)	62,360.00	Bose Institute (Council)	-
Scheme/Project	-	Scheme/Project	-
		Closing Balance	
		Cash in Hand	-
		SB A/c : Union Bank of India	10,65,239.24
		Fixed Deposits	31,88,25,040.00
	36,89,22,093.24		**36,89,22,093.24**

Sd/-
Achintya Mukherjee
Accounts Officer

INDEPENDENT AUDITORS REPORT
To the Member of Council

Qualified Opinion

We have audited the accompanying financial statements of **BOSE INSTITUTE Governing Body** (the entity), which comprise the Balance Sheet at March 31st 2021, and the Income & Expenditure account and notes to the financial statements, including a summary of significant accounting policies and other explanatory information. In our opinion and to the best of our information and according to the explanations given to us, except for the effect of the matter described in the *Basis for Qualified Opinion* section of our report, the accompanying financial statements give a true and fair view of the financial position of the entity as at March 31st, 2021, and of its financial performance for the year then ended.

Basis for Qualified Opinion

1. No Fixed Asset register was provided for our verification. The Institute has not carried out test of impairment, if any, in accordance with the requirement of AS 28 notified by the Institute of Chartered Accountants of India (ICAI).

2. No cash balance certificate as on 31st March, 2021 was provided for our verification.

3. Share certificate for the investment in 7.5% Preference share of C.E.S.C Ltd. was not available for our verification.

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

Key Audit Matters

Key audit matters are those matters that, in our professional judgment, were of most significance in our audit of the Financial Statements of the current period. These matters were addressed in the context of our audit of Financial Statements as a whole, and in forming our opinion thereon, and we do not provide a separate opinion on these matters. In addition to the matters described in the Basis for Qualified Opinion, we have determined the matters described below to be the key audit matters to be communicated in our report:

INDEPENDENT AUDITORS REPORT
To the Member of Council

Key Audit Matter	Auditors' response to Key Audit Matter
Fixed Assets: The carrying amount of Fixed Assets of the Institute is Rs 23,74,713/-. Due to the significance of the value of the Fixed Assets, we have considered the same to be significant to our overall audit strategy and planning.	We assessed the controls in place, evaluated the appropriateness of capitalization process, performed tests of details on costs capitalized, the timeliness of the capitalization of assets and the derecognition criteria for assets retired from active use. We reviewed the judgments made by management including the nature of underlying costs capitalized; determination of realizable value of the assets retired from active use; the appropriateness of asset live applied in the calculation of depreciation; useful lives of assets as per the technical assessment of the management.

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

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

Auditor's Responsibilities for the Audit of the Financial Statements

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

Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with SAs will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in

INDEPENDENT AUDITORS REPORT
To the Member of Council

the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

Place: Kolkata

Date: 31.08.2021

For SPAN & Associates
Chartered Accountants
FRN: 302192E

CA Amlan Kusum Mandal
Membership No: 064631
UDIN: 21064631AAAACC1644

BOSE INSTITUTE (GOVERNING BODY)

BALANCE SHEET AS AT 31st MARCH 2021

	Schedule No.	*As on 31/03/2021* Rs.	*As on 31/03/2020* Rs.
FUNDS & LIABLITIES			
CAPITAL FUND			
AS PER LAST ACCOUNT		23,17,833.36	23,17,833.36
ACHARYA JC BOSE CENTENARY FUND			
AS PER LAST ACCOUNT		15,99,768.40	15,99,768.40
SPECIAL FUND			
AS PER LAST ACCOUNT	1	29,62,629.96	29,62,629.96
DEPOSITS & OTHER LIABILITIES	2	11,68,370.66	11,98,291.66
TOTAL		**80,48,602.38**	**80,78,523.38**
PROPERTIES & ASSETS			
FIXED ASSETS			
AS PER LAST ACCOUNT	3	23,74,712.85	23,74,712.85
INVESTMENTS			
AS PER LAST ACCOUNT	4	75,37,093.09	63,19,249.67
RECEIVABLE & DEPOSITS			
AS PER LAST ACCOUNT	5	3,30,938.58	11,07,066.00
CASH & BANK BALANCES	6	12,30,706.34	12,13,341.34
INCOME & EXPENDITURE A/C			
EXCESS OF INCOME OVER EXPENDITURE		(34,24,848.48)	(29,35,846.48)
TOTAL		**80,48,602.38**	**80,78,523.38**

INCOME & EXPENDITURE STATEMENT FOR THE YEAR ENDED 31ST MARCH 2021

Particulars	2020-21 Rs.	2019-20 Rs.
INCOME		
INTEREST ON TERM DEPOSIT	4,95,551.00	4,65,142.00
INTEREST ON SAVINGS BANK	-	-
TOTAL	**4,95,551.00**	**4,65,142.00**
EXPENDITURE		
SALARY & WAGES	-	10,800.00
ACCOUNTING CHARGES	-	-
AUDIT FEES	5,900.00	5,900.00
BANK CHARGES	649.00	649.00
EXCESS OF INCOME OVER EXPENDITURE FOR THE YEAR	4,89,002.00	4,47,793.00
TOTAL	**4,95,551.00**	**4,65,142.00**
INCOME BROUGHT DOWN AND ADJUSTED WITH LAST YEAR	4,89,002.00	4,47,793.00
BALANCE BROUGHT DOWN FROM LAST A/C	29,35,846.48	24,88,053.48
BALANCE TAKEN TO BALANCE SHEET	**34,24,848.48**	**29,35,846.48**

Place : Kolkata
Date : 31.08.2021

Signed in terms of our separate Report of even date.
For SPAN & Associates
Chartered Accountants
Firm Registration No. 302192E
Amlan Kusum Mandal
Partner
Membership No. 064631

Sd/-
Kamal Sing
Accountant (Cash)

Sd/-
Vikash Kumar
Audit & Finance Officer

Sd/-
Achintya Mukherjee
Accounts Officer

Sd/-
Prof. Rajarshi Ray
Registrar(O)

Sd/-
Prof. (Dr.) Uday Bandyopadyay
Director

COMPLIANCE REPORT

A. Statutory Compliance:

Sl. No.	Statutory Audit Observation	Reply of Bose Institute for compliance
1	The Institute has accounted for expenses on cash basis in the financial statements in few cases which is contrary to the Schedule 24 point 4.2 of the "Significant Accounting Policies and Notes to Accounts" as well as the fundamental accounting assumptions as per AS 1,notified by the Institute of Chartered Accountants of India. The Expenditure for the FY 2020-21 has been booked in the FY 2021-22. Thus, short booking of Expenditure found in 32 instances total amounting to Rs.136.98 Lakh. Similarly, Expenditure of earlier period was booked in the FY 2020-21. The Prior period Expenditure so booked is found in 7 Instances amounting to Rs. 35.28 Lakh.	Necessary action will be taken in the current Financial Year to follow recommendations of AS-1.
2	As per Schedule 24 Clause 17 of Notes on Accounts the excess payment as per Due Drawn statement has not been considered in Accounts. Thus, the Establishment Expenses for this year and also the same for the earlier period have not been adjusted. The extent of expenditure to be rectified and the recoverable amount to be shown in Balance sheet are not quantified.	Matter taken up with DST & CAG and MOF and the matter is also under the jurisdiction of Honourable court. No adjustments in the books of accounts were done for want of decision or instruction from DST, CAG, MoF or Honourable Courts.
3	In Union Bank (A/C 3355) the unidentified receipt Rs. 1.94 Lakh during the FY 2020-21 has been shown in "Grant in aid unallocated". The total unidentified Receipts stands as on date Rs. 10.33 Lakh. Further Rs. 2.88 Lakh received during F.Y 2018-19 but remained unidentified and not accounted for till date.	The matter will further be taken up with bank to identify the sources of receipt.

COMPLIANCE REPORT

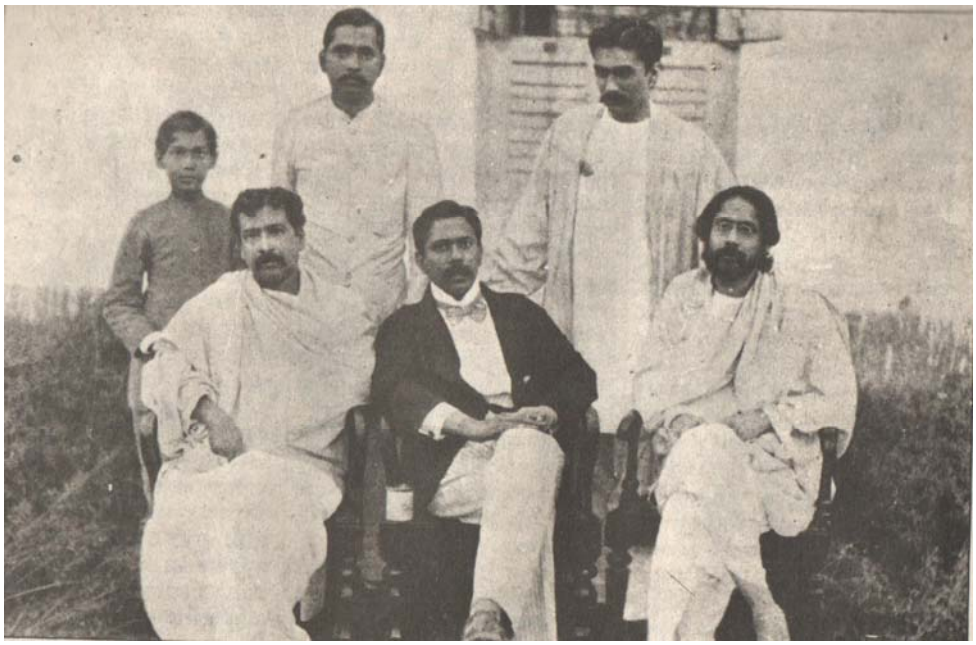
Sl. No.	Statutory Audit Observation	Reply of Bose Institute for compliance
4	No Fixed Asset Register was available. Being informed that Fixed Asset register has been updated till 31st March, 2017 and the same for the period 1st April, 2017 to onwards will be started soon. Details related to location of asset, description of asset, life of asset and asset coding is yet to be prepared. Periodic physical verification of fixed assets and impairment testing are not performed. In view of this it is not possible to opine on correctness or otherwise of fixed assets.	The consultant has started the work but suspended due to Pandemic and shifting of office to Unified Academic Campus.
5	Intangible assets in the form of books and journals are not amortised over the licence period and are being carried forward and depreciated even after expiry of their licence period which is not in accordance with the requirement of AS 26 notified by the Institute of Chartered Accountants of India. The amount of such expired licences is presently not ascertainable.	Necessary action will be taken in future to ascertain the values and suitable entries will be given in the books for expired licences of books and journals.
6	Refer Schedule 3 of Balance sheet Liability under "Earmarked /endowment Fund- Development Fund (Planning commission) closing balance as on 31.03.2021 Rs. 856.05 Lakh and corresponding Assets Schedule 10 "Investment from Earmarked/ Endowment Fund Asset acquired under for development and modernisation fund amounting to Rs. 666.57 Lakh have been held under "investment and under earmarked fund" and has not been capitalised thereby understating the fixed assets to that extent. Consequent impact on depreciation and current year's profit is not ascertainable.	The matter will be settled with the help of the consultant appointed for preparation of updated Fixed Assets Register.
7	The practice of obtaining balance confirmation for receivable and payable accounts is not followed by the Institute. Party wise details along with the ageing analysis in relation to Sundry Creditors (Rs.11.86 Lakh. Credit), Adhoc Advance having a credit balances (Rs. 19.95 Lakh Credit.) and Sundry Creditors for Goods and Services (Rs.56.09 Lakh) and Liability (Rs 37.52 Lakh Credit.) as on 31stMarch, 2021 have not been made available to us. No party wise sub ledger is maintained in Books of Accounts (Tally). In Adhoc Advance, an amount advanced to a party Rs. 30.00 Lakh but the same account was credited by Rs. 50.00 Lakh. Thus, Adhoc Advance has a Credit balance. Consequential impact on the books of accounts is not ascertained.	Agreed and will follow in next year 21-22 and no Due Certificate will be obtained from parties at the time of payments.

COMPLIANCE REPORT

Sl. No.	Statutory Audit Observation	Reply of Bose Institute for compliance
8.	Capital WIP to the tune of Rs. 21.12 Lakh have no movement since long. Current status of work and consequential impact on the books of accounts is not ascertainable.	The matter will be settled with the preparation of updated Fixed Assets Register.
9	We could not verify brought forward balances of 16 items of Current Assets total amounting to Rs. 77.15 Lakh, and 14 items of Current Liabilities total amounting to Rs. 75.73 Lakh. Consequential impact on the year's revenue and the net current asset position as at the end of the year is not ascertainable.	Reconciliation process is going on and will be presented to next audit.
10	Liability towards gratuity and leave encashment is not ascertained as per the actuarial valuation and the same are accounted on cash basis contrary to requirements of AS-15 notified by the Institute of Chartered Accountants of India. The impact on current year Financial Statement is not ascertained.	Actuarial valuations process is going on as per AS -15 and will be intimated to Audit.
11	Out of Current liability of Payable to Pensioner of Rs.6.31 Lakh, appearing in Pension Fund Accounts for FY 2020-21, Rs 3.66 Lakh is a long outstanding amount the details of which were not made available to us. Hence the effect of the same on books of accounts cannot be determined.	Will be reconciled and presented to Next audit.
12	With respect to Contributory Provident Fund Account for FY 2020-21 details in relation to Payable to staff (Rs. 2.02 Lakh Credit), Receivable from Bose Institute (Out of Cl. Rs. 7.07Lakh Debit, Rs. 7.02 Lakh), Receivable from GPF (Rs. 2.64Lakh Debit) and respective contra entry in GPF Accounts as on 31.03.2021 are long outstanding amount the details of which were not made available to us. Consequential impact on the books of accounts is not ascertainable at this stage.	Will be reconciled and presented to Next audit.
13	There are some TDS entries found in Form 26AS but not booked in books of Accounts. The Interest earned is Rs. 4.50 Lakh and TDS thereon being Rs. 0.31 Lakh, Vice versa , some TDS entries are appearing in the Bank Certificate but not reflecting in Form 26AS. The interest earned Rs. 3.09 Lakh and TDS thereon being Rs. 0.23 Lakh. No reconciliation is done with the concerned deductor. Consequential impact on the books of accounts is not ascertainable at this stage.	The matter will be taken up with Tax consultants for recovery or adjustment with Tax authorities.

COMPLIANCE REPORT

Sl. No.	Statutory Audit Observation	Reply of Bose Institute for compliance
14	There are 4 items of TCS entries found in Form 26AS where amount debited Rs. 28.45 Lakh and Tax collected Rs. 0.13 Lakh but the same is not accounted for due to want of Debit note/ Invoice. No reconciliation is done with the concerned collector. Consequential impact on the books of accounts is not ascertainable at this stage	The matter has been taken up with Tax consultant for reconciliation.
15	In Books of Accounts we found debit balance in Payable accounts (6 items total amounting to Rs 48.12 Lakh) and vice versa credit balance in Receivable accounts (8 items total amounting to Rs 40.25 Lakh). Instead of segregating the same to show in proper head, wrongly clubbed in the payable and receivable account respectively. As a result, both the receivable and payable are understated by Rs.88.37 Lakh).	These ledgers are very old rearranging and regrouping them were done for better presentation of accounting statements. Further reconciliation will be done and necessary adjustment entries will be given if required.
16	Refer Schedule 24 Clause 11 of notes of Accounts; the Institute has not identified any contingent Liability. No information of Suit filed / Court cases by / against the Institute is provided to us. The extent of contingent liability and whether any provision creation is necessary on the same cannot be ascertained.	Will be taken care of during next audit.
17	Unspent balance is Rs.888.28 Lakh (Out of 65 projects, 20 projects for FY 2020-21 Rs 535.98 Lakh) has not been surrendered to competent authority.	The process of refunding of unspent balances of terminated projects are in the way.



Acharya Jagadis Chandra Bose with Lokendranath Palit and Rabindranath Tagore

Standing from Left to Right:
Rathindranath Tagore , Mahimchandra Thakur, Surendranath Thakur (Silaidaha, 1899)