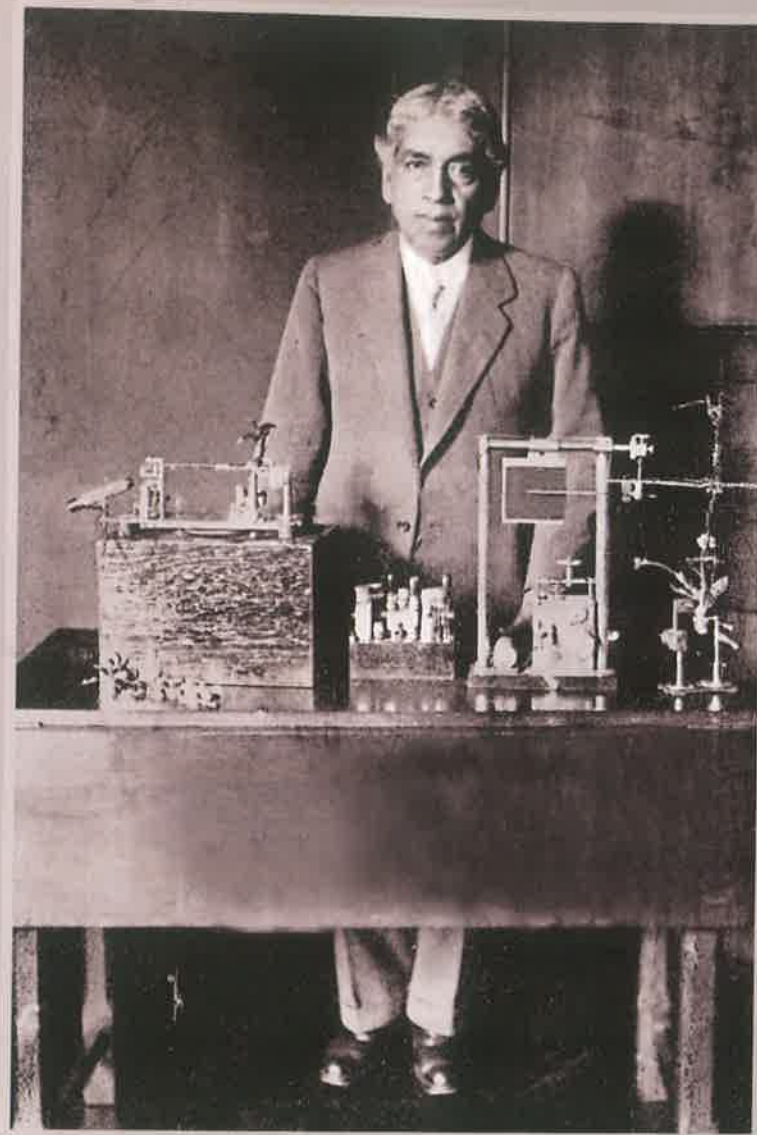




Sir J. C. Bose with the apparatus for measuring
the Heartbeat of Marigold



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Annual Report

2014-2015

Bose Institute

ANNUAL REPORT

2014-15



BOSE INSTITUTE
KOLKATA

ANNUAL REPORT OF BOSE INSTITUTE FOR 2014 - 2015



The 98th Foundation Day of Bose Institute was celebrated on 30th November, 2014. **Dr. Srikumar Banerjee**, DAE-Homi Bhabha Chair Professor, Bhabha Atomic Research Centre, Mumbai graced the occasion as Guest of Honour and delivered the 76th Acharya Jagadis Chandra Memorial Lecture on **Order and Chaos – In Assemblies of Atoms and in Human Societies**.



Prof. Sushanta Dattagupta, Hon'ble Vice Chancellor, Visva Bharati, presided over the programme. Prof. Sibaji Raha, Director, Bose Institute, delivered the Welcome Address and presented the Institute Report. Sir Nilratan Sirkar Prize 2014 was awarded to Ms. Moniya Chatterjee, Senior Research Fellow, Division of Plant Biology and Prof. B. B. Biswas Outstanding Student Award 2014 was presented to Ms. Aritrika Pal, Senior Research Fellow, Dept. of Biochemistry.



Bose Institute

93/1, Acharya Prafulla Chandra Road
Kolkata -700 009



Compiled and Edited by the
J. C. Bose Centre
(comprising J. C. Bose Museum and Publication unit)
consisting of the following members :

Prof. Dipankar Home	(Chairman)
Prof. Gautam Basu	(Co-Chairman)
Prof. Kalyan Kr. Mukhopadhyay	(External Expert, Advisor)
Prof. Pradip Kr. Parrack	(Member)
Dr. Gaurab Gangopadhyay	(Member)
Shri Tarun Kr. Maji	(Member)
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Contents

BOSE INSTITUTE ♦ 7

MANAGEMENT OF THE INSTITUTE ♦ 9

SCIENTIFIC REPORTS ♦ 11

I. PLANT FUNCTIONAL BIOLOGY OF STRESS RESPONSES FOR IMPROVEMENT AND EXPLORING THE PLANT GENETIC RESOURCES ♦ 11

II. STRUCTURAL STUDIES AND BIOPHYSICAL PROBLEMS ♦ 39

III. COMPUTATIONAL BIOLOGY ♦ 54

IV. MOLECULAR MEDICINE ♦ 66

V. BASIC AND APPLIED MICROBIOLOGY ♦ 100

VI. SYSTEMS BIOLOGY ♦ 113

VII. BASIC AND APPLIED PROBLEMS IN PHYSICAL AND ENVIRONMENTAL SCIENCES ♦ 124

OUTREACH AND MAN POWER DEVELOPMENT ♦ 157

SERVICE DEPARTMENT / SECTION ♦ 160

ACHARYA J.C. BOSE BIOTECHNOLOGY INNOVATION CENTRE ♦ 160

CENTRAL INSTRUMENTS FACILITY ♦ 161

CENTRE FOR ASTROPARTICLE PHYSICS & SPACE SCIENCE ♦ 162



ENVIRONMENTAL SCIENCES SECTION ♦ 164

FALTA EXPERIMENTAL FARM ♦ 166

J C BOSE CENTRE ♦ 174

LIBRARY ♦ 175

WORKSHOP ♦ 180

LIST OF PERSONNEL ♦ 182

STATEMENT OF ACCOUNTS FOR THE YEAR 2014-2015 ♦ 189

COMPLIANCE REPORT ♦ 212

ON GOING PROJECT DURING 2014-15 ♦ 215

From the Director's Desk

It is my privilege to present the Annual Report of Bose Institute for the year April 1, 2014 till March 31, 2015. This volume is, actually, much more than just an obligatory chore; it chronicles our hope, achievements and ambitions during the period under review. This is not meant to be a detailed report of our scientific and technical activities, which only the experts can fully appreciate. Rather, this volume attempts to give the general reader a bird's eye view of what the Institute does, sponsored by the people's money. The charter of Bose Institute, clearly laid down by our Founder, the illustrious doyen of modern Indian science – Acharya Jagadis Chandra Bose, is to pursue the fullest and unfettered investigation in the ever-opening new branches of science and also to ensure the widest possible diffusion of the new knowledge created through such investigations. To remain competitive at the international scale, this

cannot be done in isolation, or in penury. Substantial financial support is needed and in our country, the lion's share of such support still comes from the public coffers; support for research from the private sector, although slowly picking up, is still woefully inadequate. Thus, when we compare our achievements with our international counterparts, we cannot deny the existence of an initial handicap.



That pessimism notwithstanding, the achievements of Indian scientists have steadily improved over the years and Bose Institute is proud to declare that we have not fallen behind in the race. In spite of somewhat limited resources, our performance indicators have shown steady improvement. Our publications on an aggregate are

showing improvements in terms of number of papers per full-time scientist as well as average impact factor per paper. This is all the more noteworthy since we have, over the past few years, inducted a number of young colleagues, who are still in the process of establishing their laboratory facilities to the optimal level. As a rule, this enthusiastic group of young people have shown tremendous promise and we are confident they would start to enhance the reputation of Bose Institute through their output. I am also extremely happy to see that these bright young people take their social responsibility very seriously; they share the burden of the extensive outreach programmes that the institute considers its responsibility to conduct on a regular basis.

The Publication Committee of Bose Institute, under the chairmanship of Prof. Dipankar Home, has done a wonderful job of producing this volume. They, of course, could not have done it without the whole-hearted support and help from all sections of our staff; all practicing scientists know through their personal experience that it is a lot easier to provide a technical description of their research but a lot harder to dispense with the professional jargon and give a readable account of the work that could be understood by the non-expert. It is my belief that that feat has been achieved in this volume to a very large extent. My sincere thanks to all my colleagues, who have made considerable efforts to this end.

I should also put on record our gratitude to our funding agency, the Department of Science & Technology, Government of India, whose continued support in spite of the hard financial situation of last year allowed us not only to survive but aspire to greater heights. We hope the next years would prove to be better, so that we can continue to upgrade our research infrastructure and compete at the international cutting edge.

I appeal to all for their continued support and encouragement. On behalf of all my colleagues, I invite all readers to contact the individual scientists if they should want to get more information about any topic covered in this volume.

Sibaji Raha
Director, Bose Institute



Rockefeller Foundation fellowship and Homi Bhabha fellowship. The institute has over the years provided yeoman service in manpower development, having trained a large number of Ph.D. students many of whom are now reputed experts in their fields in India and abroad; on an average, 30-40 scholars are awarded Ph.D. degree every year. Over the past decade, scientists of Bose Institute have maintained an enviable record of publication in peer reviewed journals. A number of its scientists and research scholars participate every year in numerous academic activities (seminars, conferences, workshops) in India and abroad as invited speakers, chairpersons and resource persons.

A large number of extramural research projects, with support from various government agencies as well as international funding agencies, are carried out at Bose Institute.

Research Activities

At the time of founding Bose Institute, the illustrious founder, Sir J. C. Bose had unequivocally declared that the objective of Bose Institute would be to practice seamless science, without compartmentalisation on the basis of specialisation. Bose Institute strives to achieve this ideal, encouraging inter-disciplinary research to the fullest. Broadly, the current research activities of our scientists cover the following areas:

Institutional Plan Projects for the 12th Five-Year Plan (2012-2017)

- I. Plant Functional Biology of Stress Responses for Improvement and Exploring the Plant Genetic Resources
- II. Structural Studies and Biophysical Problems
- III. Computational Biology
- IV. Molecular Medicine
- V. Basic and Applied Microbiology
- VI. Systems Biology
- VII. Basic and Applied Problems in Physical and Environmental Sciences

Manpower Development, Academic

Bose Institute has recently started a new chapter in the realm of manpower development. In collaboration with the University of Calcutta, an integrated M.Sc.-Ph.D. course in Plant Molecular Biology & Technology has been initiated in September 2007.

Science and Society

In addition, a Rural Biotechnology Centre has been developed to provide the knowhow of basic biotechnology to the rural people to improve the socioeconomic status. Although the beginning is modest, the response of the local people, the primary beneficiaries of the project, has been one of tremendous enthusiasm and efforts are now on not only to sustain it but also to substantially expand its scope.

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 consisting of twelve members including the Director. 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.

Members of the Governing Body

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

Members of the Council

1. Prof. Bikash Sinha, Chairman One eminent active Scientist with expertise in the area(s) of research pursued at B. I. nominated by the DST.
2. The Secretary, Department of Science and Technology, Government of India or his nominee
3. Prof. S. N. Chatterjee Two eminent and active scientists in the area of research pursued in B.I. nominated by the



4. Shri Swami Atmapriyananda Governing Body. They may not necessarily be members of the Governing Body.
5. Prof. MRS Rao Two eminent and active Scientists to be nominated by the DST
6. Prof. JP Khurana
7. Financial Adviser, Department of Science and Technology, Govt. of India
8. The Chief Secretary, Government of West Bengal or his nominee
9. The Director, Indian Association for the Cultivation of Science, Kolkata
10. The Director, S. N. Bose National Centre for Basic Science, Kolkata
11. The Director, Bose Institute
12. The Registrar, Bose Institute – Non-Member Secretary

Members of the Finance Committee

1. Principal Secretary, Higher Education Department, Govt. of West Bengal.
2. Shri Somnath Sanyal, Representative of the Governing Body
3. Joint Secretary and Financial Adviser to the Department of Science and Technology, Govt. of India or his nominee
4. Accountant General (A & E), West Bengal
5. Director, Bose Institute
6. Registrar, Bose Institute, - Secretary.



Sir J.C. Bose lecturing on the Nervous System of plants at the Sorbonne in Paris (1926)

I. Plant Functional Biology of Stress Responses for Improvement and Exploring the Plant Genetic Resources :

Participation of Institutional Project-I for the 12th Five-year Plan (2012-2017)

Dr. Sampa Das (Coordinator), Dr. S. Gupta-Bhattacharya, Dr. S. R. Sikdar, Dr. T. K. Ghose, Dr. Debabrata Basu, Dr. Gaurab Gangopadhyay, Dr. Pallob Kundu and Dr. Shubho Chaudhuri

Dr. A. N. Lahiri Majumder (Emeritus Scientist, Raja Ramanna Fellow), Dr. S. Sen Mandi (Emeritus ICMR), Dr. A. Pal (CSIR-Emeritus Scientist), Dr. D. N. Sengupta (Honorary Scientist), Dr. Anupama Ghosh (Inspire Faculty)

Introduction:

To address various biotic and abiotic stress induced physiological, plant yield and plant development related problems- proteomic/ transcriptomic/ next generation sequencing and other molecular technique based attempts are being made to identify novel genes / proteins/ regulatory elements and their key functions associated with plants' biological processes metabolism. Recent initiatives have also been undertaken to understand epigenetic, transcriptional/post transcriptional and post translational regulations of selected key genes, upstream regulators, miRNAs and proteins playing role in plant defense response and plant developmental processes under variable situations. Using plant genetic engineering technology, effective exploitation of selected novel genes and regulatory elements are being pursued to improve the efficacy of target plants in the field .

Attempts are also being made to identify a number of allergenic proteins through immunoproteomic analyses from air borne pollens and fungal spores.

Dr. Debabrata Basu, Professor

Scientific Reports:

A Next Generation Sequencing Based Transcriptomic Analysis to Understand Non-host Resistance Mechanism of *Sinapis alba* Against *Alternaria brassicicola*:

To understand the non-host resistant mechanism of *Sinapis alba* against the necrotrophic fungal pathogen *Alternaria brassicicola*, we have used a NGS (Illumina HighSeq2000) based comparative transcriptomics analysis between the resistant *Sinapis alba* and susceptible *Brassica juncea* upon challenge with *A. brassicicola*. Through RNA-Seq we have generated, assembled and analyzed around 85 million sequence reads individually from *B. juncea* and *S. alba* inoculated with *A.*



brassicicola as well respective uninoculated samples. More than 70% of the transcripts were annotated using *Arabidopsis* as the reference and further classified by GO.

Comparative transcriptome analysis with the upregulated transcripts of the resistant and susceptible plants on challenge with the pathogen, has given the opportunity to identify number of important classes of genes, which are linked with plant defense response. The genes like; ABA biosynthetic, receptors and responsive genes along with receptor like kinases, callose synthesis and deposition, glycosyl hydrolases and several PA-phosphatases showed upregulation in *S. alba* compared to susceptible *B. juncea* upon challenge with *A. brassicicola*. However, in *B. juncea* the upregulated classes of genes were salicylic acid, ROS (reactive oxygen species) and cell death associated. Validation of some of the important differentially regulated pathways were carried out by qRT-PCR of few linked genes as well as studying phenotypic expression of enhanced ROS generation and cell death in *B. juncea* and elevated callose deposition in *S. alba* upon challenge with *A. brassicicola*.

Publication:

1. Moniya Chatterjee, Sumanti Gupta, Anirban Bhar, Dipankar Chakraborti, Debabrata Basu and Sampa Das (2014) Analysis of root proteome unravels differential molecular responses during compatible and incompatible interaction between chickpea (*Cicer arietinum*L.) and *Fusarium oxysporum* f. sp. *ciceri* Race1 (Foc1) BMC Genomics, 15:949 <http://www.biomedcentral.com/1471-2164/15/949>

Students Awarded Ph.D.:

Name of Student (University/Year)	Title of Thesis
Mrinmoy Mazumder C. U., 2014	Identification of <i>in vivo</i> function of <i>Alternaria brassicicola</i> induced <i>Sinapis alba</i> L. gene(S) in susceptible <i>Brassica juncea</i> L. background.

Dr. Shubho Chaudhuri, Associate Professor

Scientific Reports:

Epigenetic regulations during plants response to different environmental or developmental stimuli:

Project-I

Understanding the epigenetic regulation involved in the transcription of salt and cold stress induced genes in rice:

Reprogramming of cellular function in response to external stress stimuli is one of the important mechanism by which plants adapt to the environment. Stress adaptation involves alteration in the expression levels of several genes. The highly complex structure of chromatin imparts resistance to several nuclear processes including transcription. Several covalent modifications at the N-terminal tails of histones and changes in DNA methylation together generate epigenetic code to promote accessibility of nuclear factors to their cognate binding site. Using rice as a system, we have studied different epigenetic changes involved in regulating the expression of stress responsive genes. Our

results indicate that there are differential epigenetic marks at the promoter region of stress responsive genes in response to different abiotic stress-induced transcription. These epigenetic changes cause significant rearrangement in the chromatin architecture at the promoter region of the genes. In different stress tolerant varieties of rice, enrichment of such chromatin modification marks was observed in these loci, even in absence of stress. These findings indicate an important role of epigenetic control in the transcriptional activation of different inducible genes of rice in response to abiotic stress.

Project-II

Investigating the role of ARID/HMG in modulation of chromatin structure in planta:

ARID-HMG belongs to a novel HMGB group of proteins where AT-rich interaction domain (ARID) is fused with HMG-box domain in a single polypeptide. ARID-HMG family is highly plant specific with homologs found both in higher plants as well as in lower plants such as *Physcomitrella*. These proteins are ubiquitously expressed in different parts of the plant tissue and are primarily localized in the nucleus. The DNA binding shows that ARID-HMG can bind to double stranded DNA but have weaker binding affinity compared to canonical HMGB protein. The protein prefers AT-rich DNA as a substrate and also shows structural bias towards supercoiled DNA. Structure based on protein DNA docking of ARID-HMG and DNA complex indicates that the protein interacts with the DNA through major groove and the ARID domain and the junction region between ARID and HMG-box domain are the major interacting regions. Interestingly, both the domains of ARID-HMG when expressed separately retain their DNA binding property. The HMG-box domain shows stronger affinity towards DNA while affinity of the ARID domain is similar to full length protein, suggesting that DNA binding of ARID-HMG is mostly mediated by the ARID domain. Moreover, both ARID-HMG and its HMG-box domain can induce supercoiling in a relaxed plasmid DNA. Also, docking structure indicates that HMG-box domain of ARID-HMG interacts with nucleosome near entry/exit point. Collectively, these results signify that both the domains of ARID-HMG contribute to different DNA-dependent activities that are essential for proper functioning of ARID-HMG *in vivo*.

Publication:

1. Roy D, Paul A, Roy A, Ghosh R, Ganguly P and Chaudhuri S (2014) Differential Acetylation of Histone H3 at the Regulatory Region of OsDREB1b Promoter Facilitates Chromatin Remodelling and Transcription Activation during Cold Stress. Plos One, DOI: 10.1371/journal.pone.0100343.

Grants-In-Aid Schemes:

Title of the Scheme	Schemes funded by
Investigating the role of ARID/HMG4 (At1g04880) protein in transcription regulation of cold stress responsive gene	CSIR
Investigating the genome wide changes in histone H3K27 acetylation and gene expression in rice during cold stress.	DST

**Participation in Conferences / Symposia / Workshops & Invited Talks Delivered at Various Organizations**

Participation in conference with group members:

(i) Mr. Dipan Roy Amit Paul and Shubho Chaudhuri selected for poster presentation in Keystone symposia on "Chromatin Mechanism & Cell Physiology" held at Oberstdorf Haus, Germany. Poster entitled "Epigenetic language for the expression of stress responsive gene in rice" (ii) Mr. Amit Paul presented poster in WAST symposia on "Evolving plant Biology from Chromosome to Genomics" held at Kolkata. The poster entitled "Epigenetic regulation involved in the transcription regulation of stress responsive genes in Rice" Amit Paul, Dipan Roy, Adrita Roy, Payel Ganguly, Rwitie Mallik and Shubho Chaudhuri.

Dr. Sampa Das, Senior Professor and Coordinator

Scientific Reports:**Identification and Expression of insect/pathogen resistant gene(s)/ protein(s) with special emphasis on understanding plant's defense response to biotic stress:**

A proteomic and immune-technique based study had been undertaken to elucidate the molecular basis behind insecticidal efficacy of the agronomically important, *Colocasia esculenta* tuber agglutinin (CEA) against *Bemisia tabaci* (commonly known as whitefly) and *Lipaphis erysimi* (commonly known as mustard aphid). Confocal microscopic analyses highlighted the binding of 25 kDa stable homodimeric CEA lectin to insect midgut. Ligand blots followed by LC MS/MS analyses identified some of the above mentioned binding partners of CEA as vacuolar ATP synthase and sarcoplasmic endoplasmic reticulum type Ca²⁺ ATPase from *B. tabaci*, and ATP synthase, heat shock protein 70 and clathrin heavy chain assembly protein from *L. erysimi* midgut membrane fractions.

Surface plasmon resonance analysis revealed the interaction kinetics between ATP synthase of *B. tabaci* with CEA. Pathway prediction study based on *Drosophila* homologs suggested the interaction of CEA with insect receptors that probably led to disruption of cellular processes causing growth retardation and loss of fecundity of target insects. These findings strengthen our current understanding of the entomotoxic potentiality and mechanism of action of CEA on target insects (Roy et al 2014).

Chickpea (*Cicer arietinum* L) being the third most important pulse crop is threatened by the attack of wilt causing soil borne fungus *Fusarium oxysporum* f.sp.ciceris with 10-90% annual yield loss. Intensive comparative transcriptomic study applying next generation sequencing technology and total proteomic analyses of wilt susceptible and tolerant chickpea genotypes at 48 hours post infection resolved a number of differentially expressed transcripts and more than 100 proteins involved in wilt resistance mechanism. These proteins were categorized into 10 functional classes. Network analyses of identified proteins revealed intra and inter relationship of these proteins with their neighbors as well as their association with different defense signaling pathways (Chatterjee et.al. 2014).

Publications:

1. Roy A, Gupta S, Hess D, Das K P and Das S (2014) Binding of insecticidal lectin colocasia esculenta tuber agglutinin (CEA) to midgut receptors of *Bemisia* and *Lipaphis erysimi* provides clues to its insecticidal potential. *Proteomics*, 14(13-14): 1646-1659
2. Chatterjee M, Gupta S, Bhar A, Chakraborti D, Basu D and Das S (2014) Analysis of root proteome unravels differential molecular responses during compatible and incompatible interaction between chickpea (*Cicer arietinum* L.) and *Fusarium oxysporum* f. sp. ciceri Race1 (Foc1) BMC Genomics, 15:949. <http://www.biomedcentral.com/1471-2164/15/949>

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
Development of pod borer resistant Transgenic pigeonpea & chickpea (Jan 2011- Dec 2016)	ICAR, National Fund

Students Awarded Ph.D.:

Name of Student (University/Year)	Title of Thesis
Anindita Sengupta (C.U., 2014)	A Molecular Approach Towards Elucidation of Interaction Between <i>Bacillus thuringiensis</i> Coded Cry Proteins with Its Receptors in <i>Helicoverpa armigera</i>

Participation in Conferences / Symposia / Workshops & Invited Talks Delivered at Various Organizations

Visited Cape Town, South Africa and delivered lecture in the 13th International Symposium on Biosafety of Genetically Modified Organisms during 10-14 November, 2014.

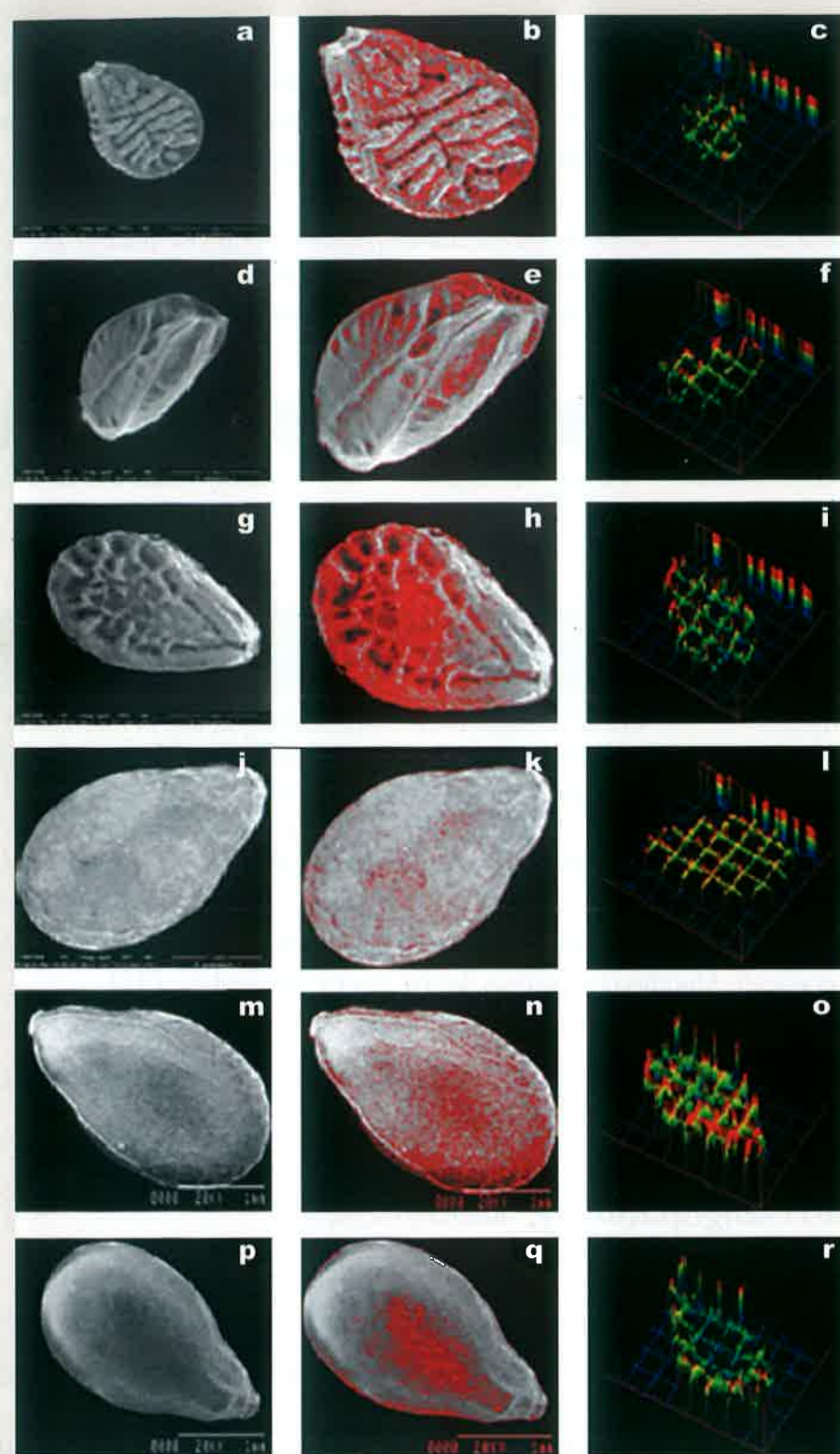
Group members:

Ayan Das delivered lecture at (i) Riverside, University of California in the 2nd International Hemipteran-Plant Interaction Symposium during June 22-25, 2014.

Dr. Gaurab Gangopadhyay, Associate Professor

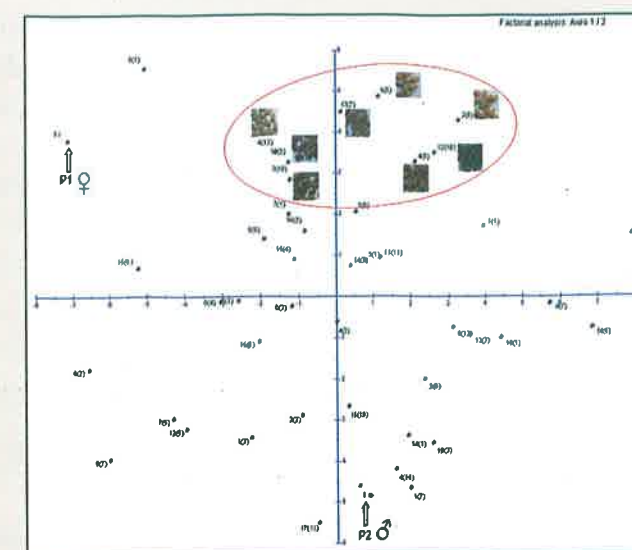
Scientific Reports:**Improvement of cultivated Sesame through seed phenomics and Marker Assisted Breeding:**

One of the major sesame breeding objectives is development of genotypes with light coloured seeds of uniform shape and size vis-à-vis high oil content, lignans, tocopherols, PUFA and phytosterols. Software aided image analysis based seed phenomic study resulted in identification of wild sesames, which could be distinguished from cultivated varieties based on seed shape and seed coat architecture. Chemical analysis of oil through GC, HPLC and spectroscopic techniques indicated superior oil profile of *Sesamum mulayanum* Nair, wild sesame. Inter-



Analysis of surface contours of representative Sesame seeds. SEM photographs of *S. angustifolium* (a), *S. radiatum* (d), *S. mulayanum* (g), *S. prostratum* (j), *S. indicum* (USC02) (m), *S. indicum* (VN05) (p); assignment of automatic bright / dark objects for measurements: (b), (e), (h), (k), (n) and (q); surface plots of respective images: (c), (f), (i), (l), (o) and (r). [Figure from publication – Prasad, Mukherjee and Gangopadhyay (2013) *Plant Breeding and Seed Science*, 68: 119-136]

specific hybridization was done between *S. mulayanum* and one indigenous accession (*S. indicum*, selected on the basis of phenomic analysis). The co dominant SSR (Short/Simple Sequence Repeat) markers distinguished parental types from the recombinant ones. The segregation pattern of the molecular markers tested in the F₂ breeding population predominantly revealed non - Mendelian ratios. The recombinants were categorized on the basis of seed phenomic traits since those have direct relationship with oil quality. Both the desired lignans (sesamin and sesamol) were significantly higher in three recombinants in comparison to the wild parent (*S. mulayanum*); moreover, these recombinants maintained high oil content like its female parent (*S. indicum*):



Principal component analysis of the F₂ recombinants and parents of inter specific hybridization in sesame (Parents: P₁ - *S. indicum* (NBMP02 - IC 131989) and P₂ - *S. mulayanum*). The eight promising recombinants are marked.

Screening of a F₁ population of Mulberry to look for association between Nitrate Reductase activity and yield:

Nitrate reductase (NR) enzyme and the gene behind it as a candidate one was used for early screening of promising recombinants in Marker Assisted Breeding of mulberry. A set of three genotypes of mulberry, comprising of male (V1), female (Kajli-OP), selected F₁ hybrid (Gen1); and fifty randomly selected recombinant lines of a mulberry breeding programme were the study materials. NR enzyme activity revealed unique trend throughout different time points of day/night in both the parents as well as the selected hybrid. While looking for the gene behind this unique enzyme, the photo regulatory nature of its expression was also evident. Its rise in expression was contrary to the enzymatic peak attainment as during evening to night NR gene showed maximum expression while it was low during day time. The trend of normal distribution of NR activity and biomass yield data is comparable. Isolation of full length NR gene both from the parents and hybrid taking the cue from partial coding sequence obtained in this study will lead to SNP identification. This will be helpful for candidate gene based marker development in mulberry.

Identification of developmental stage specific proteins during *in vitro* morphogenesis of Pineapple and Vanilla:

Pineapple is an important fruit crop while the orchid *Vanilla* is in high demand for flavouring compound vanillin. This necessitates *in vitro* mass propagation of these two plants. Establishment of reproducible *in vitro* protocols has led to consequent endeavor to identify development stage specific proteins through two-dimensional gel electrophoresis (2-DGE) - based proteomic approach. In case of pineapple the developmental stages were meristem,



meristem derived regenerating callus and leaves of regenerating plantlets; while in case of Vanilla the developmental stages were nodes, node derived regenerating callus and leaves of regenerating plantlets. Selected protein spots after PMF and MS-MS analysis revealed mostly photosynthesis related proteins (viz. Oxygen-evolving enhancer protein 1, Phospho-2-dehydro-3-deoxyheptonate aldolase 1_chloroplastic) and development related proteins (Scarecrow-like protein 28, Peroxidase 10) in pineapple; while in case of Vanilla the significant hits were Light-independent protochlorophyllide reductase subunit B and Photosystem II reaction center protein L.

Publications:

1. Arora V, Ghosh MK, Ghosh PK, Kumar SN and Gangopadhyay G (2015) Molecular markers to assess the hybrid nature of an improved mulberry genotype. Journal of Plant Science and Research, 2(1): 116 (5 pages).
2. Arora V, Ghosh MK, Bindroo BB and Gangopadhyay G (2014) Phenomic analyses of indigenous and exotic accessions of Mulberry (*Morus* spp.). International Research Journal of Biological Sciences, 3 (7): 40-48.
3. Prasad R and Gangopadhyay G (2014) Selection of prospective parents among Indian and exotic Sesame (*Sesamum indicum* L.) for marker assisted breeding. Indian Journal of Genetics, 74(2): 197-204.
4. Prasad R, Mukherjee KK and Gangopadhyay G (2013*) Image analysis based on seed phenomics in Sesame. Plant Breeding and Seed Science, 68: 119-136. (DOI: 10.2478/v10129-011-0085-z) * (published on September 2014)

GenBank Submissions:

1. Arora V, Ghosh MK and Gangopadhyay G (2014) *Morus alba* cultivar GEN 1 chalcone synthase gene, partial cds. GenBank Accession KM210515.
2. Arora V, Ghosh MK and Gangopadhyay G (2014) *Morus alba* cultivar GEN 1 chalcone synthase mRNA, partial cds. GenBank Accession KM210516.
3. Arora V, Ghosh MK and Gangopadhyay G (2014) *Morus alba* cultivar KAJLI OP chalcone synthase mRNA, partial cds. GenBank Accession KM210517.
4. Arora V, Ghosh MK and Gangopadhyay G (2014) *Morus alba* cultivar MI-0008 chalcone synthase mRNA, partial cds. GenBank Accession KM210518.
5. Arora V, Ghosh MK and Gangopadhyay G (2014) *Morus alba* cultivar MI-0008 ppr protein mRNA, partial cds. GenBank Accession KM210519.
6. Arora V, Ghosh MK and Gangopadhyay G (2014) *Morus alba* cultivar KAJLI OP ppr protein mRNA, partial cds. GenBank Accession KM210520.

Participation in Conferences / Symposia / Workshops & Invited Talks Delivered at Various Organizations

- (i) acted as the Resource person of Plant Science in the North-Eastern States Students' Training on Basic Science 2014 (NESST-BASE 2014) at Mayapuri Campus of Bose Institute, Darjeeling

from 26th May –28th May 2014. Compiled and prepared the booklet for the trainees (ii) participated in One-day Symposium on "Science Education: Past Present and Future" organized by Science Communicators Forum (SCF), Kolkata on 20th September 2014 held at Meghnad Saha Auditorium, Rashbehari Siksha Prangan CU (iii) participated in the National Symposium on "Environmental impact on Biodiversity and Plant Development" organized by Department of Biological Sciences, Presidency University, Kolkata on 19.02.2015 (iv) acted as one of the mentors in the DST-INSPIRE Internship Science Camp 2014 for school students on 23.04.2014 organized by JBNSTS (Jagadis Bose National Science Talent Search), Kolkata; delivered a hand on demonstrative lecture on Plant Life Processes (v) invited and acted as a counselor in the Directorate of Distance Education Programme of Vidyasagar University at Jogomaya Devi College P.G. Study Centre in the month of June 2014 (taken three theoretical classes in the Personal Contact Programme) (vi) invited and participated in a live talk show in DD Bangla on career prospects of allied sciences like Biotechnology, Microbiology, Genetics etc. on 03.08.2014 at 10:00 am. (vii) delivered an invited lecture on "Crop improvement by traditional and new techniques: the importance of conservation and sustainable use of genetic diversity" at Mahadevananda Mahavidyalaya, Barrackpore, WB on 7th January 2015. (viii) invited to deliver the 24th Foundation day lecture of Vivekananda Institute of Biotechnology on 18th January 2015 at Nimpith Ramkrishna Ashram, WB: Title of talk "Phenomics assisted Molecular Breeding: Towards Second Green Revolution".

Dr. Anupama Ghosh, DST-Inspire Faculty

Scientific Reports:

Survival strategies of corn smut fungus *Ustilago maydis* during host colonization:

Ustilago maydis is a biotrophic fungus that infects *Zea mays*. During host colonization the fungus is exposed to a number of plant defense responses like for instance elevated levels of reactive oxygen species (ROS) in the vicinity of the invasion site. Depending upon the compatibility of the pathogen and the host strain this ROS stimuli can either initiate a cell death response in the pathogen or could be overcome by the defense response of the pathogen itself. In this project we are engaged in dissecting these survival and death pathways of *Ustilago maydis* during a compatible and incompatible interaction with the host plant *Zea mays*. Our current focus is on the metacaspase gene of the pathogen. Metacaspases have been previously shown to be key executioners of caspase independent cell death in many different fungi and other lower eukaryotes. Through generation of metacaspase deletion mutants of *U. maydis*, we found that *U. maydis* metacaspase, UmMca is an exception to this rule. Our data showed that UmMca plays a significant role in aiding the cell to get rid of insoluble intracellular protein aggregates that accumulate during various stress conditions. Besides, we could also show a significant contribution of a group of three small heat shock proteins namely HSP12, 20 and 30 in the pathogenicity of the fungus.

**Functional characterization of *U. maydis* effector proteins:**

In this project we are engaged in investigating the functions of different groups of secreted effector proteins of *Ustilago maydis* in the context of their role in manipulating host defense responses. Currently we are focusing on the ribonucleases. Our data showed a differential expression pattern of all the six different genes studied over a period of 12 days post infection when compared to the axenic culture. The increased expression pattern of these nucleases during pathogenic invasion of the host tissue that is *Zea mays* indicates their probable role in the virulence of the pathogen. Currently we are planning and beginning to execute generation of the deletion mutants of respective genes to study their effect on *U. maydis* pathogenesis.

A proteomic approach to explore the host pathogen interface of rice and *Rhizoctonia solani* interaction: in collaboration with Dr. Sampa Das

This project is aimed to study the proteome of the apoplastic fluid from rice either infected with *Rhizoctonia solani* or uninfected. Through this study we are planning to investigate both the secretome of *R. solani* during host invasion as well as plant defense proteins. The method of isolation of the apoplastic fluid is standardized however experiments are ongoing to optimize the conditions for 2-dimensional separation of the extracted proteome.

Publication:

1. Ghosh A (2014) Small heat shock proteins (HSP12, HSP20 and HSP30) play a role in *Ustilago maydis* pathogenesis. *FEMS Microbiology Letters*, Sep 22; doi: 10.1111/1574-6968.12605.

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
Survival strategies of the corn smut fungus <i>Ustilago maydis</i> during host colonization (starting date: 10.10.2013)	DST-INSPIRE Faculty Scheme

Dr. T. K. Ghose, Professor**Scientific Reports****1. Genetic Diversity Analysis of Rice Landraces of West Bengal**

- In relation to bacterial leaf blight resistance we are now working on the inherent genetic diversity of the rice copper transporter genes (COPT genes), Xa13 gene, xa13 and its promoter. We have also disease phenotyped a set of rice landraces for BLB disease and are trying to associate the alleles with the disease phenotype
- A genetic diversity analysis of aroma genes of prominent aromatic and basmati landraces is also in process. The aroma phenotype has been scored for a set of aromatic rice landraces and allele phenotype association is in progress

2. Correlating the various alleles of the BLB resistant genes with disease phenotype

- SEM of BLB disease infected leaves were done for observing the xylem anatomy variation in different rice landraces.
- Genetic diversity analysis of the conserved motifs of 6 BLB resistance genes of a set of rice landraces were done using PCR based methods.
- Sequencing of the alleles were done.

Publications:

1. Das B, Sengupta S, Prasad M, Ghose TK. 2014. Genetic diversity of the conserved motifs of six bacterial leaf blight resistance genes in a set of rice landraces: BMC Genetics 15:82. (Highly accessed).
2. Sengupta S, Das B, Acharyya P, Prasad M, Ghose TK 2014. Genetic diversity analysis in a set of Caricaceae accessions using resistance gene analogues; BMC Genetics 15:137.

Dr. Swati Gupta Bhattacharya, Senior Professor**Scientific Reports:****Studies on airborne allergenic pollen grains and spores: Biochemical, clinical and molecular approach:**

Airborne fungal spore monitoring unearthed Ascospores, *Periconia* sp., *Fusarium lateritium* from Kolkata (Urban site); *Aspergillus ochraceus* from Barrackpore (Industrial area) and *Curvularia* sp from rice fields(rural area) as most dominant fungal species. Questionnaire survey and patients' hospitalization data collections were also done and these records were found to show positively correlated with spore load in these areas.

Using immunoproteomics techniques IgE reactive proteins such as glycosyl hydrolase from *Aspergillus oryzae*, Glyceraldehyde-3-phosphate dehydrogenase from *Fusarium lateritium*, thaumatin like protein from *Lantana camara* were newly identified. Glycan moiety of Pectate lyase, a major allergen from *Helianthus* pollen grains was found to be responsible for IgE binding and was purified by chromatographic methods. Extensive peptide *De novo* sequencing and homology based protein identification has been described in identifying allergens from Cocos pollen, *Lantana* pollen and *Curvularia pallescens* a common Fungal spore.

Gene encoding vicilin like protein, the major allergen from coconut pollen has been sequenced. Computationally predicted IgE binding epitopes have been synthesized and their allergenic potency was tested. Attempts are being made to clone it and express in E coli.

Characterization and identification IgE epitopes of an aspartic protease allergen (Rhi o 1) from the airborne fungal pathogen *Rhizopus oryzae* was done. Currently we are working on development of hypoallergenic vaccine development for cyclophilin pan-allergens.

**Publications:**

1. Sircar G, Saha B, Jana T, Dasgupta A, Gupta Bhattacharya S and Saha S (2015) DAAB: a manually curated database of allergy and asthma biomarkers. *Clinical & Experimental Allergy* (John Wiley & Sons Ltd), 45: 1259–1261 Impact factor-4.32.
2. Ghosal K, Pandey N and Gupta Bhattacharya S (2015) Biomonitoring of Pollen Grains of a River Bank Suburban City, Konnagar, Calcutta, India And Its Link And Impact On Local People. *Annals of Agriculture and Environmental Medicine* (Poland), 22(2): 236-242. Impact factor-3.06.
3. Dey D, Ghosh N, Pandey N & Gupta Bhattacharya S (2014) A Hospital-Based Survey on Food Allergy in the Population of Kolkata, India. *International archives of allergy and immunology*, (Karger Publ. Switzerland) 164(3): 218-221. Impact factor-2.673.
4. Ghosh D, Mueller G A, Schramm G, Edwards L L, Petersen A, London R E and Bhattacharya S G (2014) Primary identification, biochemical characterization, and immunologic properties of the allergenic pollen cyclophilin Cat r 1. *Journal of Biological Chemistry* (ASBMB, USA), 289(31):21374-21385. Impact factor-4.6.

GenBank Submissions:

1. Sircar G and Gupta Bhattacharya S (2014) *Rhizopus oryzae* aspartyl endopeptidase mRNA, complete cds. GenBank Accession KM459700 and KM45969.

Participation in Conferences / Symposia / Workshops & Invited Talks Delivered at Various Organizations

(i) **Dr. Swati Gupta Bhattacharya** participated in the National Symposium on Evolving Plant Biology: From Chromosome to Genomics (27th -29th November, 2014) at Kolkata and International Conference on Informatics and Integrative Biology (17th -19th December, 2014) at Kolkata.

Group members:

- (a) Bodhisattwa Saha (i) attended 6th Annual Congress of Proteomics Society of India (7th – 9th December, 2014) at Mumbai to give Poster presentation. He received best scientific essay writing and artwork award consisting of 200 Euros book grant from Springer at the conference (ii) presented poster at the “Proteomic Forum 2015” (22-25th March 2015) at Technical University of Berlin, Germany and received a travel grant award from the German Society for Proteome Research
- (b) Gaurab Sircar (i) attended 102nd Indian Science Congress (3rd – 7th January, 2015) at Mumbai to give oral presentation and nominated for Young Scientist Award (ii) attended 6th Annual Congress of Proteomics Society of India (7th – 9th December, 2014) at Mumbai to give Poster presentation
- (c) Debarati Dey (i) attended BSACI Annual Meeting (28th – 30th September, 2014) at Telford, UK to give Poster presentation and awarded with DBT travel grant (ii) attended 102nd Indian Science Congress (3rd – 7th January, 2015) at Mumbai to give oral presentation.

- (d) Nandini Ghosh (i) attended Annual Congress of EAACI (7th – 11th June 2014) at Copenhagen, Denmark to give Poster presentation in thematic poster session and JMA poster session. She was awarded with best abstract prize in both the session (200 Euro cash in each session) and also selected among 100 travel grant winners all over the world to attend the conference (ii) attended ICAICON 2014 (11th – 14th December 2014) at Mysore, Karnataka, India to give oral presentation.
- (e) Koyel SenGupta and Bijoya Karmakar (i) attended 102nd Indian Science Congress (3rd – 7th January, 2015) at Mumbai to give Poster presentation.
- (f) Bodhisattwa Saha, Gaurab Sircar, Debarati Dey, Nandini Ghosh, Koyel SenGupta, Bijoya Karmakar and Anubhab Laha (i) participated in National Symposium on Evolving Plant Biology: From Chromosome to Genomics (27th -29th November, 2014) at Kolkata.
- (g) Gaurab Sircar, Nandini Ghosh, Sangeeta Roy, Koyel SenGupta and Anubhab Laha (i) participated in 23rd S. M. Sircar Conference of Plant Physiology Forum (4th April, 2014) at Bose Institute, Kolkata.
- (h) Nandini Ghosh, Sangeeta Roy and Anubhab Laha (i) participated in International Conference on Informatics and Integrative Biology (17th -19th December, 2014) at Kolkata.

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
Diagnosis of mold allergy among inhabitants of urban and rural peoples of the gangetic plane of west Bengal through aerobiological and immunochemical studies. with Dr.T.K. Ghose (Co-PI)	CSIR
Studies on mould spore diversity as environmental allergen in outdoor and indoor environments of urban and rural areas of Agartala, Tripura. with Dr. Sudipto Saha (PI)	DBT
Systematic discovery of biomarkers of asthma caused by common environmental allergens using human plasma proteomics, cytokine profiling and network biology – a systems approach to drug discovery.	ICMR

GenBank Submissions:

Sircar G and Gupta Bhattacharya S (2014) *Rhizopus oryzae* aspartyl endopeptidase mRNA, complete cds. GenBank Accession KM459700 and KM45969.

Dr. Pallob Kundu, Associate Professor

Scientific Reports:**Genome-wide analysis of Alternaria stress-responsive microRNAs and their targets in tomato:**

MicroRNAs are crucial regulator of reprogramming of gene expression cascade during plant-pathogen interaction. We have used tomato (Pusa Ruby) plant and early blight pathogen,



Alternaria solani for the analysis of miRNA and transcriptome expression profiles in a compatible interaction. Next generation sequencing (NGS) technique based whole transcriptome analysis revealed that, (i) a total of 224 known miRNAs, ranging from 18nt to 24nt expressed in tomato, which belonged to 126 miRNA families, (ii) both conserved and Solanaceae specific miRNAs were differentially expressed, and (iii) 2944 genes expression was varied. Most of the miRNAs were down-regulated, and 13 miRNAs were highly differentially regulated ($\log_2FC \geq 3$). Furthermore, using stringent selection criteria we could detect 74 putative novel miRNAs. GO terms enrichment and KEGG pathway analyses of predicted targets of differentially expressed miRNAs, as well as transcriptome, indicated that genes of plant-pathogen interaction and plant hormone signal transduction pathways were mostly affected by these miRNAs. We have also found that five different miRNAs targeting ~37% of tomato NB-LRR genes. Individual miRNA and target interaction are being studied to understand the importance of this interaction in disease biology.

Analysis of signalling mechanism that leads to the regulation of miR-genes under biotic and environmental cues:

Analysis of the promoter region of the miR167 gene, one of the highly expressed conserved miRNAs, indicated that biotic stress related cis-elements have an important role in transcriptional regulation of miR167. Spatio-temporal regulation of miR gene promoter investigated in transgenic plants developed with miR167 promoter-GUS reporter gene. Specific role of biotic stress related cis-elements are analyzed.

Studies on molecular signalling associated with disease symptom manifestation:

Tomato leaf curl disease, caused by geminiviruses, symptom resembles developmental defects. We hypothesized that symptoms were due to long-term alteration of expression of development related gene(s). Our results show, in infected plants TORNADO1 (SITRN1), a gene important for leaf cell expansion and venation formation, transcript level increased significantly. We investigated mechanism of regulation of TRN1 gene during viral infection. Our analysis showed that TRN1 preferentially overexpressed from one of the two promoters and a W-box element in the promoter is crucial for the regulation. Further analyses confirmed that a plant stress specific transcription factor, WRKY16, preferentially interact with one of the W-boxes to promote TRN1 transcription during infection. Subsequent experiments suggested that regulation of salicylic acid pathway during the biotic stress response mediate differential expression of the WRKY16 transcription factor, which in turn influence the expression level of TRN1. This study unraveled a novel mechanism for developmental gene regulation during plant stress-response, which might influence symptom development in infected plants.

Understanding the membrane mediated signalling during disease initiation:

The role of membrane bound transcription factors (MTFs) in transmission of stress signals is investigated. In genome wide analysis all NAC transcription factors in tomato have been identified, and among these, 13 have transmembrane domain (hence called SINAC MTF). These SINAC MTFs have been characterized using bioinformatic tools and biochemical analyses, and their expressions in normal tomato plants have been confirmed. Interestingly, SINAC MTFs are differentially expressed based on the type of stimuli they have been exposed to, including

fungal, bacterial and viral biotic stresses to tomato plants. To investigate significance of differentially expressed SINACMTFs in biotic stress response, two of these SINAC MTFs were cloned and characterized. Efficient membrane localization has been observed. A C-terminal deleted version of SINAC MTF3 interacted with a NAC binding site (NCBS) and showed transcriptional regulatory function. Putative NCBSs were also detected in the promoter region of biotic-stress responsive SINACMTFs, indicating auto regulation of these genes may take place during stress. Detailed analyses on mechanism of these MTFs' membrane release during stress signalling are in progress.

Publications:

1. Kundu P, Li M, Lu R, E Stefani, L Toro (2015) Regulation of transcriptional activation function of rat estrogen receptor α (ER α) by novel C-terminal splice inserts. *Mol Cell Endocrinol.*, Feb 5; 401:202-12.
2. Datta A, Ghosh A, Airolidi C, Sperandeo P, Mroue KH, Jiménez-Barbero J, Kundu P, Ramamoorthy A, Bhunia A (2015) Antimicrobial peptides: Insights into membrane permeabilization, lipopolysaccharide fragmentation and application in plant disease control. *Sci Rep.*, Jul 6; 5:11951.

Grants-In-Aid Schemes:

Title of the Scheme	Schemes funded by
with Dr. Sampa Das : Co PI Regulation of microRNA transcription and biogenesis by fungal-stress in tomato	DBT
with PI: Prof. D.N.SenGupta, CoPI: Pallob Kundu : Functional analysis of the DNA polymerase lambda gene and the protein from indica rice cultivars	DST, SERB
Exploring membrane-associated NAC-transcription factors (NAC MTFs) in tomato to apprehend membrane-mediated signaling during pathogenesis	CSIR

Participation in Conferences / Symposia / Workshops & Invited Talks Delivered at Various Organizations

Group members:

- (a) Deepti Sarkar, Jayanti Jodder, Sayani Dey, Ranjan Kumar Maji, Arijita Sarkar, Zhumur Ghosh, Pallob Kundu presented on (i) Expression and transcriptional regulation of microRNAs during *Alternaria* stress in tomato at the Conference on Informatics & Integrative Biology (CIIB-2014), December 17 - 19, 2014 Organized by Bioinformatics Center, Bose Institute, Kolkata.
- (b) Deepti Sarkar, Sayani Dey, Ranjan Kumar Maji, Zhumur Ghosh and Pallob Kundu presented on (i) Identification of key regulators of *Alternaria*-stress response in tomato by



whole transcriptome analysis at the symposium on Evolving Plant Biology: From Chromosomes to Genomics, 27th -29th November, 2014, Organized by Bose Institute, Kolkata, University of Kolkata, West Bengal Academy of Science and Technology and The Ramakrishna Mission Institute of Culture.

- (c) Payel Bhattacharya and Pallob Kundu presented on (i) Stress responsive membrane-bound NAC transcription factors in tomato at the symposium on Evolving Plant Biology: From Chromosomes to Genomics, 27th -29th November, 2014, Organized by Bose Institute, Kolkata, University of Kolkata, West Bengal Academy of Science and Technology and The Ramakrishna Mission Institute of Culture.
- (d) Jayanti Jodder, Deepti Sarkar, Rohit Das and Pallob Kundu presented on (i) Understanding the complex regulation of miR167 and its target genes' expression under patho-physiological changes in tomato at the symposium on Evolving Plant Biology: From Chromosomes to Genomics, 27th -29th November, 2014, Organized by Bose Institute, Kolkata, University of Kolkata, West Bengal Academy of Science and Technology and The Ramakrishna Mission Institute of Culture.
- (e) Arunava Mandal, Deepti Sarkar and Pallob Kundu presented on (i) Mechanism of a virus stress-induced regulation of a leaf developmental gene expression in tomato: significance in disease symptom manifestation. At the symposium on Environmental Impact on Biodiversity and Plant Development, Department of Biological Sciences, Presidency University, Kolkata, 19th-20th February, 2015.

Dr. A.N. Lahiri Majumder, Raja Ramanna Fellow, DAE

Scientific Reports:

Abiotic stress regulation in plants:

A. Abiotic stress regulated expression of Galactinol Synthase genes in rice

Galactinol Synthase (GolS), the first committed enzyme in Raffinose Family Oligosacchride (RFO) synthesis pathway produces galactinol from UDP-glucose and inositol. The two isoforms of *Oryza sativa* GolS genes, located on Chromosome 3 (*GolS1*) and chromosome 7 (*GolS2*) are interspersed by conserved introns with premature termination codons (PTC). A non-canonical regulation mechanism, controlling the splicing and maturation of both the *OsGolS* isoforms and linked to abiotic stress conditions have been identified. This regulatory circuit may contribute to the adaptation of plants to stress and phloem loading as suggested by the biological role of galactinol in green tissue.

B. Comparative analysis of cis elements of *Ino1* genes from *Oryza* and *Porteresia*

An analysis of the upstream elements of the *Ino1* gene(s) of *Oryza* and *Porteresia* revealed presence of a number of abiotic stress related sequences. Several deletion mutants have been

constructed and their potential function for induction of stress tolerance *in vivo* in *Arabidopsis* have been assessed through GUS transient assay.

C. Genome-wide screening for abiotic stress markers in rice landraces

A large number of rice landraces, obtained from several ecological areas have been screened for their agronomic characters and growth under different abiotic stress conditions. Analysis of their root growth character revealed interesting overlap between salinity and mechanical stress factors. Commonality between the two phenomena was also obvious in the transcriptome analysis of the root parts undergoing both stress factors. *Pclno1* like abiotic stress markers are being looked for in these germplasms.

D. Generation of transgenic salt-tolerant rice plants

Homozygous salt-tolerant transgenic IR64 rice lines have been generated with introgression of *PcINO1*, *PcIMT1*, a combination of the two genes and with introgression of a chloroplast Fructose-1,6-bisphosphatase (*PcCFR*) gene. The transgenic plants (T3) have been characterized by molecular analysis and physiological experiments.

Publication:

1. Sengupta S and Majumder A L (2014) Physiological and genomic basis of mechanical-functional trade-off in plant vasculature, *Front. Plant Sci.*, 5, 1-18., doi: 10.3389/fpls.2014.00224 [IF:3.6].

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
Inositol metabolism in relation to abiotic stress in plants : Molecular & transgenic approach	DAE
Generation of salt-tolerant rice plants:A translational approach. Prof. A. N. Lahiri Majumder (Co-ordinator and PI Project No.-I &II) Prof. D. N. Sengupta (PI Project No.-III) Dr. Shubho Chaudhuri (PI Project No.-IV)	DBT

Students Awarded Ph.D.:

Name of Student (University/Year)	Title of Thesis
Ms Sritama Mukherjee (C.U. 2014)	Inositol metabolic pathways in relation to salt-tolerance in plants : A molecular and transgenic approach

Symposia and Seminar Organized:

Served as the Organizing Secretary for the National symposium entitled "Evolving Plant Biology : From Chromosomes to Genomics" during November 27-November 29, 2014 organized by the West Bengal Academy of Science & Technology in collaboration with Bose Institute , University of Calcutta and the Ramkrishna Mission Institute of Culture.



Dr. Sonali Sengupta, Staff Scientist-DBT & DST Fast Track Young Scientist

Scientific Reports:

Overlap between Salt and Mechanical stress response: evaluating plant smartness

Characterization of the *Mimosa pudica* touch-sensory network is under progress using actin pull down assay followed by proteomic analysis. A network prediction has been made which suggests possible cytoskeleton rearrangements during bending of the pulvini upon the touch stimulus.

Understanding the nature of cross-talk between abiotic stresses with special reference to salt, drought and mechanical stress is being investigated. Transcriptome and phenome analysis helped developing a scoring method for the plant's inherent resilience towards stress. Following such scoring method, screening of various rice genotypes are now attempted for evaluating their adaptability towards stress.

Publications:

1. Sengupta S and Majumder A L (2014) Physiological and genomic basis of mechanical-functional trade-off in plant vasculature, *Front. Plant Sci.*, 5, 1-18., doi: 10.3389/fpls.2014.00224 [IF:3.6].
2. Sengupta S. (2014) The Possible Overlap Between Salinity and Mechanical Challenges in *Porteresia coarctata*, *Proc Indian Natn Sci Acad* 80 (5), 1013-1023. [Invited article as INSA Young Scientist Medal Awardee]

Participation in Conferences / Symposia / Workshops & Invited Talks Delivered at Various Organizations

- (i) Delivered invited talk in the National symposium on "Evolving Plant Biology : From Chromosomes to Genomics" organized by West Bengal Academy of Science & Technology in collaboration of Bose Institute, Calcutta University & Ramkrishna Mission Institute of Culture; Nov-27-29, 2014
- (ii) Delivered an invited talk on "Understanding Intelligence in Plants: Acharya J.C. Bose and Beyond", at JBNSTS on the occasion of National Science Day- 2015 Celebration on February 28, 2015, organized by JBNSTS and INSA.

Presentation with Group Members:

- (i) Delivered talk on "Overlapping molecular physiology of salinity and mechanical stress responses in rice root: are plants smart enough to make choices?" at the Gordon Research Conference, Salt and water Stress in plants, Aug 3-8, 2014, Newry ME, USA. Group members include Sonali Sengupta, Sanghamitra Adak, Arindam Ray and Arun Lahiri Majumder.
- (ii) Sonali Sengupta, Sanghamitra Adak, Arindam Ray, Abhishek Mukherjee and Arun Lahiri Majumder participated in American Society of Plant Biology meeting at Minneapolis, USA, July 26-30, 2015 and presented a paper on "An integrated approach to model the command center in plant root tip: re-evaluation of Darwin's Root-Brain hypothesis".

Dr. Amita Pal, CSIR-Emeritus Scientist

Scientific Reports:

MicroRNA expression profile of *Vigna mungo* resistant inbred line during compatible and incompatible interactions with Mungbean Yellow Mosaic India Virus:

Role of different miRNAs during incompatible interaction between Mungbean Yellow Mosaic India Virus (MYMIV) and MYMIV-resistant RIL of *Vigna mungo* VM-84 was investigated. Two small RNA libraries were prepared using high throughput Illumina sequencing from the leaves of MYMIV-challenged and mock-inoculated plants. Sequencing followed by *in silico* analysis of the small RNA (20-24 nucleotides) reads revealed variations in expression profile of both conserved miRNAs, viz. miR156, miR159, miR160, miR162, miR164, miR166, miR319 and in novel miRNA7 during plant virus interaction, and were validated using qRT-PCR. Different important target transcripts like zinc finger, CCAAT-box transcription factor, fructose 2-6 biphosphate, HDZIP protein were identified and reported first time as potent *V. mungo* miRNA targets.

Molecular characterization of a stress responsive *Vigna mungo* MAP Kinase and its promoter: in collaboration with Dr. Shubho Chaudhuri

Plants employ a cascade of signaling events in response to pathogenic attack. MAP Kinases are one such key signaling molecule that plays a primary role in sensing probable attack of MYMIV and protecting blackgram plants against the pathogens modulating defense responses. Expression analysis of VmMAPK from MYMIV challenged leaves revealed its maximum expression at early time point. The full length VmMAPK cDNA (1380 bp) was obtained by RLM RACE. VmMAPK was cloned in expression vector pET32a and purified. Biochemical analyses of the protein indicate autophosphorylation activity and the myelin basic protein phosphorylation. The kinase has differential affinity for divalent cations; optimum activity at pH 7 and optimum temperature of 42°C. The promoter of VmMAPK was isolated and *in silico* analysis predicts the presence of stress responsive elements like W-box, ethylene responsive and TCA elements.

Publications:

1. Kundu A, Patel A, Paul S and Pal A (2015) Transcript dynamics at early stages of molecular interactions of MYMIV with resistant and susceptible genotypes of the leguminous host, *Vigna mungo*. *PLOS One* DOI:10.1371/journal.pone.0124687.
2. Paul S, Kundu A and Pal A (2015). Extraction of small RNA and qPCR validation of miRNAs in *Vigna mungo*. *Bio-protocol* 5(5): e1417. <http://www.bio-protocol.org/e1417>.
3. Maiti S, Patra S, Pal A and Dey N (2015) Identification of a novel salicylic acid inducible endogenous plant promoter regulating expression of CYR1, a CC-NB-LRR type candidate disease resistance gene in *Vigna mungo*. *Plant Cell Tissue Organ culture* 120:489-505; DOI 10.1007/s11240-014-0616-z.

**Book Chapter:**

1. Pal A and Ghosh B (2014) Plant Morphogenesis Somatic Embryogenesis. In: History of Science in India (Ed. Sharma AK, Paria N, Das MN and Sen Sharma P) Vol.IV, Part I (Plant Science) pp. 328-360.
2. Maiti S, Basak J and Pal A (2014) Current understanding on plant R-genes/proteins and mechanisms of defense responses against biotic stresses. In: Review of Plant Pathology, Ed. B. N. Chakraborty and U. Chakraborty, Vol 6, Scientific Publishers (India), Jodhpur, ISBN: 978-81-7233-916-6 pgs.93-126. DOI: 10.13140/2.1.2098.5607.

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
Understanding molecular mechanism of MYMIV-resistance in <i>Vigna mungo</i> through genomic approach	CSIR
As Co-PI Identification and functional characterization of genes regulating unique flowering behavior in tree bamboo	CSIR

Participation in Conferences / Symposia / Workshops & Invited Talks Delivered at Various Organizations

- (i) gave the valedictory talk on "Emerging Techniques in Genomics" in the workshop on Basic techniques of Molecular Biology, held in the Department of Botany, University of Calcutta on 21st May, 2014.

Dr. Amita Pal's group members :

- (a) Anirban Kundu, Anju Patel, Subrata Kundu, Dipjyoti Chakraborty, Sujay Paul and Amita Pal (i) presented posters on "Biology of MYMIV-Vigna Interactions: Insights from the omics data analysis", and
- (b) Prasun Biswas, Nazma Anjum, Amita Pal and Malay Das (ii) presented posters on "Why does it take so long for bamboo to flower?" in the National Symposium on "Evolving Plant Biology: From Chromosomes to Genomics", organized by West Bengal Academy of Science and Technology on 27th to 29th November, 2014;
- (c) Prasun Biswas, Sukanya Chakraborty, Shrabasti Das. Amita Pal, Malay Das presented posters on "Identification and characterization of multiple copies of Flowering Locus T (FT) homologs in a rarely flowering tree *Bambusa tulda*." in the National Symposium on "Environmental impact on biodiversity and plant development", Sponsored by DBT builder, Department of Biological Sciences, Presidency University, Kolkata on 19th to 20th February, 2015.

Dr. Prabir Kumar Saha, Consultant Scientist**Scientific Reports:****Analysis of gene pool with reference to seeds:**

The work was carried out with fifty Indian sesame accessions (48 *Sesamum indicum* L. and two *S. mulayanum* Nair. Family: Pedaliaceae) having potential medical importance, were preliminarily categorized by using seed morphological characters. Hierarchical cluster analysis was performed by using seed morphological characters and representatives from each cluster were selected by using SRSWOR method. Thus, 24 accessions were selected for further diversity assessment. Wide variations in the agro-morphological characters among the accessions were also observed and confirmed by ANOVA for quantitative characters. The dendrogram obtained by using the same method as above. Total 11 representative accessions were selected for the further RAPD analyses. In RAPD analysis, nine primers showed high level of polymorphisms. The results of cluster analysis depicted that all the 11 accessions could be well distinguished by RAPD markers. These data collectively demonstrated large phenotypic and genotypic diversity among the selected Indian sesame genotypes that can be used as a valuable gene pool for sesame breeding program.

Publications:

1. Sarkar S and Saha P K (2014) An emerging scenario of Indian sesame seed research. *Sci. & Cult.* 80 (7-8), 217-226.
2. Chatterjee A, Sen M, Saha P K and Roy A (2014) Study of primary and secondary metabolites of *Nicotiana tabacum* L. in different combination of growth regulators. *J. Bot. Soc. Bengal* 68(2), 101-104.

Participation in Conferences / Symposia / Workshops & Invited Talks Delivered at Various Organizations

- (i) participated in the National Symposium on 'Evolving Plant Biology: From Chromosomes to Genomics'. Organized by West Bengal Academy of Science & Technology, in Collaboration with Bose Institute, Kolkata and The Ramkrishna Mission Institute of Culture, Kolkata held at Bose Institute and Ramkrishna Mission, Kolkata during 27-29 November, 2014; (ii) participated in the National Symposium on 'Plant Diversity: structure, Function, Utilization and Conservation' organized by Botanical Society of Bengal held at Department of Botany, University of Calcutta during 4-6 December, 2014; (iii) delivered invited lecture entitled- "Perspective of Indian Sesame (*Sesamum indicum* L. and *S. mulayanum* Nair.)" in the 102nd Indian Science Congress held in University of Mumbai, Mumbai during 3rd to 7th January, 2015; (iv) participated, Chaired a Session and presented a paper entitles 'Study of primary and secondary metabolites of *Nicotiana tabacum* L. in different combination of growth regulators' in the National Seminar on Contemporary progress in plant sciences held in Department of Botany, University of Burdwan, Burdwan during 20-21 March, 2015.



Dr. Dibyendu Narayan Sengupta, Honorary Scientist

Scientific Reports:

Progress in the studies on Gene expression in indica rice cultivars and towards overexpression of genes in rice plants :

In our running DBT, GOI, sanctioned project on overexpression of the enzyme Samdecarboxylase (SamDC) to over produce spermidine (3+) and spermine (4+) for protection of the membrane damage due to the abiotic stress like dehydration and salinity stress, the rice cDNA was introduced into IR64 rice cultivar and several lines of putative transgenic rice plants were developed, many of them are now in T2 stage and showed tolerance to the Hygromycin. Presence of transgenes have been detected by Southern blot analysis from few of them. We are going to identify the site of integration after we detect the expression of the transgene SamDC. So far we have generated 25 of transgenics in T2 generation. The *E.coli* expressed recombinant SamDC protein was used to generate polyclonal antibody and western blot analysis of the protein extracts from the lamina of transgenic rice plants were done. Enhanced level of SamDC was detected in several transgenic lines with respect to control. Now we are trying to get northern blot analysis and activity analysis of the SamDC enzyme in lamina and roots of the T3 homozygous lines.

Similarly we are trying to produce transgenic IR64 rice plants by introducing the rice cDNA for OsBZ8, ABA inducible transcription factor. After several attempts we have three different T0 lines of IR64 rice, raised after selection through resistance against Hygromycin (50 µg/ml) through tissue culture. The whole plants were transferred to soil in pots and recently their seeds have been harvested. From the T1 generation plants, genomic DNA will be prepared and genomic PCR of the transgenes like hygro and 35S:OsBZ8 will be done to detect the presence of the transgene in the transgenics. To obtain more of the putative transgenic, Agro infection experiments using the same construct DNA are going on with the scutellum derived callus cultures.

The ABA level in seeds, roots and leaves before and after salinity stress are going on and will be repeated next year also. In addition studies on expression of the genes for ABA biosynthesis like NCED, ABA aldehyde oxidase (AAO), and the catabolic gene like ABA 8 hydroxylase (ABA8Hydrox) are going on. The expression of SamDC1, SamDc2 genes were compared in roots and lamina of salt sensitive and salt tolerant rice cultivars simply by RT-PCR and difference within the cultivars were obtained. Real time PCR will be tried shortly. The cDNAs for 14-3-3 f and g have been amplified and their gene expression by RT-PCR has been detected. Here we, plan to study its association with nitrate reductase, sucrose phosphate synthase, and bZIP class of factor homologous to EmBP1, like OsBZ8.

Last year we have started DST-SERB sanctioned project on DNA Polymerase lambda gene and protein expression to study activity, and cloning of its cDNA from indica rice cultivars since the enzyme was found to be involved in DNA repairing. The expression of 67 kDa size DNA Pol lambda protein was found to be high in the freshly germinated seedlings and then in anthers. To

clone the cDNA for the Pol lambda all our effort previously were unsuccessful but now we have amplified the cDNA fragments from the 3' end and also from the 5' ends and one cDNA of 1097 bp, just missing the N-terminal or the 5' end 500 bp ORF. After cloning in TA vector and sequencing, we found homology with the japonica cultivar of rice. We hope to get the 5' end missing sequence by using new primers from the sequence of the indica rice cultivars. Now we are planning to overexpress the DNA Pol Lambda gene in *E.coli* to produce the antibody and also to check the expression of a few miRNA found to be reported by other group complementary to the ORF sequence from rice.

Publications:

1. Basu S, Roychoudhury A and Sengupta D N (2014) Identification of trans-acting factors regulating SamDC expression in *Oryza sativa*, *Biochemical and Biophysical Research Communication*, 445 (2014) 398-403.
2. Sihi S, Bakshi S and Sengupta D N (2015) Detection of DNA Polymerase Lambda activity during seed germination and enhancement after salinity stress and dehydration in the plumules of indica rice (*Oryza sativa* L.) *Indian Journal of Biochemistry & Biophysics*, Vol52 (1), February, pp 86-94.

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
With Dr. Pallob Kundu (Co-PI) Functional analysis of the DNA polymerase lambda gene and the protein from indica rice cultivars	DST, SERB
Generation of salt-tolerant rice plants: A translational approach. Prof. A. N. Lahiri Majumder (Co-ordinator and PI Project No.-I & II) Prof. D. N. Sengupta (PI Project No.-III) Dr. Shubho Chaudhuri (PI Project No.-IV)	DBT

Dr. Swati Sen Mandi, ICMR-Emeritus Medical Scientist

Scientific Reports:

Molecular Documentation and Bioprospecting of Medicinal Potential in Plants of Eastern and North Eastern India:

Dendrobium thyrsiflorum:

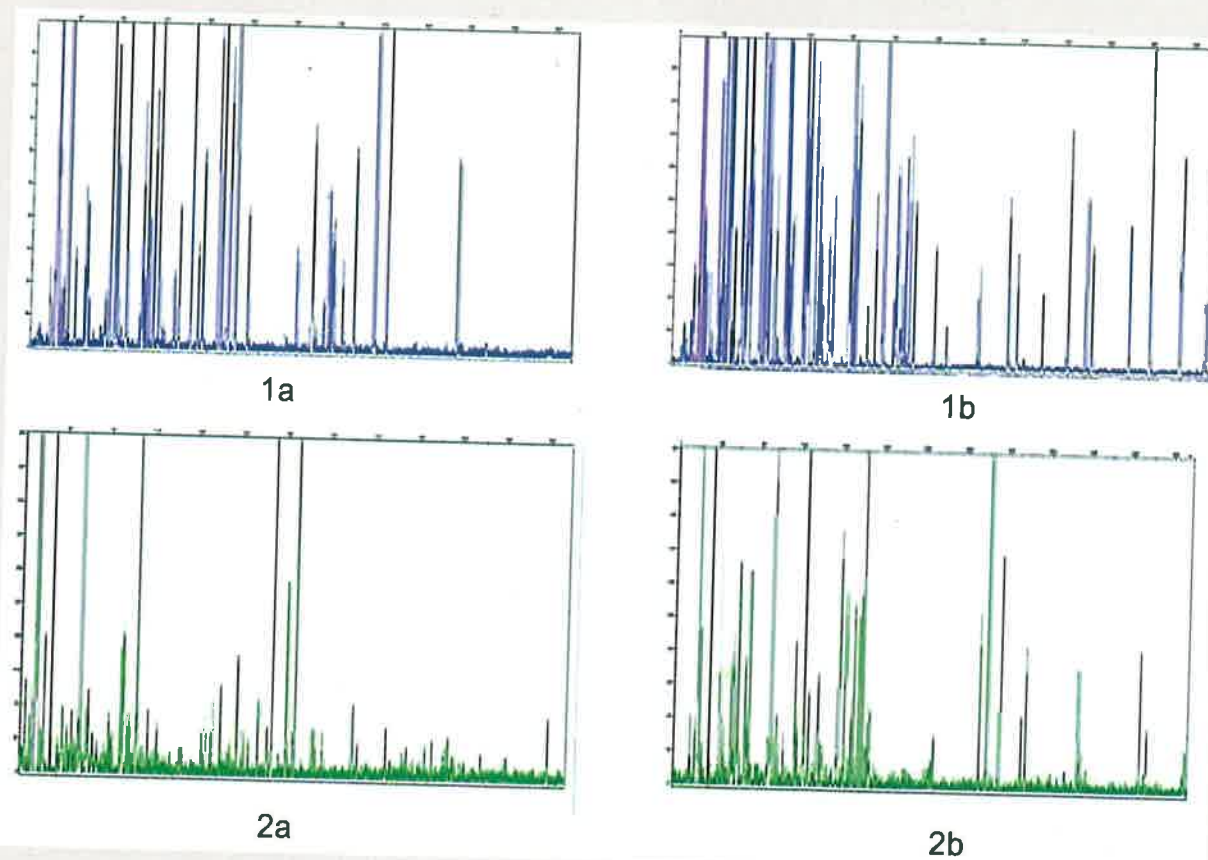
Dendrobium thyrsiflorum is an orchid species of immense pharmaceutical and horticultural importance. Our study on this species has enabled establishment of AFLP markers associated with biochemical traits in particular with the antioxidant activity of *D. thyrsiflorum*. Trait Related Markers (TRM) thus developed would be useful in Marker assisted selection (MAS) of elite land races and clonal propagation thereof for assisting commercial cultivation of this valuable orchid.



Sequencing and BLASTN analysis of the TRM would also help in identifying prospective genes associated with high antioxidant activity in these plants. Species specific AFLP Markers developed in these studies would also help in authentication of the prescribed plants for use of pharmaceutical industry in order to maintain efficacy of the drug extracted from each batch of vendor collected plants. Such studies would provide a scope for utilizing these important orchids in a wide range of commercial use.

Butea sp:

Palash (*Butea sp*) is used as tonic and anthelmintic in Ayurveda. Palash is considered anti-inflammatory, antimicrobial, antihelminthic, anti-diabetic, diuretic, analgesic, antitumor and astringent. Its leaves are astringent, diuretic and anti-ovulatory properties. In the present study species specific DNA markers have been identified for two species of *Butea* viz *Butea monosperma* and *Butea superba* through AFLP analysis. These markers will be useful for authenticating this medicinally useful drug plants for production of herbal medicines (of uniform efficacy in each batch).



DNA Fingerprinting chromatogram of two species of *Butea* (a- *Butea monosperma* and b- *Butea superba*) using two pair of primers (1 and 2) showing species specific peaks.
1. EcoRI ATG + MseI-CTC and 2- EcoRI ACA + MseI-CTG
X-Axis-Base pair of all eles, Y-Axis-Intensity of alleles

The large variation in AFLP pattern between 2 species of *Butea* with almost similar morphology, excepting flower colour, indicates the possibility of large variation in their biochemical /medicinal potential. Studying the variation in medicinal potential of these two studied species and exploring the molecular mechanism causing these variation would be a worthwhile proposition.

Bioprospecting of useful genes associated with trait related DNA marker:

In continuation of the DNA Fingerprinting studies correlated with compounds of medicinal potential found in plants, young researchers, particularly of NE Universities / Colleges visited this laboratory on several occasions for brief periods as a follow up of their training during earlier workshops. This year the young scientists were from Nagaland and Manipur. An important aspect of their study was learning to identify prospective gene through DNA sequencing and subsequent bioinformatic analysis of appropriate DNA markers.



**Publications :**

1. Ghosh S and Sen Mandi S (2015) SNP in Chalcone Synthase gene is associated with variation of 6-gingerol content in contrasting landraces of *Zingiber officinale*. *Roscoe; Gene* 566, 184–188.
2. Pal H, Ghosh S, Swati Sen Mandi S (2015).Molecular Authentication of Endangered Medicinal Plant *Panax assamicus* and *Panax bipinnatifidus* from North-East India by Species Specific AFLP Marker. *The Journal for Threatened Taxa. Photon* 113, 138-147.

Participation in Conferences / Symposia / Workshops & Invited Talks Delivered at Various Organizations:

(i) delivered an invited lecture in a National Seminar on Biodiversity on "Plant Biodiversity assessment using Species Specific and Trait Related DNA Markers" at St. Joseph's College, Jakhama, Kohima, Nagaland on 3rd October, 2014 (ii) delivered an invited lecture on "Integrated Approach to Medicinal Plant Research" at Dept of Physiology, University of Calcutta on 1st April, 2015.

Social Relevance of research performed at Bose Institute:

North East India with its vast repository of medicinal plants and associated traditional knowledge for use of these plants in folk medicine as well as in the Indian Traditional Systems of medicine combined with modern biotechnological research provide leads to developing Alternative System of medicine to the modern world thus constituting an area of study of social relevance worldwide.

In addition to conducting state-of-art research in authentication and evaluation of medicinal potential through genetic, biochemical and chemical analysis together with bioprospecting of medicinally important genes, this programme routinely holds Workshops and Hands-on-Training to young researchers countrywide with particular focus on North East India with an aim to Transferring Technology appropriately to laboratories of participating scientists.

Dr. Samir R. Sikdar, Senior Professor and Coordinator, Rural Biotechnology Programme

Scientific Reports:**Exploring *Rorippa indica* for development of aphid tolerant *Brassica juncea* lines through genomic and proteomic approaches:**

Mustard aphid - *Lipaphis erysimi* causes severe damage to the crop *Brassica juncea* leading to an eventual yield loss ranged from 35.4% to 91.3% per year. To understand the mechanism of aphid tolerance and interaction of *Rorippa indica*, an aphid tolerant wild crucifer against *L. erysimi*, cDNA amplified fragment length polymorphism (cDNA-AFLP) analysis was carried out. Two putative ESTs, one homologous to PDF1.2c- a defensin and the other HSP90 α - a nematode resistant gene from *Arabidopsis* has been selected for further study and its effect against *L. erysimi* by developing transgenic *B. juncea* lines. The full length genes corresponding to the ESTs have been isolated, cloned and successfully introduced into *B. juncea* cultivar. Details molecular analyses of the transgenic lines are under progress.

Alternatively, a proteomic study has also been initiated to identify the differential upregulated proteins in *R. indica* upon *L. erysimi* infestation using 2 D gel electrophoresis and MALDI-TOF based MS analysis. Till date, a total of 296 protein spots were detected and were found statistically significant. Out of 296 spots 56 unique spots were identified using PDQuest software against aphid infestation.

Production and molecular characterisation of mushroom hybrids developed by protoplast fusion between *Agaricus bisporus* + *Calocybe indica* and *Agaricus bisporus* + *Pleurotus florida*:

Through PEG-mediated protoplast fusion a total of 12 & 7 somatic hybrid strains were developed between *Agaricus bisporus* + *Calocybe indica* and *Agaricus bisporus* + *Pleurotus florida*, respectively. Based on hyphal & colony morphology, barrage reaction and ISSR DNA marker based molecular characterization all the regenerated hybrid strains were proved to be recombinant types. Spawn could be produced from some of the hybrid strains. Basidiocarp production is under progress using different substrate combinations.

Publications :

1. Debnath A J, Basu D, Sikdar S R (2014) An approach to standardise transient expression of GUS in Sesame (*Sesamum indicum* L.) using Sonication Assisted *Agrobacterium tumefaciens*-mediated Transformation (SAAT) method. *Isr J Plant Sci.* 61(1-4):37-45.
2. Mallick P and Sikdar S R (2015) Restriction fragment length polymorphism and sequence analysis of rRNA-ITS region of somatic hybrids produced between *Pleurotus florida* and *Lentinula edodes*. *Ann. Microbiol.* DOI: 10.1007/s13213-015-1121-2.
3. Mallick P and Sikdar SR (2015) Fruit body production and characterization of hybrid edible mushroom strains developed by protoplast fusion between *Pleurotus florida* and *Lentinus squarrosulus*. *Int J Pharm Bio Sci.* 6(3):(B)301-314.

Book Chapter :

1. Bandopadhyay L and Sikdar S R (2015) Rural Biotechnology in Transforming Agriculture and Rural Livelihood, eds. Bahadur B, Rajam M V, Sahijram L & Krishnamurthy KV in Plant Biology and Biotechnology Vol. II Plant Genomics and Biotechnology, Chap. 37, pp 743-754, Springer (DOI 10.1007/978-81-322-2283-5_37).

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
Production and molecular characterization of somatic hybrid mushroom strains between <i>Agaricus bisporus</i> + <i>Pleurotus florida</i> and <i>Agaricus bisporus</i> + <i>Calocybe indica</i>	DAE
Training of four different income generation schemes to the schedule cast people and setting up individual scheme in the beneficiaries own land for their financial upliftment.	DST

**Students Awarded Ph.D.:**

Name of Student (University/Year)	Title of Thesis
Pijush Mallick (K.U., 2015)	Production and Molecular Characterization of Somatic Hybrid Strains Developed through Protoplast Fusion Between <i>Pleurotus florida</i> + <i>Lentinula edodes</i> and <i>Pleurotus florida</i> + <i>Lentinus squarrosulus</i>

Participation in Conferences / Symposia / Workshops and Invited Talks Delivered at Various Organizations**Dr. S.R. Sikdar's group members:**

Poulami Sarkar, Lekha Bandopadhyay, Sayantan Ghosh, and S.R. Sikdar presented poster on "Deciphering and exploiting a highly upregulated novel defensin from *Rorippa indica* for aphid tolerance in *Brassica juncea*" in the National Symposium on "Biotechnology and Molecular Biology for Industry and the Common Man" and XXXVI Meeting of Plant Tissue Culture Association of India, 2015 organized by Plant Tissue Culture Association of India during 29th -31st January 2015 in St. Aloysius College, Mangaluru.



A National Symposium entitled **Evolving Plant Biology : From Chromosomes to Genomics**, has been organized at Bose Institute, jointly with West Bengal Academy of Science and Technology, Calcutta University and Ramakrishna Mission Institute of Culture, Kolkata during November 27-29, 2014. On this occasion, Prof. A. K. Sharma was honoured for his enormous contribution in plant chromosome research. A number of distinguished scientists from all across the country participated and delivered scientific talks.

II. Structural Studies and Biophysical Problems :**Participation of Institutional Project-II for the 12th Five-year Plan (2012-2017)**

Dr. K. P. Das (Coordinator), Dr. Pinakpani Chakrabarti, Dr. Pradeep Parrack, Dr. R. Chattopadhyaya, Dr. Gautam Basu, Dr. Jayanta Mukhopadhyay, Dr. Anirban Bhunia, Dr. Ajit Bikram Dutta, Dr. Subhrangsu Chatterjee

Introduction:

Resolution of Protein structure is the key criterion to determine functional organization of a protein. Study on the structure-function relation coupled with expression analyses have been undertaken to design therapeutically and other economically important protein molecules.

Dr. Gautam Basu, Senior Professor**Scientific Reports:****Crystal structure of GluRS from *E. coli* : in collaboration with Dr. Ajit Bikram Dutta**

We published a paper describing the preliminary diffraction data on an engineered *E. coli* GluRS. Structural refinement is in progress for generating the crystal structure. In addition attempts were made on for co-crystallizing *E. coli* GluRS with tRNA^{Glu} and an ATP analogue.

Understanding the role of Zn-binding domain in bacterial GluRS

We published a paper where the role of the Zn-binding domain in bacterial GluRS was elucidated by studying several mutants of *E. coli* GluRS. Experiments for cloning, overexpression and purification of a GluRS from a thermophilic bacterium that lacks the Zn-binding domain were undertaken. The aim is to crystallize this special GluRS.

Occurrence of cisPro at helix N-termini

Although transPro is known to be over-represented at N-termini of alpha-helices in proteins, not much is known about the occurrence of cisPro at N-termini of helices. From database analysis of protein structures and NMR studies on designed peptides it was established that cisPro also occurs at helix N-termini for certain sequence motifs and plays an important functional role which is why these motifs are often found to be evolutionarily conserved.

Presentation of Bioactive Proteins on the P22 Virus-like Particle: in collaboration with Trevor Douglas

P22 virus like particles have been demonstrated to be extremely useful in creating new materials in the laboratory of Prof. Trevor Douglas at Indiana University, USA. During a short visit to Prof. Douglas's laboratory, I helped design SPR experiments that quantitatively measured the binding of Dec protein on the surface of the virus. The results are important for surface display of proteins of choice. The work has been submitted for publication.



Hydrogen generation from protons using self assembled virus particles and hydrogenase: in collaboration with Trevor Douglas

During a short visit to Prof. Douglas's laboratory at Indiana University, USA, I helped design IR experiments to detect a carbon mono-oxide ligand bound to the catalytic center of an engineered hydrogenase encapsulated in P22 virus. The system was shown to effectively generate hydrogen gas, a futuristic fuel, from protons. The work has been submitted for publication.

Publications:

1. Chongdar N, Dasgupta S, Datta AB, Basu G (2014) Preliminary X-ray crystallographic analysis of an engineered glutamyl-tRNA synthetase from Escherichia coli. *Acta Cryst.*, F70: 922-927.
2. Kumar A, Manna AK, Ray U, Mullick R, Basu G, Das S and Roy S (2014) Specific sequence of a Beta turn in human I α protein may contribute to species specificity of hepatitis C virus. *J Virol.*, 88:4319-27.

Dr. Anirban Bhunia, Assistant Professor

Scientific Reports:

Design, Synthesis and High Resolution Structure Determination of Biomolecules Using Nuclear Magnetic Resonance (NMR) Spectroscopy:

(a) Main aim of my lab is to design new antimicrobial peptides, which can significantly bind to the outer membrane of the gram-negative bacteria and can penetrate through the bacterial membrane. This special kind of peptides not only ruptures the cell membrane but also alters the DNA folding which leads to stoppage of bacterial replication. Both mechanisms of action are different and a solid platform to generate new antibiotic library for the next generation drugs.

(b) Unravelling the molecular mechanism of Amyloid fibril formation requires two important problems to be addressed namely, protein folding and protein aggregation. Though, in recent years, in-silico approaches are successful in predicting the folds of the small to medium sized proteins, the folding of intrinsically unstructured amyloid monomers into ordered Beta-sheet fibril is still a challenge. Accurate experimental constraints are quint-essential to channelize the available information to design molecules for treating Amylogenic diseases. The other side of the problem is to explain how this partially folded peptide aggregate and organize itself into an ordered long beta sheet fibre. The expertise of Dr. Bhunia in using several spectroscopic techniques in combination with computational modelling will be put to use to design small peptide molecules and its analogues, to inhibit the fibrillation process at its inception itself.

(c) In biology, protein aggregation is a fatal event. Various types of diseases including neuronal disorders happen due to misfolding and aggregation of many important proteins. We have designed some short peptides, structured with a β -hairpin loop significantly binding to the amyloidogenic states of proteins and helps to prolong their high mass aggregated states. The research is under way and we hope to discover some interesting peptide analogs to stop protein aggregation.

Publications:

1. Bera S, Ghosh A, Sharma S, Debnath T, Giri B and Bhunia A (2015) Probing the role of Proline in the Antimicrobial activity and lipopolysaccharide binding of Indolicidin, *J. Colloid Interface Sci.*, 452:148-59.
2. Datta A, Ghosh A, Airoidi C, Sperandio P, Mroue KH, Barbero JJ, Kundu P, Ramamoorthy A and Bhunia A (2015) Antimicrobial peptides: Insight into Membrane Permeabilization, Lipopolysaccharide Fragments and Application in Plant Disease Control. *Nature Sci. Rep.*, 5: 11951.
3. Dhara D, Kar RK, Bhunia A and Misra AK (2014) Convergent Synthesis and Conformational Analysis of the Hexasaccharide Repeating Unit of the O-Antigen of Shigella flexneri Serotype 1D. *Eur. J. Org. Chem.* 2014: 4577-84.
4. Di Mauro MA, Nandi SK, Raghavan CT, Kar RK, Wang B, Bhunia A, Nagaraj RH, and Biswas A (2014) Acetylation of Gly1 and Lys2 promotes aggregation of human β D-crystallin. *Biochemistry*, 53(46): 7269-82.
5. Ghosh A, Datta A, Jana J, Kar RK, Chatterjee C, Chatterjee S, Bhunia A (2014) Sequence context induced antimicrobial activity: Insight to Lipopolysaccharide permeabilization. *Mol. Biosyst.*, 10(6): 1596-612.
6. Ghosh T, Kar RK, Bhunia A and Misra A (2014) Synthesis of the pentasaccharide repeating unit of the O-antigen of E.coli O175 using one-pot glycosylation and its conformational analysis. *Tetrahedron*, 53(46):7269-82.
7. Ghosh A, Kar RK, Krishnamoorthy J, Chatterjee S, Bhunia A (2014) Double GC:GC Mismatch in dsDNA Enhances Local Dynamics Retaining the DNA Footprint: A High-Resolution NMR Study. *Chem.Med.Chem.*, 9(9): 2052-58.
8. Ghosh A, Kar RK, Jana J, Saha A, Jana B, Krishnamoorthy J, Kumar D, Ghosh S, Chatterjee S and Bhunia A (2014) Indolicidin Targets Duplex DNA: Structural and Mechanistic Insights Employing Combination of Spectroscopy and Microscopy. *Chem.Med.Chem.* 9(9): 2059-64.
9. Ghosh A, Pithadi A, Bhat J, Bera S, Midya A, Fierke C, Ramamoorthy A and Bhunia A, (2015) Self-assembly of a 9-residue amyloid-forming peptide fragment of SARS Corona Virus E-protein: Mechanism of self aggregation and amyloid inhibition of hIAPP. *Biochemistry*, 54: 2249-2261.
10. Ghosh A, Ratha BN, Gayen N, Mroue KH, Kar RK, Mandal AK and Bhunia A (2015) Biophysical Characterization of Essential Phosphorylation at the Flexible C-terminal Region of C-Raf with 14-3-3 ζ Protein. *PLoS ONE*, 10(8): e0135976.
11. Gupta S, Chit JC-Y, Feng C, Bhunia A, Tan S-M, Bhattacharjya S (2015) An Alternative phosphorylation switch in Integrin α 2 (CD18) tail for DOK1 binding. *Nature Sci. Rep.*, 5: 11630.



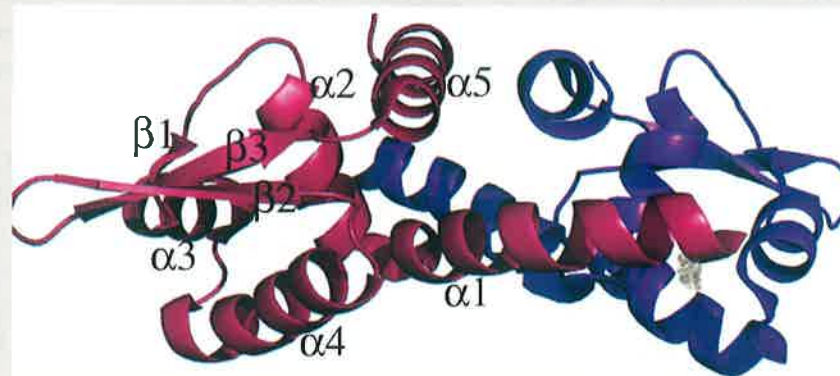
12. Jana M, Kar RK, Bhunia A, Misra A (2014) Synthesis of the tetrasaccharide repeating unit of the O-antigen of the Escherichia coli O69 strain and its conformational analysis. *RSC Adv.*, 4: 079-84.
13. Lee DK, Bhunia A, Kotler SA and Ramamoorthy A (2015) Antimicrobial peptides and inhibition by cholesterol: A solid-state Nuclear Magnetic Resonance study. *Biochemistry*, 54: 1897-907.
14. Nandi SK, Chakraborty A, Panda AK, Ray SS, Kar RK, Bhunia A, and Biswas A (2015) Interaction of ATP with a small heat shock protein from Mycobacterium leprae: Effect on its structure and function. *PLOS Negl. Trop. Diseases.*, 9: e0003661
15. Ravichandran Y, Krishnamoorthy J, Ramamoorthy A, Bhunia A (2014) Potent gamma-secretase inhibitors/modulators interacts with Amyloid-beta fibrils but do not inhibit fibrillation: A high resolution NMR study. *Biochem. Biophys. Res. Comm.*, 447(4): 590-5.
16. Santra A, Si A, Kar RK, Bhunia A and Mishra AK (2014) Linear synthesis and conformational analysis of the pentasaccharide repeating unit of the cell wall O-antigen of Escherichia coli O13. *Carbohydr. Res.*, 391: 9-15.
17. Sudheendra US, Dhople V, Datta A, Kar RK, Shelburne CE, Bhunia A, Ramamoorthy A (2015) Membrane Disruptive Antimicrobial Activities of Human beta defensin-3 Analogs. *Eur. J. Med. Chem.*, 91, 91-99, DOI: 10.1016/j.ejmech.2014.08.021.

Patent:

Dr. Anirban Bhunia and Dr. Santasabuj Das. Indian Patent No.: 462/DEL/2015

Dr. P. Chakrabarti, Senior Professor**Scientific Reports:****Structural studies on proteins from *Vibrio cholerae*:**

Vibrio cholerae is the causative agent of the diarrheal disease cholera, which is usually acquired by oral ingestion of the bacterium with contaminated water or food. We have been working with a number of proteins (such as, Ace and HlyU) which are involved in *Vibrio cholerae* pathogenesis. HlyU in *Vibrio cholerae* is known to be the transcriptional activator of the hemolysin gene, HlyA and possibly a regulator of other virulence factors influencing growth,



Overall structure of HlyU dimer; helices and strands are labelled in one subunit.

colonization and pathogenicity of this infective agent. We have solved the crystal structure of dimeric HlyU at 1.8 Å. Cys38 in the structure was found to be modified as sulfenic acid; the oxidized form was not seen in another structure solved under reducing condition. Although devoid of any metal binding site, the presence of a Cys residue exhibiting oxidation-reduction suggests the possibility of the existence of a redox switch in transcription regulation. A structure-based phylogenetic analysis of WTH proteins revealed the segregation of metal and non-metal binding proteins as well as those in the latter group that are under redox control.

Bactericidal effect of nanoparticles:

We have been interested in understanding the antimicrobial effect of ZnO nanoparticles (NP). ZnO-PEI NP (derivative of ZnO-NP) was made in aqueous medium using the capping agent polyethyleneimine (PEI). The nanoparticles were characterized by XRD measurements, TEM and other techniques; the weight % of coating shell in the polymer-capped particles was determined by TGA. ZnO-PEI NP is more soluble in water than the uncapped ZnO-NP, and forms a colloidal suspension in water. The PEI-functionalized NP was found to be effective in killing antibiotic resistant *Helicobacter pylori* and the molecular basis of inactivation has been elucidated. PEI-capped ZnO-NP exhibited better antibacterial activity when compared with that of uncapped ZnO-NP against a range of multiple-antibiotic-resistant (MAR) Gram-negative bacterial strains harboring genes of high-pathogenicity island. ZnO-NP effectively killed these microorganisms by generating reactive oxygen species (ROS) and damaging bacterial membrane. ZnO-PEI NP at LD50 dose in combination with tetracycline showed synergistic effect to inhibit tetracycline-resistant *E. coli* MREC33 growth by 80%. These results open up a new vista in therapeutics to use antibiotics (which have otherwise been rendered useless against MAR bacteria) in combination with minimized dosage of nanoparticles for the more effective control of MAR pathogenic bacteria.

Publications:

1. Chakraborti S, Mandal AK, Sarwar S, Singh P, Chakraborty R and Chakrabarti P (2014) Bactericidal effect of polyethyleneimine capped ZnO nanoparticles on multiple antibiotic resistant bacteria harboring genes of high-pathogenicity island, *Colloids and Surfaces B: Biointerfaces*, 121: 44-53.
2. Mukherjee D, Datta AB and Chakrabarti P (2014) Crystal structure of HlyU, the hemolysin gene transcription activator, from *Vibrio cholerae* N16961 and functional implications. *Biochim. Biophys. Acta*, 1844: 2346-2354.

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
J.C. Bose National Fellowship	DST

Participation in Conferences / Symposia / Workshops & Invited Talks delivered at Various Organizations:

Presented papers at (i) IYCr South Asia Summit Meeting on Vistas in Structural Chemistry, Karachi, Pakistan, April 28-30, 2014; (ii) the Congress and General Assembly of the International Union of



Crystallography, Montreal, August 5-12, 2014; (iii) Humboldt Kolleg on Interdisciplinary Science: Catalyst for Sustainable Progress, IAS Auditorium, IISc, September 4-6, 2014; (iv) Meeting of the International Network of Protein Engineering Centres (INPEC), St-Petersburg, Russia, September 10-14, 2014; (v) Indo-US Conference and Workshop on Recent Advances in Structural Biology & Drug Discovery, IIT Roorkee, October 9-11, 2014; (vi) National Workshop on Crystallography Education, Gauhati University, November 8, 2014; (vii) Recent Advances in Crystallography (to celebrate IYCr, and the Golden Jubilee Year of the Department of Chemistry), IIT Bombay, November 17, 2014; (viii) Guha Research Conference 2014, Khajuraho, December 4-8, 2014; (ix) International Conference on Informatics and Integrative Biology, CIIB-2014, Calcutta University Technology Campus, December 17-19, 2014; (x) the Second Conference of the Bangladesh Crystallographic Association, Dhaka, January 10, 2015; (xi) National Seminar on Bioinformatics, Bharathidasan University, Tiruchirappalli, January 28-29, 2015; (xii) National Symposium on Molecules to Systems, Presidency University, January 29-31, 2015; (xiii) Modern Methods in Computing Biology: A Brainstorming Workshop, A*STAR, March 23-24, 2015 Singapore; (xiv) chaired sessions at National Science (Vijyoshi) Camp for the KVPY and INSPIRE fellows, Science City, Kolkata, November 10-12, 2014.

Participation in conferences by group members:

Dr. Tanya Chatterjee attended (i) Indo-US Conference and Workshop on Recent Advances in Structural Biology & Drug Discovery, IIT Roorkee, October 9-11, 2014 (ii) Devlina Chakravarty and Jesmita Dhar attended International Conference on Informatics and Integrative Biology, CIIB-2014, Calcutta University Technology Campus, December 17-19, 2014 (iii) Shamila Sarwar attended the Regional Conference of Young Scientist on Nanoscience and Nanomaterials, JNC SAR, Bangalore, February 18-20, 2015.

Dr. Subhrangsu Chatterjee, Scientist, Ramanujan Fellow

Scientific Reports:

Design, synthesis of Novel Aptamers, Peptides, Small molecules selectively bind G quadruplexes:

Focus of my research is to design new kinds of aptamers (LNA, BNA, ENA), antimicrobial peptides, small molecules which significantly bind to the telomeric and oncogenic G quadruplexes which are essential structures to be investigated and targeted to cause cancer cell death. We also want to investigate the role of POT1 protein and other transcription factors in controlling the telomerase activity. We employ high resolution NMR and other biophysical techniques to unravel molecular interactions.

Recently we have invented a new antimetastatic cancer therapeutic agent (filed for patent in USA, Europe and Australia)

AU2013322120 (A1) (Australian Publication)

EP2900234 (A1) (European Publication)

Understanding misfolding and aggregation of proteins and peptides by high resolution NMR:

Protein and peptide aggregation can be very fatal and cause different kinds of neurodegenerative diseases. Our focus is to design and synthesize new kinds of peptides and small molecules which inhibit protein/peptide aggregation and misfolding.

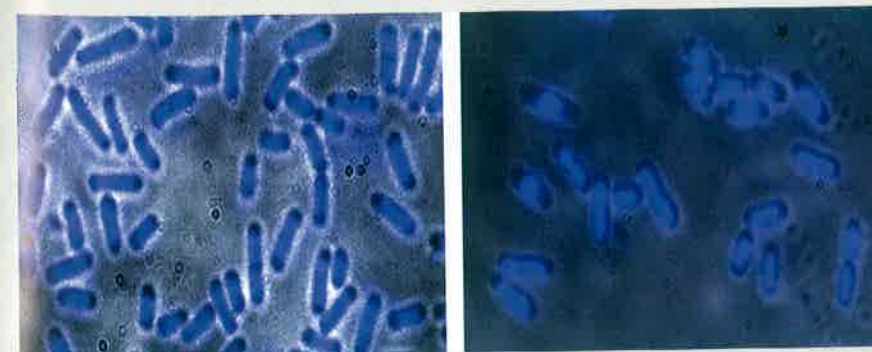
Publications:

1. Ghosh A, Datta A, Jana J, Kar RK, Chatterjee C, Chatterjee S, Bhunia A (2014) Sequence context induced antimicrobial activity: insight into lipopolysaccharide permeabilization Mol Biosyst. 10(6):1596-612.
2. Ghosh Anirban, Kar Rajiv Kumar, Jana Jagannath, Saha Abhijit, Jana Batakrishna, Krishnamoorthy Janarthanan, Kumar Dinesh, Ghosh Surajit, Chatterjee Subhrangsu and Bhunia Anirban (2014) Indolicidin Targets Duplex DNA: Structural and Mechanistic Insight through a Combination of Spectroscopy and Microscopy ChemMedChem. Volume 9, Issue 9, pages 2052-2058.
3. Ghosh A, Kar RK, Krishnamoorthy J, Chatterjee S, Bhunia A (2014) Double GC:GC Mismatch in dsDNA Enhances Local Dynamics Retaining the DNA Footprint: A High-Resolution NMR Study. ChemMedChem. 9(9):2059-64.
4. Ghosh S, Jana J, Kar R K, Chatterjee S, Dasgupta D (2015) Plant Alkaloid Chelerythrine Induced Aggregation of Human Telomere Sequence-A Unique Mode of Association between a Small Molecule and a Quadruplex. Biochemistry, 3;54(4):974-86.
5. Nakka Kiran Kumar, Chaudhary Nidhi, Joshi Shruti, Bhat Jyotsna, Chatterjee Subhrangsu, Malhotra Renu, De Abhijit, Santra Manas Kumar, Dilworth F Jeffrey and Chattopadhyay Samit (2015) Nuclear matrix-associated protein SMAR1 regulates alternative splicing via HDAC6-Mediated deacetylation of Sam68 (Proc Natl Acad Sci U S A. 112(26):E3374-83)

Dr. Tanaya Chatterjee, DST-Women Scientist

Scientific Reports:

Antimicrobial effect of silver nanoparticles:



DAPI stained E. coli cells (control in the left panel and 100 mM Ag-NP treated in the right panel) as viewed under Zeiss Axiovert 200M fluorescence microscope.

Scanning Electron Microscopy and fluorescence microscopy were used to study the morphological changes of two types (Gram-positive and Gram-negative) of bacterial cells induced by silver nanoparticles (Ag-NP). E. coli was found to be more



susceptible to Ag-NP as compared to *S. aureus*. The Gompertz equation, which is normally used to model the bacterial growth kinetics, has been modified by incorporating a death term, and was found to be useful in explaining the non-monotonic nature of the growth curve. The modified Gompertz model derived here is of general nature and can be used to study any microbial growth kinetics under the influence of antimicrobial agents.

Publication:

1. Chatterjee T, Chatterjee BK, Majumdar D and Chakrabarti P (2015) Antibacterial effect of silver nanoparticles and the modeling of bacterial growth kinetics using a modified Gompertz model. *Biochim. Biophys. Acta*, 1850: 299-306.

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
Biophysical studies on proteins of <i>Vibrio cholera</i> and their interactions with small molecules for possible therapeutic applications.	DST-Women Scientists Scheme

Dr. Rajagopal Chattopadhyaya, Professor

Scientific Reports:

Stability of *Curcuma longa* rhizome lectin: role of N-linked glycosylation:

Curcuma longa rhizome lectin, of non-seed origin having antifungal, antibacterial and α -glucosidase inhibitory activities, forms a homodimer with high thermal stability as well as acid tolerance. *Curcuma longa* rhizome lectin, a mannose binding monocot family plant protein of non-seed origin having antifungal, antibacterial and α -glucosidase inhibitory activities, was studied to understand the role of glycans with complex-type oligosaccharides attached to Asn 66 and Asn 110, thereby elucidating the roles of carbohydrate moieties in lectin stability, denaturation and refolding. By size exclusion chromatography the wild-type lectin elutes as a dimer of ~35,000 Da whereas the deglycosylated recombinant lectin elutes as a dimer of ~30,000 Da. Far UV CD spectra, fluorescence emission maximum, hemagglutination assay show no change in secondary or tertiary structures or sugar binding properties between wild-type and recombinant forms of the turmeric lectin under physiological pH. But reduced agglutination activity and loss of tertiary structure are observed in the acidic pH range for the recombinant protein. In thermal and GdnCl-induced unfolding, the wild-type possesses higher stability compared to the deglycosylated recombinant lectin, as measured by a higher T_m of denaturation or a greater free energy change respectively. Reversibility experiments after thermal denaturation reveal that deglycosylated proteins tend to aggregate during thermal inactivation but the wild-type shows a much greater recovery to the native state upon refolding. These results suggest that N-glycosylation in turmeric lectin is important for the maintenance of its proper folding upon changes in pH, and that the complex-type oligosaccharides help in maintaining the active conformation and prevent aggregation in unfolded or partially folded molecules.

Influence of Plant Extracts on Fenton-reaction mediated DNA damage:

Transition metals like iron, which is most abundant in our body, can react with H_2O_2 to produce hydroxyl radical (OH $\cdot$) via the Fenton reaction as follows: $Fe^{2+} + H_2O_2 + H^+ \rightarrow Fe^{3+} + OH\cdot + H_2O$. The OH $\cdot$ produced is highly reactive and a major source of oxidative stress in cells, damaging proteins, lipids and DNA. Oxidative DNA damage is implicated in many diseases such as cancer, neurodegenerative and cardiovascular diseases. Thus, considerable attention is being given to research on natural antioxidants because synthetic antioxidants have many harmful side effects. The Indian medicinal plants chosen for our study have well documented antioxidant properties and some of them also possess iron chelating activity. It was reported that Fenton reaction mediated DNA damage is enhanced by the extracts from *Terminalia chebula*, *Terminalia belerica*, *Embllica officinalis*, *Acacia catechu* and *Spondius dulcis*. No such effect was significant in the cases of *Dolichos biflorus* and *Hemidesmus indicus*. Active compounds from some of the plants have also been identified and isolated for further study. Once the compounds are identified, another future goal is to understand how they interact with the DNA substrates and their mode of action. We are also studying how these plant extracts influence the activities of some enzymes which are known to be important vis-à-vis cancer.

Publications:

1. Biswas H and Chattopadhyaya R (2014) Thermal, Chemical and pH Induced Unfolding of Turmeric Root Lectin: Modes of Denaturation. *PLoS One* 9(8): e103579. doi:10.1371/journal.pone.0103579.
2. Chattopadhyaya R (2014) Review of Molecular Biology: Genes to Proteins, *Current Science*, 107(1):125-126.

Participation in Conferences / Symposia / Workshops & Invited Talks delivered at Various Organizations:

Participated in the (i) 28th Annual Symposium of The Protein Society, during July 27-30, 2014, at San Diego, California, USA and presented his work on the three dimensional structures of enteric pilins there as a poster. The abstract of the poster has been published in the July 2014 issue of *Protein Science* as a result.

Dr. K. P. Das, Senior Professor and Coordinator

Scientific Reports:

(1) Structural and functional studies of α -crystallin: in collaboration with Dr. I. B. Chatterjee and Dr. R. Banerjee, CU

Many factors contribute to cataract development. Recent studies indicate that smoking is associated with high prevalence of cataract. However, the mechanism(s) by which cigarette smoke (CS) causes cataract remains unexplored. CS contains thousands of compounds and specific chemical(s) in CS



linked to cataract is unidentified. Cigarette smoke contains p-benzoquinone (p-BQ) which is converted to p-benzoquinone (p-BQ) in the lungs. p-BQ is a redox cycling agent that generates reactive oxygen species and oxidative stress. We hypothesize that p-BQ derived from CS may reach the eye and produce adduct with lens proteins inducing cataractogenesis. In order to study the effect of p-BQ on the modification of chaperone activity of α -crystallin, we undertook a detailed biophysical investigation on α A-crystallin-p-BQ adduct. The presence of p-BQ-protein adducts in smokers' lens and systematic structure-function perturbation of p-BQ- α -crystallin adduct reveal that p-BQ has obvious implications in cataractogenesis in smokers.

(2) Molecular basis for stress management by Arabidopsis DNA Pol I : in collaboration with Dr. Sujit Roy, Burdwan University

We are investigating the physical and molecular basis of stability of Arabidopsis DNA Pol I, under UV-B and salinity stress in connection with the function of the N-terminal BRCT domain and Ser-Pro rich region in the regulation of the overall structure of this protein. Tryptophan fluorescence studies, fluorescence quenching and Bis-ANS binding experiments using purified recombinant full length Pol I and its N-terminal deletion forms revealed UV-B induced conformational change in BRCT domain deficient Pol I. On the other hand, the highly conserved C-terminal catalytic core PolX domain maintained its tertiary folds under similar condition. Circular dichroism (CD) and FT-IR studies are being carried out to detect changes in the secondary structural elements. Urea-induced equilibrium unfolding studies have revealed increased stability of Pol I and its N-terminal deletion mutants at high NaCl concentration. *In vivo* aggregation studies in Arabidopsis and tobacco indicated possible aggregation of Pol I lacking the BRCT domain. Interaction of Pol I with the eukaryotic molecular chaperone HSP90 is also being studied to ascertain its possible role in regulating PolI stability. Our study is expected to provide comprehensive information on the biophysical characteristics of Pol I and reveal role of BRCT and Ser-Pro rich modules in regulating the effects of genotoxic stress in plants.

Publications:

1. Banerjee V and Das KP (2014) Structure and Functional Properties of a Multimeric Protein α A-Crystallin Adsorbed on Silver Nanoparticle Surface. *Langmuir*, 30(16): 4775-4783.
2. Chowdhury A, Choudhury A, Banerjee V, Banerjee R and Das K P (2014) Spectroscopic studies of the unfolding of a multimeric protein α -crystallin, *Biopolymers*, 101(5): 549-560.
3. Roy A, Gupta S, Hess D, Das KP and Das S (2014) Binding of insecticidal lectin colocasia esculenta tuber agglutinin (CEA) to midgut receptors of Bemisia and Lipaphis erysimi provides clues to its insecticidal potential. *Proteomics*, 14(13-14): 1646-1659.
4. Sarkar A, Banerjee V, Blaise M, Banerjee B, Das K P, Karn D and Banerjee R (2014) Critical Role of Zinc ion on *E. coli* Glutamyl-Queuosine-tRNA^{Asp} Synthetase (Glu-Q-RS) Structure and Function. *Protein J.*, 33(2):143-149.

Participation in Conferences / Symposia / Workshops & Invited Talks delivered at Various Organizations:

(i) Delivered an invited lecture entitled: "Study of the biomolecular interactions to control fibrillation of insulin" at North East Regional Seminar on Trends in Colloid and Interface Science (NERSTCIS - 2014) held at the Chemistry Department of North Eastern Hill University during November 27-28, 2014 (ii) delivered an invited talk entitled: "Molecular mechanism of stabilization of α -crystallin by Zn^{+2} - implications for its chaperone function" at the 4th Meeting of the "Bio-world 2014: Protein Structure and Function" held at Delhi IIT, during December 12-14, 2014 (iii) attended as part of the organizers one day conference on Trends in Surface Science and Related Areas, held at the Chemistry Department of Presidency University, July 24, 2014 (iv) delivered a talk on "Techniques for Studying Biomolecular Conformation and Interactions - Use of FT-IR and SPR" at the refreshers course organized by the Chemistry Department of Jadavpur University on 22 January 2015.

Dr. Ajit Bikram Datta, Assistant Professor

Scientific Reports:

Structural and biochemical studies to understand the regulation and and specificity of ubiquitination machinery in eukaryotes:

Ubiquitination refers to the post translational modification that occurs to a diverse array of proteins in eukaryotes via covalent conjugation of a small 76 residue protein known as Ubiquitin. Modification of substrate proteins *in vivo* by ubiquitination has been implicated in a plethora of cellular processes including proteostasis, DNA repair, transcription regulation, intracellular signaling, and cell-cycle progression. Improper functioning of ubiquitination has been found to be responsible for various neurodegenerative diseases and cancers. A cascade of three sequential enzymatic steps involving the ubiquitin activating enzyme (E1), conjugating enzyme (E2), and ubiquitin ligase (E3) results in the formation of a covalent bond between the Ubiquitin C-terminus and a specific lysine in the substrate protein. Human genome codes for a wide repertoire of E2s (about 30) and E3s (> 600), which, in a combinatorial manner dictates the substrate selection as well as the modification topology, both being crucial for the specific cellular response. Thus the spatio-temporal specificities of E3-E2 and E3-substrate interaction and their regulations are crucial to elicit the desired the biological reaction.

We have undertaken multiple research projects to understand diverse aspects of ubiquitination machinery and their regulation. We have recently been able to understand the role of the extended N-terminus of Ube2E class of conjugating E2 enzymes in regulating their enzymatic activity. This research work has been accepted in the Journal of Molecular biology.

In order to understand various aspects of E3-E2 interactions that lead to the activation of E2 ~ ubiquitin thio-ester conjugates facilitating ubiquitin transfer to the substrate, we have obtained crystals for two candidate E3 ligases (ZNR1 and RNF13) in complex with their cognate E2 or



E2 ~ ubiquitin conjugate. The structure of the latter has been solved using the data collected at the home source, while the structure solution for the former is underway. Both of these novel E3 ligase structures in complex with the E2/E2 E2 ~ Ub is expected to provide us with deeper understanding of E3-E2 interactions and their reaction mechanisms. We have also initiated biochemical and mutational analyses to validate our findings from the complex crystal structures.

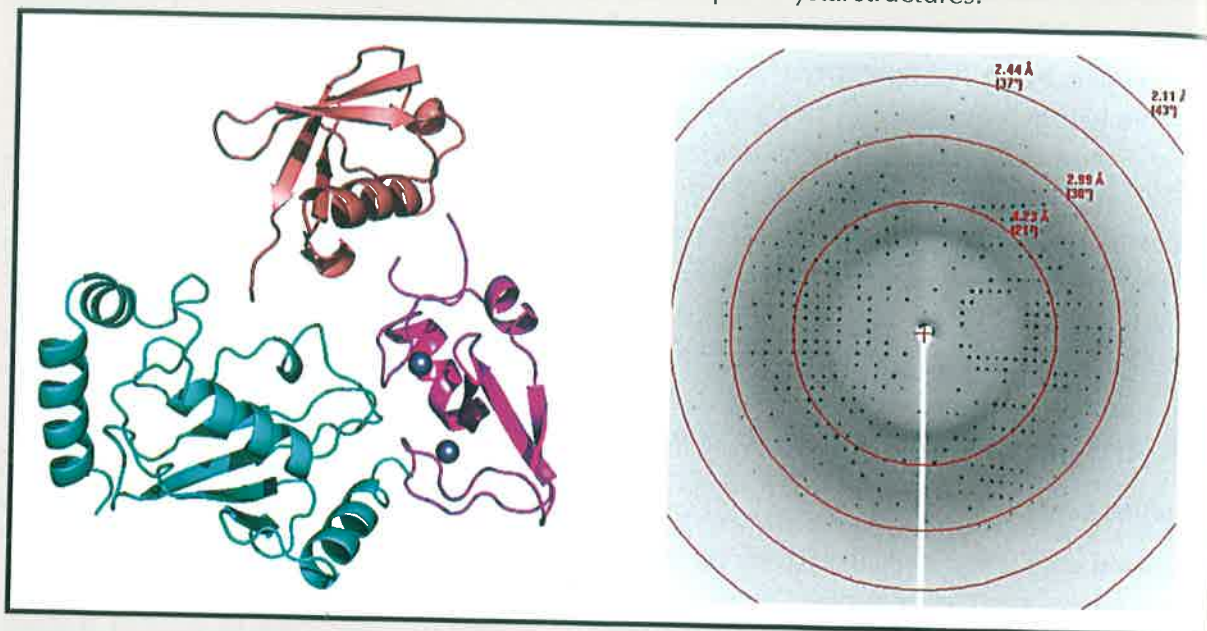


Figure 1. a) Crystals structure of a RNF13 (magenta), in complex with E2(cyan) ~ Ubiquitin(salmon) complex.

Figure 1.b) A typical diffraction pattern obtained for the ZNRF1-Ube2N complex.

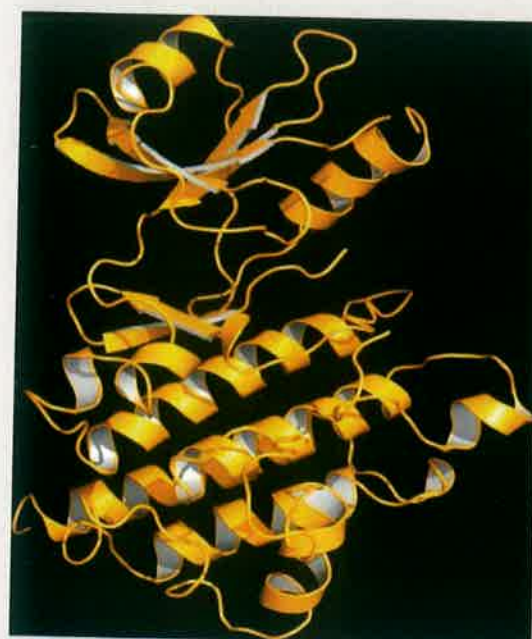


Figure 2. a) Crystal structure of Symbiosis receptor kinase mutant.

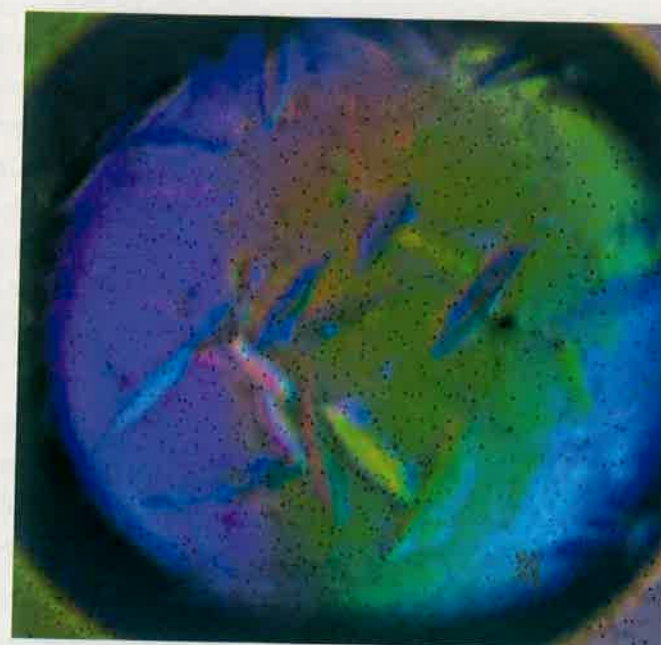


Figure 2. b) Crystals of wild-type Symbiosis receptor kinase protein.

Crystal structure of a plant receptor kinase and its mutants: in collaboration with Prof. M. Dasgupta, Dept. of Biochemistry, University of Calcutta, Kolkata

Plant receptor-like kinases play crucial roles in different plant signaling pathways responsible for diverse physiological processes. Professor DasGupta's lab identified and extensively characterized one of such kinases involved in the plant-microbe interaction that leads to the establishment of symbiosis. We initiated structural studies on the kinase domain of this symbiosis receptor kinase along with few of its interesting point mutants to understand the structure-function relationship for this important protein. We have been able to solve structures for two of the mutants of this protein and have recently been successful in crystallizing the wild-type kinase. Studies are underway to understand the structural difference between these the mutants and correlate it with their biological activity.

Publication:

1. Banka PA, Behera AP, Sarkar S, Datta AB (2015) RING E3-Catalyzed E2 Self-Ubiquitination Attenuates the Activity of Ube2E Ubiquitin-Conjugating Enzymes, *J. Mol Biol.* 427(13):2290-304.

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
Understanding the structural basis of the substrate and the E2 specificities of ubiquitin E3 ligases.	Wellcome Trust-DBT India Alliance

Dr. Jayanta Mukhopadhyay, Assistant Professor

Scientific Reports:

A recombinant reporter assay of *Mycobacterium tuberculosis*:

Developing an in vivo gene reporter assay to assess interactions among the components of the transcription machinery in *Mycobacterium tuberculosis* remains a challenge to the scientists due to the tediousness of generation of mutant strain of the extremely slow growing bacteria. We have developed a recombinant mCherry reporter assay that enables us to monitor the interactions of *Mycobacterium tuberculosis* transcriptional regulators with its promoters in vivo in *Escherichia coli*. The assay involves a three-plasmid expression system in *E. coli*, wherein, two plasmids are responsible for the *M. tuberculosis* RNA polymerase production and the third plasmid harbours the mCherry reporter gene expression cassette under the control of either a σ or a transcriptional regulator dependent promoter. We observed that the endogenous *E. coli* RNAP and σ factor do not interfere with the assay. Using the reporter assay we are able to show



that the functional interaction of *M. tuberculosis* CRP occurs with its own RNA polymerase not with *E. coli* polymerase. The recombinant reporter assay being performed in *E. coli* is much faster than if performed in *M. tuberculosis* and could avoid the hazard of handling the pathogenic bacteria. The approach could be expanded to develop reporter assays for other pathogenic and slow growing bacterial systems.

Validation of 'proposed model for promoter escape' using two-component σ factor YvrI and YvrHa of *Bacillus subtilis*:

It has been proposed that transcription is associated with the process " σ cycle", in which σ^{70} associates with RNAP to orchestrate transcription initiation and then dissociates after the transition to a stable elongation complex. General model of transcription initiation in bacteria postulates that σ is released from RNAP during transition from transcription initiation to elongation i.e., upon synthesis of RNA of critical threshold length 9-11 nt. However, several lines of evidence suggest that σ release is not obligatory, rather stochastic (σ is not released immediately after transition to elongation, but is released eventually during elongation. In order to understand the nature and mechanism of σ -release in transcription initiation in other bacterial system, we have initiated a significant effort to study the " σ cycle" in *M. tuberculosis* and *B. subtilis* transcriptional machineries.

In the structure of RNAP holoenzyme, the $\sigma R3/\sigma R4$ linker occupies the RNA-exit channel and must be displaced to permit access of nascent RNA to the RNA exit channel (when the nascent RNA reaches a length of $\sim 9-11$ nt). The displacement of $\sigma R3/\sigma R4$ linker may destabilize the interactions between $\sigma R4$ and β flap that, in turn, destabilizes the interactions of $\sigma R4$ and the -35 element, allowing RNAP to escape from the promoter and start productive elongation. This transition into elongation does not require complete release of σ , but accounts for the reduced affinity of σ (from $K_d \sim 10^{-10}$ to $\sim 10^{-6}$) for RNAP.

In *Bacillus subtilis*, σ -like factors YvrI and coregulator YvrHa activate transcription from a small set of conserved promoters. These two proteins independently contribute $\sigma R2$ and $\sigma R4$ functions to a RNAP-promoter complex. Hence, this two-subunit bacterial σ -factor poses an ideal system to validate the proposed promoter escape model. According to this model, the interaction between RNAP and $\sigma R4$ breaks, once nascent RNA reaches a length of 9-11 nt, whereas interaction between $\sigma R2$ and RNAP remains intact. Since YvrHa mimics $\sigma R2$ and YvrI mimics $\sigma R4$, the proposed model for 'promoter escape' suggests that YvrI should be released from RNAP once RNAP synthesizes a RNA of length 9-11 nt, while YvrHa will be retained.

Using biochemical and biophysical assays, we have shown that YvrI is retained in the ternary complex throughout the elongation, while YvrHa is stochastically released from the RNAP as elongation is progressed. Our observation validates the proposed model for promoter escape

and also raises the possibility that in certain bacterial species, σ could be retained by RNAP throughout the elongation step. (manuscript in preparation)

In order to understand whether the promoter escape model is valid for other bacterial systems, we are using the above methods to assess the extent of σ release in *B. subtilis* and *M. tuberculosis* for their principal σ factors.



The inaugural function of the Tagore Centre of Natural Science & Philosophy was held at the Main Campus of Bose Institute on October 14, 2014. Prof. Sibaji Raha, Director, Bose Institute, delivered the Welcome Address. Shri Partha Chatterjee, Honorable Minister-in-Charge, Parliamentary Affairs, Education (Primary, School & Higher Education), Govt. of West Bengal, was the guest-of-honour. On this occasion, Prof. Dipak Ghosh, C. V. Raman Centre for Physics & Music, gave a presentation on the theme *My thoughts vibrating with thy tune*, entitled "Music : Rabindranath Tagore and Albert Einstein". Prof. Sushanta Dattagupta, Vice Chancellor, Visva Bharati University spoke on "Rabindranath and Jagadis Chandra, life across the cosmos". This talk was illustrated with songs and music. Eminent actor Shri Saumitra Chatterjee, presented "Everyday, thy music : My own Rabindranath", along with his companions. The programme was chaired by Prof. Bikash Sinha, who delivered a lecture on "Reality". The programme was further enriched by the performance of eminent singer Dr. Mohon Singh of Visva Bharati University who also spoke on this occasion.



III. Computational Biology:

Participation of Institutional Project-III for the 12th Five-year Plan (2012-2017)

Dr. Gautam Basu (Coordinator), Dr. Pinakpani Chakrabarti, Dr. Tapas Chandra Ghosh, Dr. R. Chattopadhyaya, Dr. Tapan Dutta, Dr. Debjani Roy, Dr. Shubhra Ghosh Dastidar, Dr. Zhumur Ghosh, Dr. Sudipto Saha.

Introduction:

The institutional plan program Computational Biology aims to understand a plethora of biological processes, molecules and interactions by computational techniques. Some of our broad goals are: i) microRNA networks in stem cells, ii) mechanistic insight into the molecular biology from structural dynamics, integrating therapeutic molecular design, iii) comparative genome analysis towards the understanding of protein evolution, iv) understanding macromolecular recognition from an analysis of known structures of protein complexes, v) development of bioinformatics tools and web-based servers, vi) identification of network biomarkers in Neurodegenerative diseases, vii) structural studies of c-Jun N-terminal kinase 3 (JNK3), and, viii) a combined in silico genomics and proteomics approach for the development of antiparasitic drugs.

Dr. Gautam Basu, Senior Professor and Coordinator

Scientific Reports:

Effect of introducing Aib in a designed helical inhibitor of Hdm2-p53 interaction:

A series of molecular dynamics simulations were performed on unbound and bound complexes of HDM2 and Aib-p53 peptides. It was found that despite stabilizing a helical backbone in the unbound state, the Aib residues in Aib-p53 peptides arrested two functionally important side-chains of Phe and Tyr in non-productive conformations. In the bound state, the C-terminal Aib residues got inserted into the hydrophobic pocket of HDM2, ejecting a Leu residue. This study shows that when using Aib to design functionally important helical peptides, care must be taken to consider potential interactions between side-chains of neighboring residues and Aib in the unbound state, and alternate conformations of the Aib-containing peptide and the receptor in the bound state. A manuscript describing the work has been submitted for publication.

Publication:

1. Chongdar N, Dasgupta S, Datta A B and Basu G (2015) Dispensability of zinc and the putative zinc-binding domain in bacterial glutamyl-tRNA synthetase. *Biosci Rep.* 35:e00184.

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
Setting up of a State-of-the-art 600 MHz FT-NMR with Cryoprobe facility at Bose Institute.	DBT

Participation in Conferences / Symposia / Workshops & Invited Talks Delivered at Various Organizations

(i) Delivered invited lectures on New sequence motifs that stabilize the cis-conformation of peptidyl-prolyl bonds: in 2nd international symposium on Protein Folding and Dynamics. NCBS, Bangalore, November 5-7, 2014 (ii) delivered invited lectures at DST-Inspire camps at NIT, Ravangla, Sikkim (held on Dec 10-14, 2014) and Institute of Engineering Management, Kolkata (held on 27-31 Jan, 2015) (iii) delivered talk on Electrostatically biased molecular interactions in biology: Adenine-guanine binding and protein-protein interactions: University of Kansas, Lawrence (July 24, 2014), Indiana University, Bloomington (Aug 06, 2014) and University of Delaware, Delaware (Aug 18, 2014) (iv) delivered talk on New Sequence Motifs that stabilize the cisPro conformation in peptides and proteins: Rutgers University, New Jersey (Aug 19, 2014) and New York University, New York (Aug 20, 2014).

Dr. P. Chakrabarti, Senior Professor

Scientific Reports:

Weak non-bonded interactions in the stabilization of protein structures:

Over the past several years we have been analyzing protein structures to identify the manifestation of weak, but geometrically well-defined non-bonded interactions that can stabilize small local structures, which can also be seen in the isolated peptide moieties. This year we collaborated with an international team to write a review article on the role of CH/ π hydrogen bonds in biological macromolecules.

Delineation of structural patterns is of interest to us. π -turns are abundant in protein structures occurring independently or as part of Schellman's motif normally located at the C-terminal end of helices. However, these turns are wider as compared to other turn types, such as β -turn, and we addressed the question if water molecules can be accommodated within these turns. We found the existence of a large number of water-embedded π -turns and also examples where the water can be replaced by the side-chain hydroxyl of Ser or Thr residues.

Publications:

1. Dasgupta B, Dey S and Chakrabarti P. Water and side-chain embedded π -turns (2014). *Biopolymers*, 101, 441-453.
2. Nishio M, Umezawa Y, Fantini J, Weiss MS, and Chakrabarti P. CH/ hydrogen bonds in biological macromolecules (2014). *Phys. Chem. Chem. Phys.* 16, 12648-12683.

**Dr. Tapan K. Dutta**, Professor**Scientific Reports:****Bioinformatic analyses of bacterial ring-hydroxylating oxygenases:**

Based on Branch-site specific analysis, different sets of positively selected residues were detected from homologous ring-hydroxylating oxygenases. The importance of these residues in controlling the substrate specificity, regioselectivity and catalytic efficiency of the multicomponent naphthalene dioxygenase enzyme (NDO) is being observed in mutant strain, generated by site-directed mutagenesis. Specific amino acid substitutions were chosen based on in silico analysis of sequences, primarily between NDO and its homologous enzymes having substrate preferences towards various nitroarene compounds. So far, nine different mutant dioxygenases were constructed by manipulating the substitution of different amino acid residues, either alone or in combination of more than one residue. Currently, the performance of the wild type and mutant enzymes with different nitroarene compounds (nitrobenzene, different isomers of mono-nitrotoluenes, and different isomers of di-nitrotoluenes) is being explored on the basis of biotransformation potentials.

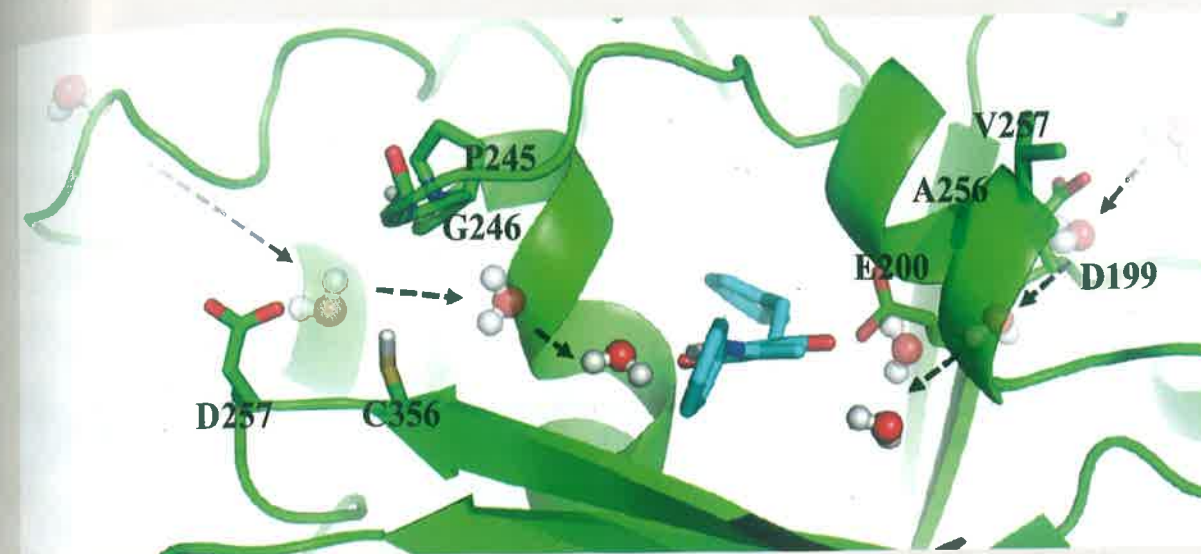
Publication:

1. Chakraborty J, Jana T, Saha S and Dutta T K (2014) Ring-Hydroxylating Oxygenase database: a database of bacterial aromatic ring-hydroxylating oxygenases in the management of bioremediation and biocatalysis of aromatic compounds. *Environ Microbiol Rep.* 6: 519-523.

Dr. Shubhra Ghosh Dastidar, Assistant Professor**Scientific Reports:****Insight into Structural dynamics of biomolecules, leading to drug design:**

The broader area of interest of our group is to gain novel insight into the mechanism of functioning of biomolecules from computational modeling and simulations of their structures. The research projects aim for the fundamental understanding of the molecular recognition processes and to use that knowledge for designing novel therapeutic molecules. The more specific interest is to understand the role of protein flexibility to determine the protein-protein and protein-ligand associations. We use high performance computing (HPC) technology to perform our scientific investigations and work in a truly interdisciplinary manner with active collaborations with experimentalists.

The figure shows the essence of the recent findings on the mechanism of TN16 binding to the α,β -dimer of tubulin. The dynamics of the entry and exit of the water molecules in the core of the β -subunit of tubulin has been found highly correlated with the entropic stabilization of the complex.

**Publications:**

1. Bhar K, Maity A, Ghosh A, Das T, Dastidar SG and Siddhanta A (2015) Phosphorylation of Leghemoglobin at S45 is Most Effective to Disrupt the Molecular Environment of Its Oxygen Binding Pocket, *Protein J.*, Apr;34(2):158-67.
2. Maity A, Majumdar S, Priya P, De P, Saha S and Ghosh Dastidar S (2015) Adaptability in protein structures: structural dynamics and implications in ligand design. *J. Biomol. Struct. Dyn.*, 33(2):298-321. doi: 10.1080/07391102.2013.873002.
3. Priya P, Maity A, Majumdar S, Ghosh and Dastidar S (2015). Interactions between Bcl-xl and its inhibitors: Insights into ligand design from molecular dynamics simulation. *J. Mol. Graph Model*, Jun; 59:1-13.
4. Sinha A, Ray A, Ganguly S, Ghosh Dastidar S, Sarkar S, (2015) variation in the ribosome interacting loop of the Sec61a from Giardia lamblia.

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
Mechanistic insight into the role of conformational Modulations in driving BC12s apoptotic network: Structural dynamics to therapeutic design	DBT

Participation in Conferences / Symposia / Workshops & Invited Talks Delivered at Various Organizations:

Oral Presentation at BII-Brainstorming symposium held at Bioinformatics Institute, Singapore during March 22-25, 2015.

Symposia and Seminar Organized:

Organized 'Conference on Informatics & Integrative Biology (CIIB-2014)' that celebrated the 25 years of the Bioinformatics Centre, Bose Institute; held during Dec 17-19, 2014.

**Dr. Tapash C Ghosh**, Professor**Scientific Reports:****Evolutionary Bioinformatics:**

The major theme of our research is to identify and understand different evolutionary forces by analyzing the genomic and functional data of various organisms to gain insight into the structural and functional organization of a genome. Very briefly, the major results of the last one year (2014-15) are as follows:

- By comparing the orthologous genes of cold and warm blooded vertebrates we provide evidence that high protein disorder in GC rich genes is an evolutionary innovation that provide functional advantages for cell survival and protein stability.
- By comparing 256 prokaryotes from four oxygen requirement groups we proposed that higher protein disorder provides an adaptive opportunity for aerobic microbes. (This work has been evaluated by F1000).
- By analyzing 679 microorganisms having different optimal growth temperatures we found a positive relationship between overlapping gene content and thermophily which will pave the ways to future research on prokaryotic adaptation to extreme temperature.
- Evolutionary studies of human phenotypic disease genes have been conducted to understand the genomic, structural and functional causes of their emergence. Interaction network perturbations were found to be an important factor to the rates of protein evolution.

Publications:

1. Acharya D, Mukherjee D, Podder S, Ghosh TC (2015) Investigating different duplication pattern of essential genes in mouse and human. *PLoS One*. Mar 9;10(3):e0120784.
2. Begum T, Ghosh TC (2014) Elucidating the genotype-phenotype relationships and network perturbations of human shared and specific disease genes from an evolutionary perspective. *Genome Biol Evol*. Oct 5;6(10):2741-2753.
3. Das J, Podder S, Ghosh TC (2014) Insights into the miRNA regulations in human disease genes. *BMC Genomics*. Nov 21;15:1010.
4. Panda A, Ghosh TC (2014) Prevalent structural disorder carries signature of prokaryotic adaptation to oxic atmosphere. *Gene*. Sep 10;548(1):134-141.
5. Panda A, Podder S, Chakraborty S, Ghosh TC (2014) GC-made protein disorder sheds new light on vertebrate evolution. *Genomics*. Dec;104(6 Pt B):530-537.
6. Saha D, Panda A, Podder S, Ghosh TC (2015) Overlapping genes: a new strategy of thermophilic stress tolerance in prokaryotes. *Extremophiles*. Mar;19(2):345-353.

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
Role of protein complexes and protein protein interaction network in eukaryotic protein evolution.	DBT
Understanding causes of codon usage bias in organisms	DBT

Students Awarded Ph.D.:

Name of Student (University/Year)	Title of Thesis
Kamalika Sen (C.U. 2014)	Genomic and functional analysis of the human genes configuring pseudogenes in the frame of evolutionary studies.

Participation in Conferences / Symposia / Workshops & Invited Talks Delivered at Various Organizations:

(i) Delivered talk on November 2014 at School of Life Sciences, Pondicherry University, Pondicherry (invited talk) (ii) delivered talk during September 2014 in EMBO workshop on "The genome: structure, expression and evolution" at Stazione Zoologica, Naples, Italy.

Honours Received:

Elected as Member of Editorial board at (i) BMC Genomics (From 2010 -) (ii) Evolutionary Bioinformatics (From 2013-)

Dr. Zhumur Ghosh, Assistant Professor**Scientific Reports:****Regulatory RNA and stem cell biology:****(a) Elucidating regulatory noncoding RNA (ncRNA) signatures in ovarian cancer and glioblastoma:**

Regulatory RNAs play a major role towards modulating the epigenetics of cancer stem cells. Long noncoding RNAs (lncRNAs) and piwi interacting RNAs (piRNAs) are two important group of regulatory RNAs which have established role in cancer. However, there has been little investigation into the potential role that Piwi and piRNAs or lncRNAs might play in modulating cancer stem cells. This work integrates dry and wet bench techniques to validate the ncRNA-mediated regulatory networks in cancer stem cells.

To fulfil this work we did the following:

- (i) We annotated human and mouse lncRNAs and piRNAs based on their genomic context and have developed two databases based on such analysis [piRNAQuest (BMC Genomics 2014) and lncRBase (PloS ONE 2014)].



(ii) We are checking how their genomic localization influences their functionality.

(b) Investigating the micro regulatory networks in leukemia stem cells:

We are treating AML patient samples to sort out leukemia stem cells using a panel of surface markers which will be further characterized in the lab and further molecular biology assays will be performed to elucidate the dominant microRNA regulatory networks in those cells.

(c) Elucidating the key determinants of the substates (naïve and primed pluripotent states) of pluripotency:

We are analyzing the gene expression datasets corresponding to naïve and primed pluripotent stem cells and are elucidating the key determinants of these pluripotency substates. We shall subsequently perform certain experiments to validate their significance.

(d) Efficient and time effective analysis of next-generation sequence data:

We have successfully designed a computational pipeline for analysing next-generation sequencing data mainly RNA-seq data. The main emphasis has been given on the alignment step which incorporates major resource and time for a particular RNA-seq data analysis. PVT (Pipelined Version of TopHat) [BMC Bioinformatics] is the protocol designed to speed up next-generation sequence analysis. Moreover we have proposed PVT-Cloud which implements PVT pipeline in cloud computing system.

Collaborations: Our lab is involved in various collaborative work within the Institute as well as with Stanford University School of medicine, USA.

Publications:

1. Chakraborty S, Deb A, Maji R K, Saha S and Ghosh Z (2014). LncRBase: An Enriched Resource for lncRNA Information. *PLoS One* 9(9): e108010.
2. Ghosh Z and Mallick B (2014). Cancer stem cells and regulatory RNAs crosstalk: Fostering possibilities for cancer therapies. *BioScience* 64(12):1138-1149.
3. Maji RK, Sarkar A, Khatua S, Dasgupta S and Ghosh Z (2014). PVT: An Efficient Computational Procedure to Speed up Next-generation Sequence Analysis. *BMC Bioinformatics* 15:167.
4. Sarkar A, Maji RK, Saha S and Ghosh Z (2014). piRNAQuest: searching the piRNAome for silencers, *BMC Genomics* 15(1):555.

Conference Proceedings:

1. Deb A, Sarkar A and Ghosh Z (2014). Substates of pluripotency-Elucidating the key Determinants, CIIB-2014.
2. Ghosh Z (2014). Regulatory Networks Modulating Stem cell biology- Key players behind the Screen, 25th Mid-year meeting of Indian Academy of Science at IISc Bangalore.
3. Maji RK, Sarkar A, Khatua S, Dasgupta S and Ghosh Z (2014). PVT: A Cloud adaptable protocol for efficient Next-generation Sequence Analysis, CIIB-2014.

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
Micro-regulatory networks in leukemia stem cells	DBT-RGYI
Epigenetic alteration inducing oncogenicity in stem cell derivatives	ICMR Task Force for Stem Cell research
Jointly with Dr. Sudipto Saha	
Systematic identification of regulatory networks in pluripotent cells integrating coding and noncoding world	ICMR

Participation in Conferences / Symposia / Workshops & Invited Talks Delivered at Various Organizations:

- (i) Delivered a talk at 25th Mid-year meeting of Indian Academy of Science at IISc Bangalore in July 2014 on *Regulatory Networks Modulating Stem cell biology- Key players behind the Screen*.

Group members

- (i) Ranjan Kumar Maji presented a poster at CIIB-2014 in Dec 2014 on PVT: A Cloud adaptable protocol for efficient Next-generation Sequence Analysis (ii) Aritra Deb presented a poster at CIIB-2014 in Dec 2014 on Substates of pluripotency - Elucidating the key Determinants.

Symposia and Seminar Organized:

Organized 'Conference on Informatics & Integrative Biology (CIIB-2014)' that celebrated the 25 years of the Bioinformatics Centre, Bose Institute; held during Dec 17-19, 2014.

Honours Received:

- Dr. Zhumur Ghosh elected as (i) Associate Fellow, Indian Academy of Science (2011-2014) (ii) Editorial Board Member, *Current Bioinformatics*

Resources developed

Databases developed:

- (a) LncRBase (for long noncoding RNAs) (PloS ONE) available at bicresources.jcbose.ac.in/zhumur/lncrbase/
- (b) piRNAQuest-searching the piRNAome for silencers (for piRNAs) (published in BMC Genomics) available at bicresources.jcbose.ac.in/zhumur/pirnaquest/

Software developed:

- (a) PVT- a computational pipeline for spliced alignment in NGS data analysis (published in BMC Bioinformatics) available at bicresources.jcbose.ac.in/zhumur/pvt/



Dr. Debjani Roy, Assistant Professor

Scientific Reports:

A network-based drug repositioning approach using relative scaling and parameterized segregation for Alzheimer's disease:

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. There are very few algorithms for drug repositioning which deal with analysis of target proteins in diseasesome as well as in interactome. In this large scale data analysis we employed human interactomes to build networks which refine the drugs and their target proteins separately using several novel parameters to extract best possible candidates for repositioning. Several drugs have been proposed as the highly significant repositioning candidates for AD. The target proteins of all of these drugs are strongly associated with several AD related biological processes. Thus our study provides the opportunity to identify promising repositioned drugs for AD and prioritize them for further therapeutic use.

Protein-Protein Interaction Network and Structural studies of Alzheimer's disease associated protein GRIP1:

Glutamate receptor interacting protein 1 (GRIP1) containing PDZ domains are implicated to play role in many neurodegenerative disorders including Alzheimer's disease (AD). GRIP1 was found to be differentially expressed and one of the topologically significant protein in the protein-protein interaction network built from protein expression data (LC-MS/MS) of AD patients. Till date very few studies have analyzed the detailed structural basis of PDZ mediated protein interaction of GRIP1. In order to gain better understanding of structural and dynamic basis of these interactions we employed molecular dynamics simulations. The result of MD simulations indicates considerable conformational flexibilities of the PDZ domain of GRIP1 which may require for its multimerization. Our study may provide detailed information about structural basis of PDZ mediated protein interaction of GRIP1 which may lead to novel therapeutic approaches in AD.

MicroRNAs and epigenetics of Alzheimer's disease: Study from the whole human genome:

Alzheimer's disease (AD) is the most prevalent neurodegenerative disease throughout the world. Most of the clinical symptoms of AD appear at a very later stage, therefore, the identification of disease marker is essential which can help proper detection of AD at an earlier stage and slow down its progression. In this work, we have performed a genome wide study to reveal the distribution of AD related proteins and proteins previously not known to be associated with AD. We have constructed regulatory networks involving genes, transcription factors and miRNAs. Several network motifs were studied from the regulatory networks. We have identified the epigenetic modification patterns of regulators of these network motifs. Our study also revealed the long non-coding RNA and other non-coding RNA mediated regulations in AD. AD biomarkers and epigenetic modifications identified in our study will provide insight into new AD therapeutic targets.

Publications:

1. Chatterjee P, Bhattacharyya M, Bandyopadhyay S and Roy D (2014) Studying the system level involvement of MicroRNAs in Parkinson's Disease. PLoS One, 9 (4): e93751.
2. Rakshit H, Chatterjee P and Roy D (2014) A bidirectional drug repositioning approach for Parkinson's disease through network-based inference. Biochemical and Biophysical Research Communications, DOI:10.1016/j.bbrc.2014.12.101.
3. Rakshit H, Rath N and Roy D (2014) Construction and analysis of the protein-protein interaction networks based on gene expression profiles of Parkinson's Disease. PLoS One, DOI: 10.1371/journal. Pone. 0103047.
4. Sengupta S, Roy D, Bandyopadhyay S (2014) Modeling of a new tubercular maltosyl transferase GlgE, study of its binding sites and virtual screening; Molecular Biology Reports; 41: 3549-3560.
5. Sengupta S, Roy D, Bandyopadhyay S (2014) Structural insight into Mycobacterium tuberculosis maltosyl transferase inhibitors: Pharmacophore-based virtual screening, docking and molecular dynamics simulations; Journal of Biomolecular structure and dynamics; DOI: 10.1080/07391102.2014.1003602.

Participation in Conferences / Symposia / Workshops & Invited Talks Delivered at Various Organizations:

Presented (i) poster on "A network-based drug repositioning approach using relative scaling and parameterized segregation for Alzheimer's disease" at Drug Discovery and Therapy World Congress, Boston USA during June 16-19, 2014. This poster was awarded the 'Best Poster' in the Conference.

Dr. Sudipto Saha, Ramalingaswami Fellow

Scientific Reports:

Prediction of linear peptide sequences mediating interactions with SH3, WW and PDZ domains:

The bioinformatics problem of predicting the occurrence of sort Linear Motifs is that these sequences are too short to elicit a statistically significant hit, especially in large protein sequences, to distinguish them from non-functional sites. The traditional approaches of identifying these LMs are exact match (low sensitivity) or search for regular expressions (low sensitivity). We have utilized three well-known supervised machine learning algorithms like Support Vector Machine (SVM), Random forest and Naïve Bayes classifier, to develop prediction models for identifying novel LM sequences binding to specific protein interaction domains like SH3, PDZ and WW and achieved a reasonably high accuracy (high sensitivity and high specificity). We have developed a prediction server, LMDIPred for predicting linear motifs binding to these domains and is available at <http://bicresources.jcbose.ac.in/ssaha4/lmdipred/>

**Biomarker discovery of Asthma using high throughput proteomics approaches: in collaboration with Dr. Swati Gupta Bhattacharya**

Blood samples from healthy and asthma patients were collected and further processed for 2D and Mass Spectrometry. Differentially expressed proteins were subjected for further orthogonal validation.

Publications:

1. Arora G, Tiwari P, Mandal RS, Gupta A, Sharma D, Saha S, Singh R (2014) High throughput screen identifies small molecule inhibitors specific for Mycobacterium tuberculosis phosphoserine phosphatase. *J Biol Chem.* 289(36):25149-65. doi: 10.1074/jbc.M114.597682.
2. Barman RK, Saha S, Das S (2014). Prediction of interactions between viral and host proteins using supervised machine learning methods. *PLoS One.* 9(11):e112034. doi: 10.1371/journal.pone.0112034.
3. Chakraborty J, Jana T, Saha S, Dutta TK (2014). Ring-Hydroxylating Oxygenase database: a database of bacterial aromatic ring-hydroxylating oxygenases in the management of bioremediation and biocatalysis of aromatic compounds. *Environ Microbiol Rep.* 6(5): 519-23.
4. Chakraborty S, Deb A, Maji RK, Saha S, Ghosh Z (2014). LncRBase: an enriched resource for lncRNA information. *PLoS One.* 9(9):e108010. doi:10.1371/journal.pone.0108010.
5. Dhal PK, Barman RK, Saha S, Das S (2014). Dynamic modularity of host protein interaction networks in Salmonella Typhi infection. *PLoS One.* 9(8):e104911. doi: 10.1371/journal.pone.0104911.
6. Maity A, Majumdar S, Priya P, De P, Saha S, Ghosh Dastidar S (2015) Adaptability in protein structures: structural dynamics and implications in ligand design. *J Biomol Struct Dyn.* 33(2):298-321. doi: 10.1080/07391102.2013.873002.
7. Sarkar A, Maji RK, Saha S, Ghosh Z (2014) piRNAQuest: searching the piRNAome for silencers. *BMC Genomics.* 15:555. doi: 10.1186/1471-2164-15-555.
8. Sarkar D, Jana T, Saha S (2015) LMPID: a manually curated database of linear motifs mediating protein-protein interactions. Database (Oxford). pii:bav014. doi: 10.1093/database/bav014.
9. Vukoti K, Yu X, Sheng Q, Saha S, Feng Z, Hsu AL, Miyagi M (2015) Monitoring newly synthesized proteins over the adult life span of *Caenorhabditis elegans*. *J Proteome Res.* 14(3):1483-94. doi: 10.1021/acs.jproteome.5b00021.

Grants-In-Aid Schemes:**Title of the Scheme****Scheme funded by**

in collaboration with Prof. Swati Gupta Bhattacharya
Systematic discovery of biomarkers of asthma caused by common environmental allergens using human plasma proteomics, cytokine profiling and network biology- a systems approach to drug discovery.
Rs. 16,93,099 for the 2015-2016

ICMR

Participation in Conferences / Symposia / Workshops & Invited Talks Delivered at Various Organizations

Attended a EMBO workshop entitled "Advances in protein-protein interaction analysis and modulation" held at Hyeres, France, 9-12 September, 2014



Acharya J.C. Bose with students of Presidency college- 1907



IV. Molecular Medicine :

Participation of Institutional Project-IV for the 12th Five-year Plan (2012-2017)

Dr. P. C. Sil (Coordinator), Dr. P. C. Sen, Dr. Subrata Majumder, Dr. Tanya Das, Dr. Gaurisankar Sa, Dr. N. N. Mandal, Dr. Atin Mandal, Dr. Kuladip Jana, Dr. Anup Kr. Misra, Dr. Mahadeb Pal, Dr. Kaushik Biswas

Introduction:

The primary focus of the division is to study molecules related to health and diseases and manipulating those molecules to improve diagnosis, prevention and treatment of diseases like Cancer, Diabetes, Cardiovascular problems, Leishmaniasis, Tuberculosis etc. The division has initiated programme for developing drugs, i.e. synthetic, from natural source, protein based etc. specific to one or more of the above diseases. With the induction of a few new faculty members having experiences in one or more of the above mentioned areas it is expected that the division will be able to achieve its mandate more effectively in the coming years.

Dr. Kaushik Biswas, Assistant Professor

Scientific Reports:

Molecular mechanisms of tumorigenesis: Understanding the role of gangliosides in tumor growth, progression and metastasis:

We have taken multidirectional approach towards understanding the basis of aberrant ganglioside expression in various tumors as well as studying the consequence of such an abnormal expression in carcinogenesis. In order to assess the role, tumor derived glycosphingolipids play in tumor growth and progression, siRNA mediated knockdown of GM2/GD2-synthase gene expression and consequently GM2 expression in 3 different tumor cell lines, CCF52, SK-RC-26B and A549 resulted in significant reduction in migration of the tumor cell lines, suggesting a plausible role of GM2 in tumor cell migration in vitro. Molecular cloning and over-expression of GM2/GD2- synthase gene in a minimally GM2 expressing cell line, SK-RC-45 resulted in increased GM2 expression and consequent tumor cell migration thereby confirming the pro-migratory role of GM2. Gene expression profiling by DNA microarray analysis of siRNA silenced CCF52 cells displayed a number of differentially expressed genes involved in migration. Validation by western blot analysis confirmed the role of integrin mediated signaling in GM2 mediated tumor cell migration. Data shows that over-expression of select gangliosides like GM2 in tumor cells results in enhanced interaction with membrane bound integrin receptors resulting in activation of the integrin mediated signaling cascades eventually leading to rearrangement of the actin cytoskeleton thereby enhancing directional migration in tumor cells. With an aim to translate these in vitro findings in an in vivo mouse tumor model, TALEN mediated genome editing was done on a GM2 over-expressing variant of mouse kidney cancer cells, Renca-v. We have been able to successfully design and construct TALEN pairs for GM2/GD2-synthase, and subsequently generate a stable and permanent GM2/GD2-synthase knockout mouse cell line (Renca-vGM2syn^{-/-}), which is syngeneic to Balb/c

mouse. GM2-synthase knockout clones exhibit significant reduction in anchorage independent growth (AIG) by reducing anoikis resistance of tumors. With the help of these cells, we have demonstrated the tumor promoting ability of GM2 in vivo using a syngeneic mouse tumor model. Finally, we have initiated a study to find out the basis of over-expression of several ganglioside synthase genes in cancer, currently focusing on the regulation of GM2-synthase gene. Preliminary data suggests that there may be a plausible epigenetic role in the regulation of GM2-synthase gene in cancer, since increased histone acetylation (H3K9 and H3K14) associated with the transcription start site (TSS) of GM2-synthase gene was found to be significantly higher in the tumor cell versus a normal cell. On a different note, we have very recently undertaken a collaborative study (recently sanctioned DBT project), to screen and identify potential anti-inflammatory compounds from natural sources, those by virtue of being anti-inflammatory may be able to protect against chronic inflammation induced disease pathogenesis, like cancer.

Publications:

1. Mahata B, Banerjee A, Kundu M, Bandyopadhyay U and Biswas K (2015) TALEN mediated targeted editing of GM2/GD2-synthase gene modulates anchorage independent growth by reducing anoikis resistance in mouse tumor cells. Scientific Reports, 5: 9048.
2. Parida P K, Sau A, Ghosh T, Jana K, Biswas K, Raha S and Misra AK (2014) Synthesis and evaluation of triazole linked glycosylated 18b-glycyrrhetinic acid derivatives as anticancer agents. Bioorganic & Medicinal Chemistry Letters, 24: 3865-3868.

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
1. Studies on the efficacy of flavonoid and non-flavonoid polyphenols against chronic inflammation induced disease pathogenesis.	DBT
2. Understanding the role of tumor derived glycosphingolipids in carcinogenesis : An in vivo approach	DBT

Dr. Tanya Das, Senior Professor

Scientific Reports:

A. Cancer stem cells: The master-regulators of tumor angiogenesis:

Cells within a tumor are heterogeneous in many respects and angiogenic potential is no exception. According to cancer stem cell (CSC) model, some cells within a tumor mass are inherently more angiogenic than the rest of population and such angiogenic heterogeneity might be due to the presence of variety of differentiation states which are phenotypically different from each other in a tumor. Considering that (i) angiogenesis is the limiting factor for tumor progression, and (ii) CSCs are extremely tumorigenic, it is logical to hypothesize that CSCs might be strong promoters of tumor



angiogenesis. Our effort towards unveiling the truth identified CSCs as the 'master regulators' of breast cancer-induced angiogenesis. CSCs, residing in the hypoxic niche of the tumor mass, secrete high levels of the pro-angiogenic factor VEGF to (i) directly invite endothelial cell migration and network formation, and (ii) optimize the angiogenic potential of non-stem cancer cells (NSCCs). However, failure of anti-VEGF therapy points towards a VEGF-independent tumor angiogenesis. Moreover, since CSCs represent only a minority sub-fraction of cells present in a tumor, an increased angiogenic output of CSCs may only be relevant when CSCs comprise more significant proportion of tumor mass, i.e., during tumor initiation, providing the angiogenic burst required to initiate active angiogenesis and tumor progression. Interestingly, our results show VEGF-independent but VEGFR2-dependent trans-differentiation of CSCs into endothelial-like cells with CD31 marker and network forming ability. In this regard, involvement of neuropilin 1 that utilizes VEGFR2 as co-receptor for VEGF-independent developmental angiogenesis can be envisaged. However, with time when CSCs and NSCCs start producing VEGF, trans-differentiation signal gets 'off' - paving way to VEGF-dependent angiogenesis involving endothelial cells. This knowledge may help in shaping how we can apply anti-angiogenic therapy for cancer regression by targeting the 'master regulators', i.e., CSCs, in years to come.

B. Targeting the molecules underneath inherent chemo-resistance of breast cancer stem cells: An approach towards sensitization by mithramycin:

Chemotherapy resistance is a major clinical challenge for the management of locally advanced breast cancer. Accumulating evidence suggests a major role of cancer stem cells (CSCs) in inherent chemoresistance evoking the requirement of drugs that sensitize CSCs towards chemotherapy. Here, we report that mithramycin A, a known specificity protein (Sp)1 inhibitor, sensitizes inherently resistant breast CSCs (bCSCs) by perturbing the expression of drug efflux transporters, ATP-binding cassette sub-family G, member 2 (ABCG2) and ATP-binding cassette sub-family C, member 1 (ABCC1), survival factors, B-cell lymphoma 2 (Bcl-2) and X-linked inhibitor of apoptosis (XIAP), and, stemness regulators, octamer-binding transcription factor 4 (Oct4) and Nanog, which are inherently upregulated in these cells compared with the rest of the tumor population. In-depth analysis revealed that aberrant overexpression of Sp1 in bCSCs transcriptionally upregulates (1) resistance-promoting genes to protect these cells from genotoxic therapy, and (2) stemness regulators to sustain self-renewal potential of these cells. However, mithramycin A causes transcriptional suppression of these chemoresistant and self-renewal genes by inhibiting Sp1 recruitment to their promoters. Under such anti-survival microenvironment, chemotherapeutic agent doxorubicin induces apoptosis in bCSCs via DNA damage-induced reactive oxygen species generation. Cumulatively, our findings raise the possibility that mithramycin A might emerge as a promising drug in combinatorial therapy with the existing chemotherapeutic agents that fail to eliminate CSCs. This will consequently lead to the improvement of therapeutic outcome for the treatment-resistant breast carcinomas.

C. An approach towards management of acquired chemo-resistance: Role of aspirin in sensitizing breast cancer stem cells:

Acquired chemo-resistance that is gained has curtailed cancer survival since the dawn of the chemotherapy. Accumulating evidences suggest a major role of cancer stem cells (CSCs) in chemo-

resistance though their involvement in acquired chemo-resistance is still not known. Here, we explored the contribution of CSCs in acquired chemoresistance and the avenues for reversing such effects by FDA-approved drug aspirin. We observed that the residual risk of recurrence was higher in patients with acquired chemo-resistance. A search for the underlying mechanisms revealed that in response to genotoxic drug combination, pre-existing CSCs generate NF κ B-IL-6-dependent inflammatory environment which (i) imparts stemness in NSCCs, and (ii) up-regulates multi-drug resistance as well as migration potential in total CSC-population. Treatment with aspirin prior to chemotherapy restrains acquired chemo-resistance by perturbing nuclear translocation of NF κ B in pre-existing CSCs which disrupts NF κ B-IL-6 feedback loop, thereby (i) resisting cellular plasticity, and (ii) sensitizing pre-existing CSCs to chemotherapy. Aspirin may, therefore, in combination with conventional chemotherapeutics, present a new treatment strategy for improving recurrence-free survival of breast cancer patients.

D. Inhibition of breast cancer stem cell migration by amplifying the E-cadherin/ β -catenin negative feedback loop:

The existence of cancer stem cells (CSCs) has been associated with tumor initiation, therapy resistance, tumor relapse, angiogenesis, and metastasis. Curcumin, a plant polyphenol, has several anti-tumor effects and has been shown to target CSCs. Here, we aimed at evaluating (i) the mechanisms underlying the aggravated migration potential of breast CSCs (bCSCs) and (ii) the effects of curcumin in modulating the same. Our results showed that bCSCs are endowed with aggravated migration property due to the inherent suppression of the tumor suppressor, E-cadherin, which is restored by curcumin. A search for the underlying mechanism revealed that, in bCSCs, higher nuclear translocation of beta-catenin (i) decreases E-cadherin/beta-catenin complex formation and membrane retention of beta-catenin, (ii) upregulates the expression of its epithelial-mesenchymal transition (EMT)-promoting target genes (including Slug), and thereby (iii) downregulates E-cadherin transcription to subsequently promote EMT and migration of these bCSCs. In contrast, curcumin inhibits beta-catenin nuclear translocation, thus impeding trans-activation of Slug. As a consequence, E-cadherin expression is restored, thereby increasing E-cadherin/beta-catenin complex formation and cytosolic retention of more beta-catenin to finally suppress EMT and migration of bCSCs. Cumulatively, our findings disclose that curcumin inhibits bCSC migration by amplifying E-cadherin/beta-catenin negative feedback loop.

Publications:

1. Adhikary A, Chakraborty S, Mazumdar M, Ghosh S, Mukherjee S, Manna A, Mohanty S, Nakka KK, Joshi S, De A, Chattopadhyay S, Sa G, Das T (2014) Inhibition of epithelial to mesenchymal transition by E-cadherin up-regulation via repression of slug transcription and inhibition of E-cadherin degradation: dual role of scaffold/matrix attachment region-binding protein 1 (SMAR1) in breast cancer cells. *J Biol Chem.* 289:25431-44.
2. Chakraborty S, Das K, Saha S, Mazumdar M, Manna A, Chakraborty S, Mukherjee S, Khan P, Adhikary A, Mohanty S, Chattopadhyay S, Biswas SC, Sa G, Das T (2014) Nuclear matrix



protein SMAR1 represses c-Fos-mediated HPV18 E6 transcription through alteration of chromatin histone deacetylation. *J Biol Chem.* 289:29074-85.

3. Chaudhuri S, Singh MK, Bhattacharya D, Acharya S, Chatterjee S, Kumar P, Bhattacharjee P, Basu AK, Sa G, Das T, Ghosh TK, Chaudhuri S (2014) The novel immunotherapeutic molecule T11TS modulates glioma-induced changes of key components of the immunological synapse in favor of T cell activation and glioma abrogation. *J Neurooncol.*, 120:19-31.
4. Saha S, Bhattacharjee P, Mukherjee S, Mazumdar M, Chakraborty S, Khurana A, Nayak D, Manchanda R, Chakrabarty R, Das T, Sa G (2014) Contribution of the ROS-p53 feedback loop in thujva-induced apoptosis of mammary epithelial carcinoma cells. *Oncol Rep.*, 31:1589-98.
5. Bhattacharya S, Ahir M, Patra P, Mukherjee S, Ghosh S, Mazumdar M, Chattopadhyay S, Das T, Chattopadhyay D, Adhikary A (2015) PEGylated-thymoquinone-nanoparticle mediated retardation of breast cancer cell migration by deregulation of cytoskeletal actin polymerization through miR-34a. *Biomaterials*, 51:91-107.
6. Ghosh S, Adhikary A, Chakraborty S, Bhattacharjee P, Mazumder M, Putatunda S, Gorain M, Chakraborty A, Kundu GC, Das T, Sen PC (2015) Cross-talk between endoplasmic reticulum (ER) stress and the MEK/ERK pathway potentiates apoptosis in human triple negative breast carcinoma cells: role of a dihydropyrimidone, nifetepimine. *J Biol Chem.* 290:3936-49.
7. Mahata B, Biswas S, Rayman P, Chahlavi A, Ko J, Bhattacharjee A, Li YT, Li Y, Das T, Sa G, Raychaudhuri B, Vogelbaum MA, Tannenbaum C, Finke JH, Biswas K (2015) GBM Derived Gangliosides Induce T Cell Apoptosis through Activation of the Caspase Cascade Involving Both the Extrinsic and the Intrinsic Pathway. *PLoS One.* 10(7):e0134425. doi: 0.1371/journal.pone.0134425.
8. Mukherjee S, Mazumdar M, Chakraborty S, Manna A, Saha S, Khan P, Bhattacharjee P, Guha D, Adhikary A, Mukherjee S, Das T (2014) Curcumin inhibits breast cancer stem cell migration by amplifying the E-cadherin/ β -catenin negative feedback loop. *Stem Cell Res Ther*, 5(5):116. doi: 10.1186/s13046-014-0116-0.
9. Mukherjee S, Saha S, Manna A, Mazumdar M, Chakraborty S, Paul S and Das T (2015) Targeting cancer stem cells by phytochemicals: A multi-modal approach to colorectal cancer. *Current Colorectal Cancer Rep.* (Ed. Anand Srikant) Springer Science, USA.
10. Saha S, Bhattacharjee P, Guha D, Kajal K, Khan P, Chakraborty S, Mukherjee S, Paul S, Manchanda R, Khurana A, Nayak D, Chakrabarty R, Sa G, Das T (2015) Sulphur alters NF κ B-p300 cross-talk in favour of p53-p300 to induce apoptosis in non-small cell lung carcinoma. *Int J Oncol.*, 47:573-82.
11. Saha S, Mukherjee S, Mazumdar M, Manna A, Khan P, Adhikary A, Kajal K, Jana D, Sa G, Mukherjee S, Sarkar DK, Das T (2015) Mithramycin A sensitizes therapy-resistant breast cancer stem cells toward genotoxic drug doxorubicin. *Transl Res.*, 165:558-77.

Students Awarded Ph.D:

Name of Student	Title of thesis
Dr. Samik Chakraborty (C.U., 2015)	Understanding the mechanisms of tumor angiogenesis and apoptosis: An approach towards molecular interventions

Grants-In-Aid Schemes:

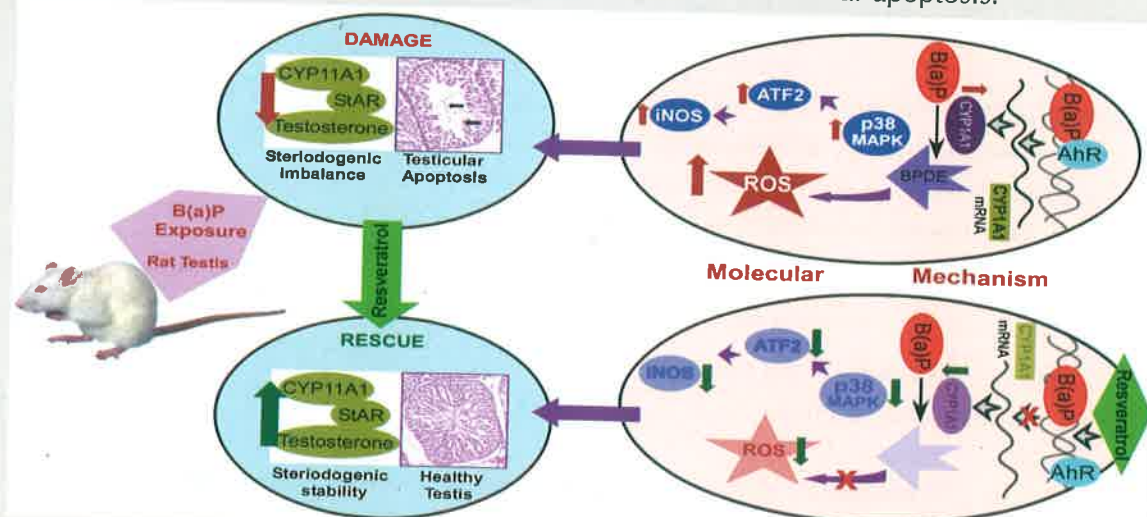
Title of the Scheme	Scheme funded by
Mapping the molecular mechanisms of resistance-to-Apoptosis switch over of non small-cell lung carcinoma by curcumin: An approach towards chemo-sensitization	DST
Binning stochastic phenotypic states of cancer cell population in different color box (As Co-PI)	DBT
Targeted alteration of MAPK family members ERK and p38MAPK/JNK to channelize oncogenic Ras-induced proliferative-signaling into apoptotic-signaling (As Co-PI)	DST
Remodeling the cellular calcium homeostasis By ethyl-4-(3-nitro)-phenyl-6-methyl-2-oxo-1,2,3,4-tetra-pyrimidine-5-carboxylate (Nifetepimine): A mechanistic approach towards cancer regression and immune-rejuvenation. (As Co-PI)	DAE
miR 325: a Distinct miRNA that controls T regulatory cell development and function.	DST

Participation in Conferences / Symposia / Workshops & Invited Talks delivered at Various Organizations:

(i) Chaired a scientific session and delivered an invited lecture at the International Conference on Cell Signaling Network, Kolkata, 2014 (ii) delivered invited talk at the Asian Conference on Environmental Mutagenesis, Kolkata, 2014 (iii) participated in the annual meeting of Molecular Immunology Forum, Bhubaneswar, 2015 (iv) chaired a scientific session and delivered a talk at the International Stem Cell Meeting, Pune, 2015 (v) delivered an invited lecture at the International Conference on Angiogenesis, Trichy, 2015.

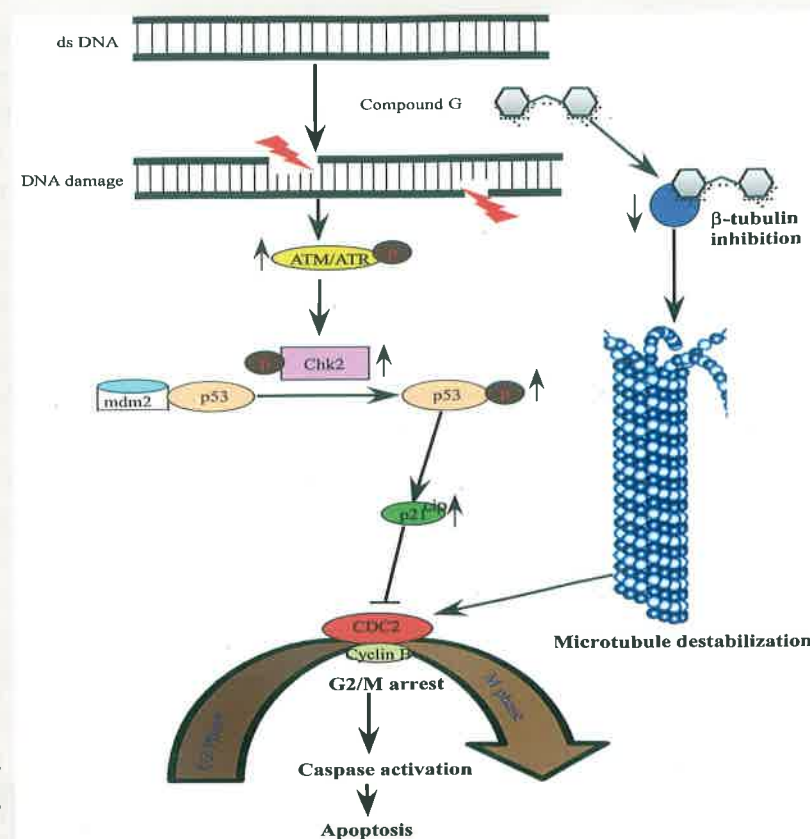
**Dr. Kuladip Jana**, Senior Scientist**Scientific Reports****(A) 3, 5, 4'-trihydroxy-trans-stilbene ameliorates benzo(a)pyrene induced testicular dysfunction and apoptosis through p38 MAPK/ATF2/iNOS signaling: in collaboration with Dr. P. C. Sen**

Benzo(a)pyrene (B(a)P) is an environmental toxicant that alters the steroidogenic profile of testis and induces testicular dysfunctions. We have investigated the ameliorative potential of the natural aryl hydrocarbon receptor (AhR) antagonist and antioxidant Resveratrol on B(a)P induced male reproductive toxicity. Our study highlighted that resveratrol co-treatment with B(a)P maintained testicular redox potential, increased serum testosterone level and prevented steroidogenic dysfunction by the enhancement of major testicular steroidogenic proteins (CYP11A1, StAR, 3 β HSD, 17 β HSD) expression relative to treatment with B(a)P only. Resveratrol suppresses B(a)P-induced testicular activation of p38 MAPK, ATF2 and iNOS production, thereby improves the oxidative status of the testis and inhibits apoptosis. Resveratrol co-treatment also decreased B(a)P-induced AhR protein level, its nuclear translocation and subsequent CYP1A1 promoter activation, thereby decreased protein and mRNA levels of testicular cytochrome P4501A1 (CYP1A1), which is the major B(a)P metabolizing agent for BPDE-DNA adduct formation. Our findings cumulatively suggest that resveratrol prevents activation of B(a)P by modulating the transcriptional regulation of CYP1A1 and acting as an antioxidant thus prevents B(a)P-induced oxidative stress and testicular apoptosis.

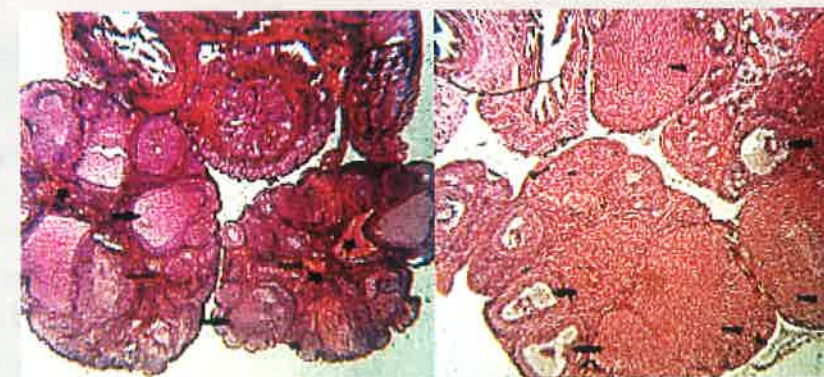
**(B) A novel stilbene derivative (Z)-3-(3, 4-dimethoxyphenyl)-2-(3, 4, 5-trimethoxyphenyl) acrylonitrile targets β -tubulin, triggers G2/M arrest and apoptosis in human cancer Cell lines: in collaboration with Dr. Kaushik Biswas & Dr. Anup Misra**

Microtubule-targeting agents (MTAs) are the most reliable antimitotics, can be used as anticancer drugs. We have identified a novel stilbene derivative, compound G (Z)-3-(3, 4-dimethoxyphenyl)-2-(3, 4, 5-trimethoxyphenyl) acrylonitrile which targets β -tubulin leads to proliferation inhibition, G2/M arrest and apoptosis in human cancer cells including MCF-7, MDA-MB-231, T47D, HeLa, A549, HCT116, SK-RC-45 etc *in vitro*. The compound exhibits lesser

cytotoxic towards non-tumorigenic normal human cell lines including MCF-10A, WI-38 and NKE cells markedly more resistant to mitotic arrest compared with cancer cells. Further to depict the precise mechanism of action of the compound we have used the technique like c-DNA microarray and the array data was validated by conventional biochemical techniques like proteome profiling, (apoptosis), western blotting, qRT-PCR etc. Further to check the therapeutic potential, the compound will be tested *in vivo* using syngeneic tumor models in either Balb/c or C57 BL/6 mice. Syngeneic tumors will be developed in mice by either subcutaneous or tail vein injection. Therapeutic efficacy of the compounds will be studied by the ability of the compounds in either blocking or delaying tumor growth, progression or metastasis.

**(C) Exploration of molecular cross-talk involved in the roadmap to hyperhomocysteinemia-induced pregnancy loss in PCOS:**

Women with pregnancy wastage encompass a wide range of phenotypes since list of candidate causes have grown rapidly in last few years. Obesity and insulin resistance (IR) remain as the most talked about features in pregnancy loss etiology. Recent evidence suggests a causal association between hyperhomocysteinemia (HHcy) and pregnancy loss; with mild-to-moderate degree of HHcy leads to a 3-fold increase in the risk of early pregnancy wastage. Moreover, over the last decade, evidence has accumulated to suggest that some cases of pregnancy wastage and later pregnancy complications are due to an exaggerated haemostatic response during pregnancy leading to placental thrombosis and infarction. Therefore, proper understanding of the

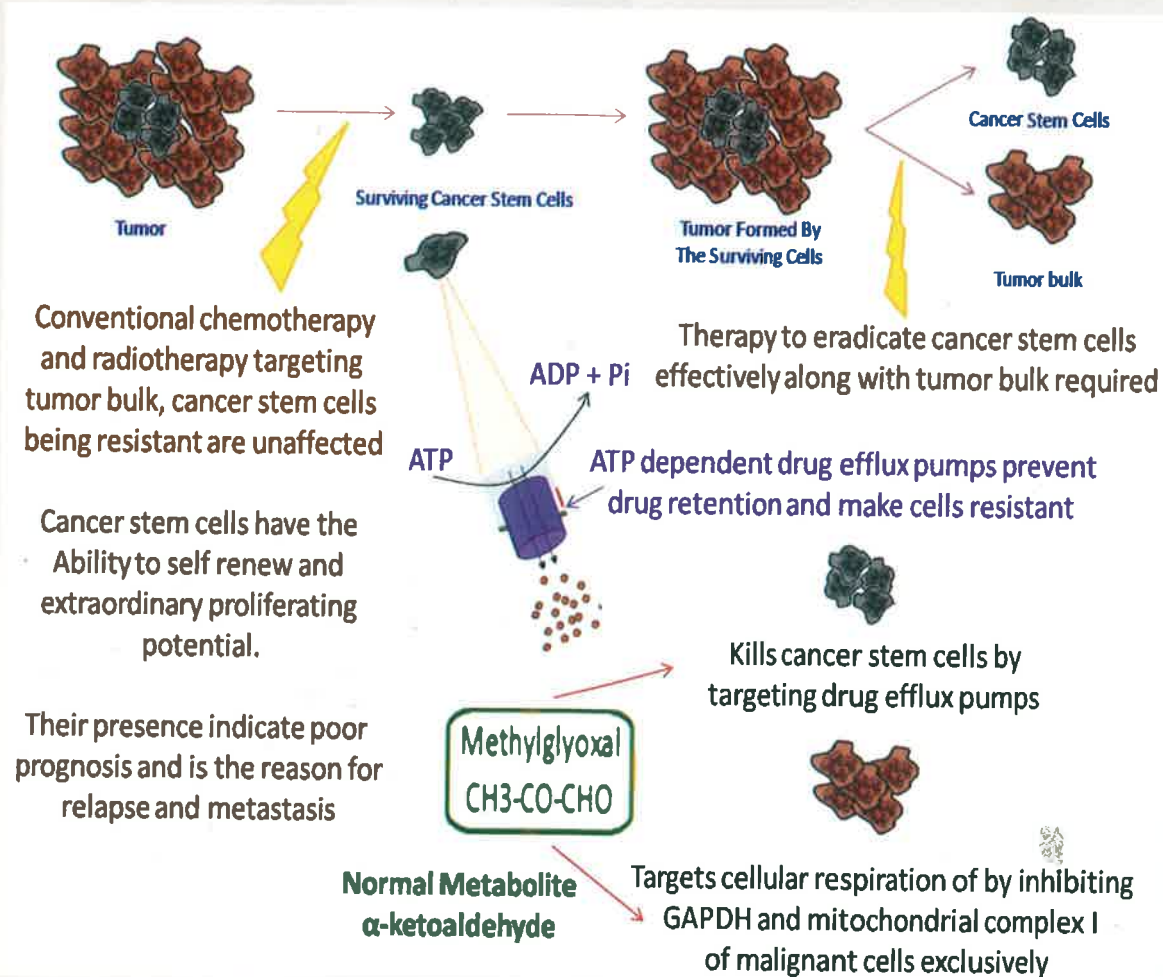




underlying pathogenesis is an absolute necessity. Bone morphogenetic proteins (BMP) are the principal players in the maturation phase of angiogenesis. Recent reports have documented inhibition of neo-angiogenesis by BMP-9 and therefore have a greater possibility to contribute in the arena of pregnancy loss. The current project may cue towards the mechanism through which hyperhomocysteinemia brings about pregnancy loss which may bring the advent of newer drugs against it. Furthermore, to substantiate a cause and effect relationship between HHcy and pregnancy wastage elucidation of candidate genes associated with the disease are conducting by qRT-PCR and microarray studies to investigate global placental gene expression.

(D) Targeted delivery of nano-conjugated Methylglyoxal to cancer cells and understanding the bioenergetics difference between normal and malignant cells at the molecular level: in collaboration with Dr. Manju Ray, Department of Biophysics

The α -ketoaldehyde methylglyoxal, a normal metabolite has been established as a potent cellular growth regulator and anti cancer agent. The tumoricidal effect of Methylglyoxal has been attributed to its ability to inhibit the oxygen consumption of malignant cells specifically compared to normal cells by blocking glycolysis and mitochondrial respiration. Recent observations reveal inhibition of Glyceraldehyde-3-phosphate dehydrogenase and mitochondrial complex I in malignant cells compared to normal cells by methylglyoxal which seeks further



investigation for understanding the signalling pathways involved and their underlying regulation. The potential of the normal metabolite to act as anti cancer drug and also this new age of using nanoparticles demands the study of a nano-conjugated methylglyoxal drug which can be more effective against cancer.

Publications:

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2. Banerjee A, Sanyal S, Majumder P, Chakraborty P, Jana K, Das C, Dasgupta D (2015) Recognition of chromatin by the plant alkaloid, ellipticine as a dual binder. *Biochem. Biophys. Res. Commun.*, 462:352-7.
3. Jana K, Dutta A, Chakraborty P, Manna I, Firdaus SB, Bandyopadhyay D, Chattopadhyay R, Chakravarty B (2014) α - lipoic acid and N-acetylcysteine protects intensive swimming exercise mediated germ cell depletion, pro-oxidant generation and alteration of steroidogenesis in rat testis. *Mol. Reprod. Dev.*, 81: 833-50.
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5. Nandi P, Banerjee B, Ghosh S, Chakraborty A, Jana K and Sen P C (2014) Involvement of nifetepimine in motility and capacitation of caprine spermatozoa. *Am. J. Expt. Biol.*, 1: 61-84.
6. Ray M, Rai N, Jana K, Ghatak S, Basu A, Mustafi SB, Raha S (2015) Beta catenin is degraded by both caspase-3 and proteasomal activity during resveratrol-induced apoptosis in HeLa cells in a GSK3b-independent manner. *Ind. J. Biochem. Biophys.*, 52:7-13.
7. Syed Benazir Firdaus, Ghosh A, Chattyopadhyay A, Jana K & Bandyopadhyay D (2014) Protective effect of antioxidant rich aqueous curry leaf (*Murraya koenigii*) extract against gastro-toxic effects of piroxicam in male Wistar rats. *Toxicol. Reports*, 1: 987-1003.

Grants-in-Aid Schemes :

Name of the Scheme	Scheme Funded by
Molecular Signalling involved the pathophysiological action of common air pollutant Benzo(a) pyrene in testicular DNA damage and apoptosis in connection to male infertility. Possible protection by Natural aryl hydrocarbon receptor antagonists	DST
Targeted delivery of Nano-conjugated Methylglyoxal to Cancer cells and understanding the bio-energetics difference between normal and malignant cells at molecular level.	DST



Dr. Subrata Majumdar, Senior Professor

Scientific Reports:

Macrophage heterogeneity dictates *Leishmania* fate: with Dr. Shyamdas Bandyopadhyay

Macrophages are available in all tissues and organs in vertebrates. It is known that considerable morphological differences among macrophage populations could be attributed to their heterogeneity, which may be significant for their versatile participation in immune responses during *L. donovani* infection in context with an immunomodulator like Ara-LAM. Therefore, it is important to examine the phenotypic and functional differences in response to Ara-LAM amongst *L. donovani*-infected macrophages obtained from different origins, like spleen, liver and peritoneum, and that could provide clues to guide their further experimental or therapeutic use.

Identification of novel kinases and phosphatases regulating *Leishmania* infection: with Shabina Parveen and Saikat Majumder

In this study, we screened the human phosphatases and tyrosine kinases siRNA libraries assessing *L. donovani* survival in the human macrophage-like cell line, THP-1. Once the kinases and the phosphatases affecting *L. donovani* survival were identified, we screened for IL-10 production from *L. donovani*-infected macrophages. Combining both parasite control and IL-10 induction, we identified seven phosphatases and Btk, which were further screened for their anti-leishmanial effects in TLR2- silenced TLR9-stimulated human macrophages. These experiments identified MTMR6 and Btk as the major dual-specific phosphatase and the tyrosine kinase affecting *Leishmania* survival in macrophages. The importance of these observations was further validated by their expressions in visceral leishmaniasis patients and *L. donovani* infected macrophages. Expression p38 MAPK and ERK1/2 were checked in THP-1 cell line upon silencing of MTMR6 and Btk validated the significance of these two signaling intermediates in *L. donovani* infection. Beside that we are also studying the regulation Dual Specific Phosphatases upon Mw treatment during Visceral Leishmaniasis.

***Leishmania* driven PGE2 production is critically dependant on phospholipases: with Amrita Bhattacharjee**

This study aimed to elucidate the signaling events responsible for *Leishmania*-infection-induced PGE2 generation, in an attempt to understand which components could be modulated to block its immunosuppressive effects. *L. donovani* stimulated PGE2 release from infected macrophages required cytosolic phospholipase A2 (cPLA2) activation. This activation, and subsequent PGE2 generation was phagocytosis independent, and mediated via TLR2 signalling. Further, during early infection *Leishmania* induced Phospholipase C(PLC) activity downstream of TLR2. PLC activation triggered a calcium flux, which, along with ERK activation, was indispensable for cPLA2 activation post infection. In addition, this PLC driven calcium also activated the Ca^{++} -calcieneurin-NFAT pathway. NFAT then induced Cyclooxygenase 2(COX2) expression. This study underlines the critical role of PLA2 and PLC in leishmanial pathogenesis.

Dendritic cell vaccination protects *Leishmania* via generation of Th17 cells: with Dr. Junaid Jibrán Jawed

In our study we have used soluble leishmanial antigen (SLA) and peptidoglycan (PGN) stimulated bone marrow derived dendritic cell for vaccination against visceral leishmaniasis caused by protozoan parasite *Leishmania donovani*. During vaccination we have found that the expression of pro-inflammatory cytokines like IL-17, IL-12 and IFN- γ has been significantly increased with significant decrease in the expression of anti-inflammatory cytokine IL-10 keeping TGF- β unaltered. The major source of IL-17 production has found to be Th-17 cells. So we are focusing on the role of DC during vaccination in the generation of Th-17 cells. We have found that during vaccination the level of those cytokines which are necessary for the generation and proliferation of Th-17 cells i.e. IL-6 and IL-23 have also increased. So we are now trying to know the role of dendritic cell's intracellular signaling comprising the effect of regulation of these soluble factors and the role of DC specific PKCs which are essential during DC mediated Th-17 cell generation.

Mw protects *Mycobacterium tuberculosis*-infected C57BL/6 mice by regulating Treg cells: with Shibali Das

Mycobacterium tuberculosis-infected C57BL/6 mice showed a strong host-protective Th1 immune response during MIP (*Mycobacterium indicus pranii*) treatment due to reduced IL-10 and TGF- β production, along with marked decrease in $CD4^{+} CD25^{+} Foxp3^{+} GITR^{+} CTLA4^{+}$ regulatory T cell (Treg) generation and activation. The reduction in Foxp3 expression was due to effective modulation of transcription factor STAT4 and STAT5 in Treg cells by MIP. Interestingly, *stat4* gene knock down completely abrogated the effect of MIP treatment on Treg cells, thus, providing a mechanistic insight into MIP mediated modulation of Treg cells, which might be helpful in combating tuberculosis.

Ara-LAM protects *Leishmania donovani*-infected BALB/c mice by regulating Treg cells: with Bidisha Paul Chowdhury

Ara-LAM pre-treated *Leishmania donovani*-infected BALB/c mice showed a strong host-protective Th1 immune response due to reduced IL-10 and TGF- β production, along with marked decrease in $CD4^{+} CD25^{+} Foxp3^{+} GITR^{+} CTLA4^{+}$ regulatory T cell (Treg) generation and activation. The reduction in Foxp3 expression was due to effective modulation of TGF- β induced SMAD signaling in Treg cells by Ara-LAM. Moreover, Ara-LAM induced IRF1 expression in the Treg cells, which negatively regulated *foxp3* gene transcription, resulting in the reduced immunosuppressive activity of Treg cells. Interestingly, *irf1* gene knock down completely abrogated the effect of Ara-LAM on Treg cells, thus, providing a mechanistic insight into Ara-LAM mediated modulation of Treg cells, which might be helpful in combating VL.

Tumor microenvironment regulation via ceramide: with Sweta Ghosh

Current therapeutic strategies to prevent cancer include targeting the cell's own cellular components as well as its micro environmental niche. In this project, we are trying to investigate the immunological modulation in cancer with respect to ceramide signaling and to utilize the



outcomes for tumor regression. Initial approaches of our study are – Investigation of mechanistic details of cisplatin mediated apoptosis in terms of ceramide signaling and role of TNF- α , determination of PKC ζ mediated tumor-micro environmental regulation in melanoma, neutralization of tumor microenvironment by using an immunomodulator, Mw.

Involvement of PKC signaling in B16F10 melanoma: with Kuntal Halder

The present study for the first time has shown a way via which differential regulation of PKC isotypes monitors immune cell and tumor cell functioning at the tumor microenvironment and subverts the growth and immune evasion mechanism of growing solid tumors. Moreover, this study has depicted the mechanism of effective anti-cancer immunotherapeutic treatment strategies against advanced stage solid tumors by reprogramming the functional discrepancy of PKC isotypes in modulating two important components of the tumor immune microenvironment namely effector T cell function and matrix metalloproteinase inhibition.

Publications:

1. Banerjee S, Halder K, Ghosh S, Bose A and Majumdar S (2015) The combination of a novel immunomodulator with a Treg suppressing antibody (DTA-1) regress advanced stage B16F10 solid tumor by repolarizing tumor associated macrophages in situ. *Oncoimmunology*, Jan 30;4(3):e995559. eCollection 2015 Mar. PMID: 25949923.
2. Bhattacharjee A, Majumder S, Bhattacharyya Majumdar S, Roy Choudhuri S.K, and Majumdar S (2015) Co-administration of Glycyrrhizic Acid with antileishmanial drug Sodium Antimony Gluconate (SAG) cures SAG-resistant viscera leishmaniasis. *Int. J. Antimicrob. Chemother.* Mar;45(3):268-77. doi:10.1016/j.ijantimicag. 2014.10.023. Epub 2014 Dec 8. PMID: 25600891
3. Chowdhury BP, Bandyopadhyay S, Das S, Majumder S, Jha MK, Majumdar SB, Saha, Majumdar S (2015) The Host-Protective Effect of Arabinosylated Lipoarabinomannan against Leishmania donovani Infection Is Associated with Restoration of IFN- γ Responsiveness. *PLoS One*. 2015 Feb 6;10(2):e0117247. doi:10.1371/journal.pone.0117247. eCollection 2015.
4. Das S, Banerjee S, Majumder S, Paul Chowdhury B, Goswami A, Halder K, Chakraborty U, Pal NK, Majumdar S, (2014) Immune subversion by Mycobacterium tuberculosis through CCR5 mediated signaling: involvement of IL-10. *PLoS One*, 2; 9(4):e92477. doi: 10.1371/journal.pone.0092477. eCollection.
5. Das S, Bhattacharjee O, Goswami A, Pal N. K, and Majumdar S (2015) Arabinosylated Lipoarabinomannan (Ara-LAM) mediated intracellular mechanisms against Tuberculosis infection: Involvement of Protein Kinase C (PKC) Mediated Signaling. *Tuberculosis*. Mar, 95(2):208-16. doi: 10.1016/j.tube.2014.11.007. Epub 2014 Dec 11. PMID: 25544312
6. Majumder S, Bhattacharjee A, Paul Chowdhury B, Bhattacharyya Majumdar S, Majumdar S. (2014) Antigen-Pulsed CpG-ODN-Activated Dendritic Cells Induce Host- Protective Immune Response by Regulating the T Regulatory Cell Functioning in Leishmania donovani-Infected Mice: Critical Role of CXCL10. *Front Immunol*. Issue June 4;5:261. doi: 10.3389/fimmu.2014.00261. eCollection.

7. Roy N, Chakraborty S, Paul Chowdhury B, Banerjee S, Halder K, Majumder S, Majumdar S and Sen P C (2014) Regulation of PKC Mediated Signaling by Calcium during Visceral Leishmaniasis *PLoS One*. Vol 9(10) e110843

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
Mechanistic insights into dendritic cell maturation and its role in Leishmania donovani: Emphasis on dendritic cell cased anti-leishmanial therapy	CSIR
Host phosphatases and kinases participating in CD40-induced anti-leishmanial Vs Pro-leishmanial pathways	DBT
TLR-2dependent engagement of the host cell kinases and phosphatases that dictate disease progression or resolution	DBT

Participation in Conferences / Symposia / Workshops & Invited Talks delivered at Various Organizations:

- (i) Invited speaker in the Chemi-Quiz symposium at Presidency University, Kolkata on Feb 20, 2015 (ii) invited speaker in the 4th ACEM conference at IICB, Kolkata on 11th Dec. 2014 (iii) invited speaker at Jadavpur University, Pharmacology Department, AICTE programme on 'Future Direction of Pharmaceutical Studies and Research' July and Nov. 2014.

Dr. Atin Kumar Mandal, Assistant Professor

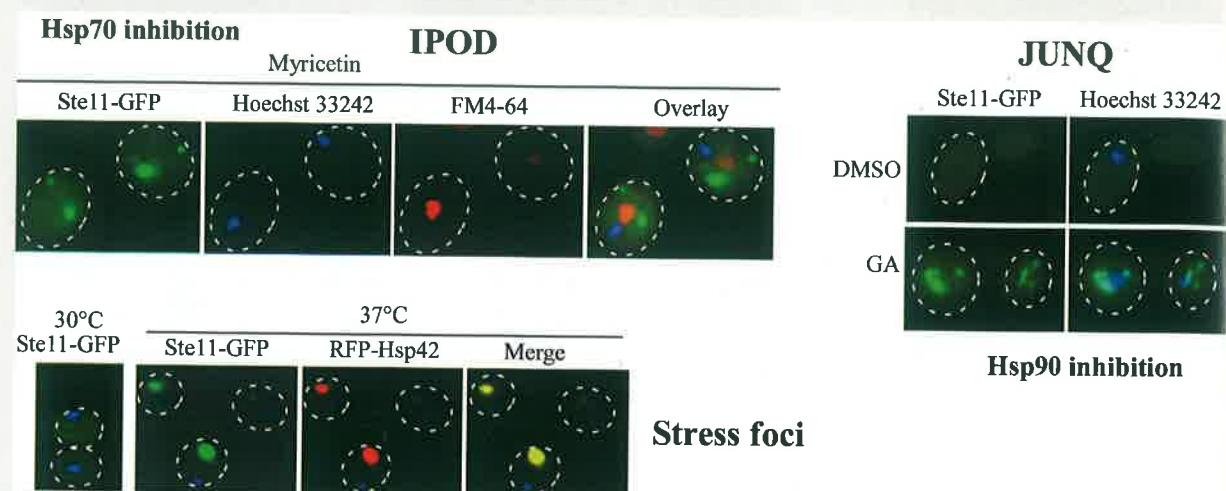
Scientific Reports:

Role of chaperones in maintaining protein kinase quality control:

Protein quality control is deregulated in various disease conditions including cancer, hypertrophic cardiomyopathy, late onset neurological diseases etc. This quality control is maintained by the synchronized role of folding and degradation machineries. The goal of the studies is to elucidate the collaboration of molecular chaperones and degradation machineries in maintaining the homeostasis of proteins, particularly protein kinase. In order to address this question we choose two model systems. First, lower eukaryote *Saccharomyces cerevisiae* which conserve protein quality control mechanism similar to higher eukaryote with an advantage to study the process by genetic as well as pharmacological manipulation; second, mammalian cell culture for relevance of the obtained results. In *Saccharomyces cerevisiae* we identify that misfolded kinases are sequestered into different quality control compartments. Kinases accumulated as insoluble aggregates (non-ubiquitinated) when chaperone Hsp70 is inhibited, but soluble aggregates (ubiquitinated) are formed which are prone to degradation when Hsp90 chaperone is inhibited. In contrast, stress foci are appeared during heat stress. The partitioning of kinases to different compartments depends on the ubiquitination status of the substrate. Hsp70 promotes



ubiquitination of kinases. Overexpression of Hsp70 clears these aggregates via the proteasome and protects yeast cells from oxidizing agent H₂O₂ or amino acid analogue that generates misfolded proteins. ATPase activity of Hsp70 is essential for these functions. Thus, distinct behaviors observed for two major chaperones in cell. Hsp90 keeps the kinase in functional form whereas Hsp70 works when the protein is misfolded. However, differential role Hsp90 chaperone was observed for mammalian Raf1 kinase whose mutation attains gain-of-function and develops diseases including hypertrophic cardiomyopathy, cancer etc. Results from yeast and mammalian cell show essential role of Hsp90 in maintaining Raf1's stability and activity by facilitating its conserved S621 phosphorylation. Strikingly, Hsp90 recruitment to the folded Raf1 is not for its stability, rather essential for signal mediated Raf1 activation.



Publications:

- Roy J and Mandal AK (2014) Cellular strategies to combat protein misfolding: Intricate role of Hsp70 in stress management. *Current Chemical Biology*, 8: 149-164.
- Roy J, Mitra S, Sengupta K and Mandal AK (2015) Hsp70 clears misfolded kinases that partitioned into distinct quality control compartments. *Molecular Biology of Cell*, 26:1583-1600.

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
Raf1 quality control and development of pathological conditions	DBT

Participation in Conferences / Symposia / Workshops & Invited Talks delivered at Various Organizations:

- Presented poster at 'Molecular Chaperones & Stress Responses' meeting at Cold Spring Harbor Laboratory, NY, USA, April 29 - May 3, 2014
- delivered invited talk at Worcester Polytechnic Institute, Worcester, MA, USA on 5th May, 2014

Dr. Nripendranath Mandal, Professor

Scientific Reports:

Achievements from Marine Biotechnology research:

Prevalence of White spot disease and disease resistance in shrimp, *Penaeus monodon*:

White spot disease (WSD) caused by white spot syndrome virus (WSSV) creates severe epizootics in captured and cultured black tiger shrimp, resulting a huge loss in the economic output of the aquaculture industry worldwide, including India. In the approach towards plausible remedy from WSD, one RAPD-SCAR marker of 457 bp was previously developed to identify disease resistant population of *Penaeus monodon* from our **Marine Biotechnology** research program. After DNA sequencing for molecular characterization, both the original 502 bp RAPD marker and 457 bp RAPD-SCAR marker had no similarity with the known NCBI/EMBL/ DDBJ genbank and so, these novel sequences were submitted to the NCBI genbank database. Moreover, both WSSV prevalence and disease resistant prevalence were studied among the cultured and wild captured populations of *P. monodon*. For this reason, cultured shrimps were collected from 32 disease affected ponds of West Bengal where, severe WSSV prevalence (59.5%) and low disease resistant prevalence (34%) were found using both developed DNA markers (71 bp and 457 bp). Wild captured samples were collected from the four different places at the West coast of India, viz. Kochi, Kerala; Mangalore, Karnataka; Vasco-Da-Gama, Goa; Veraval, Gujarat at three different seasons in the period of 2011-2013. It is observed that the WSSV prevalence increased as the latitude decreased along the West Coast of India. The cumulative WSSV prevalence at four places was the lowest (0%) at post-monsoon, whereas it was the highest (31.6%) during monsoon season. Quantitative real time PCR also showed the average copy number of WSSV to be the highest ($\sim 10^3$ copy/mg shrimp genomic DNA) at monsoon season. Additionally, estimated disease resistant prevalence was the highest in Vasco-Da-Gama (59.5%) and lowest in Kochi (40.9%) using both developed DNA markers (71 bp and 457 bp).

Achievements from Medical Biotechnology research:

Our **Medical Biotechnology** program is chiefly oriented towards developing orally administrable drugs from various medicinal plants/algae/lichens against iron-overload-induced hepatotoxic conditions and cancer.

Iron, the most important transition element of human body, is found in functional forms in haemoglobin, myoglobin, the cytochromes, enzymes with iron sulphur complexes, and other iron-dependent enzymes. The optimum level of iron is always maintained by the cells to balance between essentiality and toxicity, but its excess accumulation in liver leads to iron overload resulting in oxidative stress induced disorders including anemia, heart failure, liver cirrhosis, fibrosis, diabetes, arthritis, depression, impotency, infertility, and cancer. Till date there is no cost effective orally administrable drug available in the market that could efficiently cure the iron overload associated diseases without casting any side effects. Our approach in the



Medical Biotechnology research developed some orally administrable medicine from natural resources to combat iron-overloaded condition, by eliminating catalytically active iron present in the cytosol or by its chelation from other cell iron stores and simultaneously defending the cellular membranes from free radicals generated in the cells by its antioxidant activity. Some well-known medicinal plants like *Hemidesmus indicus* and *Nerium indicum* showed impressive activities in this approach and can be used as orally administrable drugs. Surprisingly, a microalgae, *Euglena tuba* was observed to have potential to alleviate iron-induced oxidative stress and hepatic injury in mice.

Glioma is the most common and highly malignant type of primary brain cancer in humans. Despite invasive surgery, radiotherapy and chemotherapy, malignant brain tumors remain a therapeutic challenge, due to its characteristic resistance to apoptosis. Doxorubicin, a contemporary chemotherapeutic drug used in treating gliomas, has some serious side effects that are responsible for congestive heart failure. Thus, major attention is being given in the search for better and safer antioxidants of natural origin, which may raise the efficiency of cancer treatment. One purified compound, methyl gallate isolated from the bark of *Spondias pinnata* showed selective anticancer activity against human glioblastoma by inducing apoptosis and sustained extracellular signal-regulated kinase 1/2 activation.

Publications:

1. Chakrabarty, U., Dutta, S., Mallik, A. and Mandal, N. (2014) White spot syndrome virus (WSSV) and prevalence of disease resistance in a commercially cultured population of *Penaeus monodon* Fabricius, 1798 (Decapoda, Dendrobranchiata). *Crustaceana* 87 (14), 1593 – 1605 DOI:10.1163/15685403-00003382 (Impact factor: 0.473)
2. Chaudhuri, D., Ghate N. B., Deb, S., Panja, S., Sarkar, R., Rout, J. and Mandal, N. (2014) Assessment of the phytochemical constituents and antioxidant activity of a bloom forming algae *Euglena tuba*. *Biological Research* 47:24 DOI: 10.1186/0717-6287-47-24 (Impact factor: 1.480)
3. Chaudhuri, D., Ghate N. B., Singh, S.S. and Mandal, N. (2015) Methyl gallate isolated from *Spondias pinnata* exhibits anticancer activity against human glioblastoma by induction of apoptosis and sustained extracellular signal-regulated kinase 1/2 activation *Pharmacognosy magazine* 11:269-276 (Impact factor: 1.256)
4. Chaudhuri, D., Ghate, N. B., Panja, S., Basu Mallik, T. and Mandal, N. (2014) HPLC screening of *Clerodendrum viscosum* leaf extract show possible phytochemical responsible for antioxidant and anticancer activities. *Journal of Cancer Science & Therapy* DOI: <http://dx.doi.org/10.4172/1948-5956.S1.038> (Impact factor: 4.203)
5. Dutta, S., Chakrabarty, U., Mallik, A. and Mandal, N. (2015) White spot syndrome virus (WSSV) prevalence associated with disease resistance among wild populations of black tiger shrimp, *Penaeus monodon* (Fabricius). *Aquaculture Research*. 46: 453–461. DOI: 10.1111/are.12193 (Impact factor: 1.376; Citation: 5)

6. Ghate, N. B., Chaudhuri, D., Panja, S. and Mandal, N. (2015) *Nerium indicum* leaf alleviates iron-induced oxidative stress and hepatic injury in mice. *Pharmaceutical Biology* Published online January 22, DOI:10.3109/13880209.2014.959612 (Impact factor: 1.241)
7. Ghate, N. B., Chaudhuri, D., Panja, S., Basu Mallik, T., Das, A. and Mandal, N. (2014) Antioxidants from *Clerodendrum viscosum* leaf play a role in anticancer activity against brain cancer. *Journal of Cancer Science & Therapy* DOI: <http://dx.doi.org/10.4172/1948-5956.S1.034> (Impact factor: 4.203)
8. Hazra, B., Sarkar, R., Chaudhuri, D., Ghate N. B., Panja, S. and Mandal, N. (2015) Attenuation of iron overload induced liver toxicity by *Hemidesmus indicus* root in Swiss albino mice. *International Journal of Pharma and Bio Sciences* 6(1): 354-364 (Impact factor: 5.121)
9. Mallik, A, Chakrabarty, U., Dutta, S., Mondal, D. and Mandal, N. (2014) Study on the distribution of disease resistant shrimp identified by DNA markers in respect to WSSV infection in different seasons along the entire East coast of India aiming to prevent white spot disease in *Penaeus monodon*. *Transboundary and Emerging Diseases* DOI: 10.1111/tbed.12230 (Impact factor: 2.993; Citation: 1)
10. Panja, S., Chaudhuri, D., Ghate N. B., Ha, L. M. and Mandal, N. (2014) In vitro assessment of phytochemicals, antioxidant and DNA protective potential of wild edible fruit *Elaeagnus latifolia* Linn. *Fruits* 69, 303–314 (Impact factor: 0.883)
11. Panja, S., Chaudhuri, D., Ghate, N. B. and Mandal, N. (2014) Phytochemical profile of a microalgae *Euglena tuba* and its hepatoprotective effect against iron-induced liver damage in Swiss albino mice. *Journal of Applied Microbiology* 117, 1773-1786 DOI:10.1111/jam.12643 (Impact factor: 2.479)
12. Panja, S., Ghate, N. B., Chaudhuri, D. and Mandal, N. (2014) Antioxidant from Indigenous medicinal plants inhibit proliferation of ascitic cancer cell. *Journal of Cancer Science & Therapy* DOI: <http://dx.doi.org/10.4172/1948-5956.S1.038> (Impact factor: 4.203)
13. Sarkar, R., Ghate N. B. and Mandal, N. (2014) Antioxidant activity of *Tinospora cordifolia* extract depends on the solvent system. *Journal of Computer Science & Systems Biology* 7:5 DOI: <http://dx.doi.org/10.4172/0974-7230.S1.008> (Impact factor: 5.639)

Students Awarded Ph.D:

Name of Student	Title of thesis
Rhitajit Sarkar (C.U., Biochemistry)	Ethnopharmacological study of various medicinal plants used in Indian system of traditional medicine

**Grants-In-Aid Schemes:**

Title of the Scheme	Scheme funded by
Identification and characterization of micro RNAs (miRNAs) in <i>Penaeus monodon</i>	DBT
Exploration of Lichens from Barak Valley of Southern Assam and Arunachal Pradesh (North East India) and Isolation of Phytochemicals and Bioprospecting of some selected Lichens species	DBT-NER Twinning
Purification and characterization of bioactive natural antioxidant, immunomodulator and anticancer products from <i>Dioscorea alata</i> L., of North Eastern region of India	DBT-NER Twinning

Honours received:

Elected Fellow of The Zoological Society (FZS), Kolkata, 2014 for outstanding contribution in the field of Molecular Biology and Biotechnology.

Social Relevance :

The two major fields of research in Prof. N. Mandal's laboratory, viz., **Marine** and **Medical Biotechnology** play extensive roles in addressing the basic socio-economic problems in the field of disease management in shrimp as well as human systems.

To address the serious problem of white spot disease (WSD), the marine biotechnology program is constantly working towards developing various molecular biomarkers which could identify disease resistant populations among black tiger shrimps. Performing selective breeding using DNA markers would prove to be a very effective commercial strategy for long term disease control and a platform for understanding the molecular pathogenesis of WSD. This study will open a new arena for generation of specific pathogen resistant (SPR) brood stock to get disease-free seeds for the farmers to avert huge economic loss.

On the other hand, there is a huge problem in combating iron-overload induced diseases and cancer, as no cheap, effective and safe drug against them is available in the market, till date. Keeping this thing in mind, Prof. Mandal's lab is involved in the search for better, safer and socio-economically beneficial drugs from natural resources collected from various parts of the country against non-communicable diseases. His **Medical Biotechnology** research program revealed that several unconventional natural resources, like lichens and algae too are brilliant sources of orally administrable drugs against iron-overload induced hepatotoxicity. His socially beneficial research would lead to the development of safer, cheaper and effective drugs against the deadly diseases, which would be easily available especially to the economically backward people. Previously they have reported a lichen, *Parmotrema reticulatum*, as a potent source of anticancer drug, which was highly praised in 9 different news media. The safe herbal compound Methyl gallate being isolated and studied in his laboratory, could be a useful source of drug against brain cancer in humans, due to its cost effectiveness and selectivity towards glioblastoma cells.

Dr. Anup Kumar Misra, Associate Professor**Scientific Reports:****Synthesis and bioevaluation of organic small molecules and complex oligosaccharides of microbial origin:**

- Our laboratory is actively involved in the synthesis of medicinally relevant organic small molecules and their biological screening in different drug development program (e.g. cancer, enzyme inhibitors, antioxidant etc.) in collaboration with biologists of Bose Institute and other research institutes (Visva Bharati University, Tezpur Univ., JNU, SINP, NICED, CDRI).
- Our laboratory has also been engaged in developing chemical synthesis of several complex oligosaccharides found in the cell-wall of pathogenic bacteria for their use in the preparation of glycoconjugate derivatives. Glycoconjugates have emerged as successful synthetic vaccine candidates to control microbial infections. In collaboration with biologists, immunochemical studies with the synthetic glycoconjugates are ongoing (EMR projects sponsored by DST and CSIR, New Delhi).

Publications:

- Bhaumik I, Ghosh T and Misra A K (2014) Efficient synthesis of the tetrasaccharide repeating unit of the O-antigen of *Escherichia coli* O174 strain, *Carbohydrate Research*, 399, 21-25.
- Bhaumik I, Misra A K (2014) Expedient synthesis of a pentasaccharide related to the O-specific polysaccharide of *Escherichia coli* O117:K98:H4 strain, *RSC: Advances* 4, 61589-61595.
- Dhara D, Kar R K, Bhunia A, Misra A K (2014) Convergent synthesis and conformational analysis of the hexasaccharide repeating unit of the O-antigen of *Shigella flexneri* serotype 1d, *European Journal of Organic Chemistry*, 4577-4584.
- Ghosh T, Kar R K, Bhunia A, Misra A K (2014) Synthesis of the pentasaccharide repeating unit of the O-antigen of *Escherichia coli* O175 using one-pot glycosylations and its conformational analysis, *Tetrahedron*, 70, 9262-9267.
- Jana M, Kar R K, Bhunia A, Misra A K (2014) Synthesis of the tetrasaccharide repeating unit of the O-antigen of *Escherichia coli* O69 strain and its conformational analysis, *RSC Advances*, 4, 37079-37084.
- Parida P K, Sau A, Ghosh T, Jana K, Biswas K, Raha S, Misra A K (2014) Synthesis and evaluation of triazole linked glycosylated 18-glycyrrhetic acid derivatives as anticancer agents, *Bioorganic Medicinal Chemistry Letters*, 24, 3865-3868.
- Si A, Misra A K (2015) Efficient synthesis of the pentasaccharide repeating unit of the O-antigenic polysaccharide of *Escherichia coli* O166 strain, *Synthesis*, 47, 83-88.

**Students Awarded Ph.D:**

Name of Student	Title of thesis
Abhijit Sau (C.U., 2014)	Synthetic studies on microbial complex oligosaccharides

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
Synthesis of oligosaccharide antigens of the Enterohemorrhagic <i>Escherichia coli</i> (EHEC) strains for the preparation of glycoconjugates	DST, SERC
Synthesis of oligosaccharides corresponding to <i>Shigella dysenteriae</i> for the preparation of glycoconjugates to treat Shigelosis.	CSIR

Dr. Mahadeb Pal, Associate Professor**Scientific Reports:****Understanding control of heat shock factor 1 (HSF1) function induced under different stressors in human cells:**

Normally a cell activates heat shock response (HSR) when encounters a proteotoxic stress. The HSR is down regulated to basal level as the stress signal is removed. Various pathologies including cancer, and neurodegenerative diseases associate with inefficient regulation of proteotoxic stress response. It has been found that the inefficient regulation of HSR in these disease conditions is partly due to uncontrolled function of its central regulator heat shock factor 1 (HSF1). HSF1 mediates cellular HSR through transcriptional induction of a group of protein chaperones called heat shock proteins to help refold mis-folded proteins to dampen the toxicity associated with protein denaturation. A crucial step in HSF1 function appears to engage various factors including chromatin modifying activities to help passage RNA polymerase through the target genes. Interestingly, there are indications that HSF1 engages a stress specific coactivator. We have taken both genetic and proteomic approach to understand players and their mode of function in HSF1 mediated gene activation in response to different stressors. In an independent approach we found an involvement of an oncogene with HSF1 activity the mode of action of which is being studied as well.

Understanding the role of positioned nucleosome in stress induced gene expression in human cells:

In a healthy cell the majority of cellular stress-induced genes including the targets of various oncogenes and tumour suppressor genes carry promoter proximally paused but transcriptionally engaged RNA polymerase II (pol II). An advantage of this preparatory phase is that the pol II proceed to elongation mode soon after an activation signal is encountered without going for searching for the

target gene promoter. It has been shown in yeast by genome wide mapping that stress inducible genes generally harbour promoter proximally positioned nucleosomes. By biochemical experiments promoter adjacent nucleosomes have also been implicated in promoter paused pol II stability? A gene activation process normally includes recruitment of nucleosome remodelling activities on the promoter poised complexes. We are interested to determine if any nucleosome remodeler is engaged in response to a single specific or a group of signals to remove a positioned nucleosome on the gene body.

Role of DNA-dependent protein kinase in cellular heat shock response in human cells:

DNA-dependent protein kinase (DNA-PK) is well known for its role in double stranded non homologous DNA-break repair. Lately, DNA-PK has been found to be involved in control of gene transcription. We have noticed association of DNA-PK in the preinitiation complex by RNA polymerase II by mass spec analysis. DNA-PK was downregulated by siRNA to test its requirement in the individual function of different inducible transcription factors. This biased screen identified two transcription factors that are critical regulators of cellular inflammation and cancer. Works are in progress in the lab to explore the molecular basis of involvement of DNA-PK including its mechanisms of recruitment including its signal specificity in the processes.

Identification and purification of modulators of transcription factors from medicinal plant extracts and study their mode of actions:

Plant extract containing various medicinal values have been known and methodically used since the genesis of human civilisation. India is believed to have a wealthy source of various plant species with unique medicinal values on the globe. In order to purify a specific therapeutic activity extracts of various plants with history of target therapeutic values have been screened. For activity based screening and purification we utilize very sensitive cell based reporter systems responsive to a set of transcription factors that are known to associate in inflammation, cancer or neurodegenerative diseases. The reporter systems have been constructed in the lab. Thus far two activities as inducer of HSF1 have been identified and purified to homogeneity. Understanding mechanisms of actions of these activities are in progress through in vitro as well as in vivo studies in animal models.

In parallel we also identified strong and apparently specific antitumor activities in extracts and its solvent fractions with no direct modulatory activity against any of a few transcription factors we tested. Understanding their mechanism of actions including their role in different signaling networks is in progress. The aim is to purify the activity and understand molecular mechanisms of action.

Publications:

1. Dhar G, Chakravarty D, Hazra J, Dhar J, Poddar A, Pal M, Chakrabarti P, Surolia A, Bhattacharyya B (2015) Actin-curcumin interaction: insights into the mechanism of actin polymerization inhibition. *Biochemistry* 54:1132-43.
2. Pal S, Bhattacharjee B, Mandal N C, Mandal S C. and Pal M. (2014) Chronic inflammation and cancer: potential chemoprevention through nuclear factor kappa B and p53 antagonism. *J Inflamm (Lond)* 11:23. Review.

**Grants-In-Aid Schemes:**

Title of the Scheme	Scheme funded by
Role DNA-dependent protein kinase in transcription control in human cells	DBT
Molecular mechanism of HSF1 mediated chromatin C remodeling during transcriptional induction of human hsp70 by different stressors"	DST

Participation in Conferences / Symposia / Workshops & Invited Talks delivered at Various Organizations:

Attended "5th meeting of the Asian forum of chromosome and chromatin biology" held during January 15th-18th 2015 at JNC SAR, Bangalore.

Dr. Gaurisankar Sa, Senior Professor

Scientific Reports:**Molecular basis of regulation of p53 nuclear transport with monomeric G-actin:**

Single-point mutation in the p53 DNA-binding domain accounts for the expression of both contact and structural mutants which influences the molecular events and protein-protein interaction in cancer. Wild-type p53 shuttles into the nucleus in response to DNA-damage and restrict any genetic anomaly from occurring so as to maintain the genetic integrity. In contrast, structurally destabilized p53 mutants fail to reach the nucleus, aggregate in the peri-nuclear region; which is believed to be the basis of gain-of-function. Dominant-negative activity and gain-of-function of structurally destabilized mutants, in turn, has been found to be directly linked to their increased aggregation propensity in the cytoplasm. Therefore the mutant protein when gets confined in the cytosol, becomes inactive to elicit response when challenged with DNA-damage. Though many of the oncogenic gain-of-function effects of p53 mutants have been discussed, the question addressing the molecular basis behind their altered localization remain unattempt. Here, we report that monomeric G-actin regulates p53 nucleo-cytoplasmic shuttling in response to DNA-damage. Monomeric globular actin physically interacts with p53 and directs the traffic in reaching the nucleus. It was observed through molecular-docking approach that amino acid contacts found in the interface of actin-dimer crystal in filamentous actin completely overlaps the interface of p53:G-actin docked complex. This finding explained the theoretical basis of why p53 specifically interacts with monomeric form of actin, not with the polymeric form. The zinc-binding domain mutant p53Arg175His, aggregates with monomeric G-actin in the peri-nuclear region, is believed to be the reason of mutant p53 gain-of-function. Another structural mutant p53Arg249Ser, essentially contributes instability to the interaction, is found in the interface of p53:G-actin docked complex. On contrary, contact mutant p53Arg273His, resides away from the p53:G-actin complex, also justifies its behavior as the wild-type protein. Taking into account, these results reveal G-actin to be a critical determinant in p53 nuclear

transport event where the dynamics of F/G-actin ratio and relative affinity of p53 toward monomeric form of actin explains the altered localization of p53 in context of cancer.

Switching the equilibrium from immunogenicity to tolerogenicity by clonal selection of IFN γ ^{low}FOXP3⁺CD8⁺ T-regulatory subset in tumor microenvironment:

CD8⁺ T-regulatory cells are progressively emerging as crucial components in tumor immune evasion. However, the molecular bases underlying the differentiation and functional diversity of CD8⁺ Treg cells in tumor microenvironment remain obscure. We have identified two divergent subsets of CD8⁺ Tregs, viz; IFN γ ^{hi} FOXP3-negative and IFN γ ^{low} FOXP3-positive, prevalent at different stages of cancer. IFN γ ^{hi} CD8⁺CD25⁺CD127⁺FOXP3⁻ subset, overrides at 'early' stages, is devoid of suppressive functions and have anti-tumorigenic activities. At later stage of tumor development, in a clonal selection only IFN γ ^{low}FOXP3⁺ CD8⁺ Treg cells subsist whereas IFN γ ^{hi}FOXP3⁻ one is simultaneously eliminated. Moreover, IFN γ ^{low}FOXP3⁺ subset shows synergistic immunosuppressive activities with CD4⁺ Tregs. Therefore, in tumor milieu, CD8⁺ Treg have more versatile features and functions that do not completely overlap with CD4⁺ Treg.

Publications:

1. Adhikary A, Chakraborty S, Mazumdar M, Ghosh S, Mukherjee S, Manna A, Mohanty S, Nakka KK, Joshi S, De A, Chattopadhyay S, Sa G, Das T (2014) Inhibition of epithelial to mesenchymal transition by E-cadherin up-regulation via repression of slug transcription and inhibition of E-cadherin degradation: dual role of scaffold/matrix attachment region-binding protein 1 (SMAR1) in breast cancer cells. *J Biol Chem.* 289:25431-44.
2. Chakraborty S, Adhikary A, Mazumdar M, Mukherjee S, Bhattacharjee P, Guha D, Choudhuri T, Chattopadhyay S, Sa G and Das T (2014) Capsaicin-induced activation of p53-SMAR1 auto-regulatory loop down-regulates VEGF in non-small cell lung cancer to restrain angiogenesis. *PLoS ONE* 9:e99743. doi: 10.1371/journal.pone.0099743.
3. Chakraborty S, Das K, Saha S, Mazumdar M, Manna A, Chakraborty S, Mukherjee S, Khan P, Adhikary A, Mohanty S, Chattopadhyay S, Biswas SC, Sa G, Das T (2014) Nuclear matrix protein SMAR1 represses c-Fos-mediated HPV18 E6 transcription through alteration of chromatin histone deacetylation. *J Biol Chem.*, 289:29074-85.
4. Chaudhuri S, Singh MK, Bhattacharya D, Acharya S, Chatterjee S, Kumar P, Bhattacharjee P, Basu AK, Sa G, Das T, Ghosh TK, Chaudhuri S (2014) The novel immunotherapeutic molecule T11TS modulates glioma-induced changes of key components of the immunological synapse in favor of T cell activation and glioma abrogation. *J Neurooncol.*, 120:19-31.
5. Hossain DM, Panda AK, Chakraborty S, Bhattacharjee P, Kajal K, Mohanty S, Sarkar I, Sarkar DK, Kar SK, Sa G (2014) MEK inhibition prevents tumor-shed TGF β -induced T-regulatory cell augmentation in tumor milieu. *Immunology* 144: 561-573.
6. Mahata B, Biswas S, Rayman P, Chaharvi A, Ko J, Bhattacharjee A, Li YT, Li Y, Das T, Sa G, Raychaudhuri B, Vogelbaum MA, Tannenbaum C, Finke JH, Biswas K (2015) GBM Derived Gangliosides Induce T Cell Apoptosis through Activation of the Caspase Cascade



Involving Both the Extrinsic and the Intrinsic Pathway. *PLoS One*. 10(7):e0134425. doi: 0.1371/journal.pone.0134425.

7. Saha S, Bhattacharjee P, Guha D, Kajal K, Khan P, Chakraborty S, Mukherjee S, Paul S, Manchanda R, Khurana A, Nayak D, Chakraborty R, Sa G, Das T (2015) Sulphur alters NFκB-p300 cross-talk in favour of p53-p300 to induce apoptosis in non-small cell lung carcinoma. *Int J Oncol.*, 47:573-82.
8. Saha S, Bhattacharjee P, Mukherjee S, Mazumdar M, Chakraborty S, Khurana A, Nayak D, Manchanda R, Chakraborty R, Das T, Sa G (2014) Contribution of the ROS-p53 feedback loop in thujaplicin-induced apoptosis of mammary epithelial carcinoma cells. *Oncol Rep.*, 31:1589-98.
9. Saha S, Mukherjee S, Mazumdar M, Manna A, Khan P, Adhikary A, Kajal K, Jana D, Sa G, Mukherjee S, Sarkar DK, Das T (2015) Mithramycin A sensitizes therapy-resistant breast cancer stem cells toward genotoxic drug doxorubicin. *Transl Res.*, 165:558-77.
10. Saha T, Kar RK & Sa G (2015) Structural and Sequential context of p53: A review of experimental and theoretical evidence. *Progress Biophys. Mol. Biol.*, 117: 250-263.

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
(in collaboration with Dr. T.Das) Targeted alteration of MAPK family members ERK and p38MAPK/JNK to channelize oncogenic Ras-induced proliferative-signaling into apoptotic-signaling	DST
(in collaboration with Dr. T.Das) Mapping the molecular mechanisms of resistance-to-Apoptosis switch over of non small-cell lung carcinoma by curcumin: An approach towards chemo-sensitization	DST
(in collaboration with Dr. T.Das) miR 325: a Distinct miRNA that controls T regulatory cell development and function.	DST
(in collaboration with Dr. T.Das) Binning stochastic phenotypic states of cancer cell population in different color box	DBT

Participation in Conferences / Symposia / Workshops & Invited Talks delivered at Various Organizations:

- (i) Invited to deliver a talk at the 6th Congress of the FIMSA (The Federation of Immunological Societies of Asia Oceania) and was selected as a Fellow of FIMSA in 2015 in Singapore (ii) attended *Molecular Immunology Forum Meeting 2015* in 2015 at Bhubaneswar (iii) delivered an invited lecture at *Indian Association of Cancer Research Annual Conference* at Jaipur in 2015

- (iv) was invited to deliver a lecture at the *International Conference on Angiogenesis*, Trichi in 2015 (v) delivered a talk at the *International Stem Cell Meeting*, Pune, in 2015 (vi) delivered a talk at the annual meeting of Society for Biological Chemists, Bhubaneswar, in 2014 (vii) was invited to deliver a plenary talk at Bardwan University in 2014 (viii) gave an invited talk at Gangtok Homeopathy Summit in 2015 (ix) was invited to deliver a invited talk at Bardwan University in 2015 (x) gave an invited talk at Global Homeopathy Summit in Mumbai, in 2015.

Honours Received:

- (i) Awarded as the Fellow of FIMSA (The Federation of Immunological Societies of Asia Oceania)
- (ii) Received PC Sen Memorial Award from Physiological Society of India
- (ii) Acting as a Task Force Member in Cancer Biology by DBT, Govt. of India.

Dr. Parimal C. Sen, Senior Professor

Scientific Reports:

Cross-talk between ER stress and the MEK/ERK pathway potentiates apoptosis in human triple-negative breast carcinoma cells: Role of a dihydropyrimidone, Nifetepimine: in collaboration with Dr. Tanya Das

Triple negative breast cancers (TNBC) are among the most aggressive and therapy resistant breast tumors and currently possess almost no molecular targets for therapeutic option in this horizon. In the present study we discerned the molecular mechanisms of potential interaction between ER stress response and the MEK/ERK pathway in inducing apoptosis in TNBC cells. Here we observed that induction of ER stress alone was not sufficient to trigger significant apoptosis but simultaneous inhibition of the MEK/ERK pathway enhanced ER stress induced apoptosis via a caspase dependent mechanism. Our study also demonstrated nifetepimine, a dihydropyrimidone derivative as a potent anti-cancer agent in TNBC cells. Nifetepimine down-regulated MEK/ERK pathway in MDAMB-231 and MDAMB-468 cells and resulted in blockage of ER stress mediated GRP78 up-regulation. Detailed mechanistic studies also revealed that nifetepimine by down-regulating pERK expression also declined the promoter binding activity of TFII-I to the GRP78 promoter and in turn regulated GRP78 transcription. Studies further extended to *in vivo* Swiss albino and SCID mice models also revalidated the anti-carcinogenic property of nifetepimine. Thus our findings cumulatively suggest that nifetepimine couples two distinct signalling pathways to induce the apoptotic death cascade in TNBC cells and raises the possibility for the use of nifetepimine as a potent anti-cancer agent with strong immune-restoring properties for therapeutic intervention for this group of cancer bearers.

Controlled tuning of Ca²⁺/p38MAPK to regulate eIF2α/ATF 4/CHOP signalling pathways for effective killing of breast cancer cells: Role of a synthetic indole analogue, Mephebrindole: in collaboration with Dr. Anup Misra and Dr. Subhrangshu Chatterjee

The efficacy of the cancer chemotherapeutics is limited by side effects resulting from narrow therapeutic windows between the anticancer activity of a drug and its cytotoxicity. Thus

identification of small molecules that can selectively target cancer cells has gained major interest. Malignant transformation of a normal cell is driven by gain-of-function mutations in oncogenes and loss-of-function mutations in tumor-suppressor genes. This transformation is associated with enhanced cellular stress. Cancer cells under stress utilize the Unfolded protein response (UPR) as an effective cell adaptation mechanism. The purpose of the UPR is to balance the ER folding environment and calcium homeostasis under stress. If ER stress is prolonged, tumor cells undergo apoptosis. In the present study we demonstrated an AMBI derivative 3,3'-(4-Methoxyphenyl)methylene]-bis-(5-bromo-1H-indole), named as Mephebrindole as an effective anti-cancer agent in breast cancer cells. MPB disrupted calcium homeostasis in MCF7 cells which triggered ER stress development. Detailed evaluations revealed that Mephebrindole by activating p38 MAPK also regulated GRP78 and eIF2 α /ATF4 downstream to promote apoptosis. Studies extended to in vivo mice models revalidated its anti-carcinogenic property thus highlighting the role of MPB as an improved chemotherapeutic option.

Publications:

1. Ghosh S, Adhikary A, Chakraborty S, Bhattacharjee P, Mazumdar M, Putatunda S, Gorain M, Chakraborty A, Kundu G C, Das T, and Sen P C (2015) Nifetepimine, a Dihydropyrimidone, Couples ER Stress with MEK/ERK pathway to Induce Apoptosis in Human Triple-negative Breast Carcinoma Cells. *J. Biol. Chem.* 290, 3936-3949.
2. Ghosh S and Sen P C (2015) Role of ATPases in disease processes in regulation of ATPases. Edited by Sajal Chakraborti and Naranjan S. Dhalla. Springer publisher.
3. Nandi P, Banerjee B, Ghosh S, Chakraborty A, Jana K and Sen P C (2014) Involvement of nifetepimine in motility and capacitation of caprine spermatozoa. *Am. J. Expt. Biol.* 1, 61-84.
4. Roy S, Chakraborty B, Paul Chowdhury S, Banerjee K, Halder S, Majumder S, Majumdar and Sen P C (2014) Regulation of PKC mediated signaling by Calcium during Visceral Leishmaniasis. *PLoS ONE*, DOI: 10.1371/journal.pone.0110843.

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
With Dr. T.Das (Co-PI) Remodeling the cellular calcium homeostasis by ethyl-4-(3-nitro)-phenyl-6-methyl-2-oxo-1,2,3,4-tetrahydro-pyrimidine-5-carboxylate (Nifetepimine) : A mechanistic approach towards cancer regression and immune rejuvenation	Department of Atomic Energy

Participation in Conferences / Symposia /Workshops & Invited Talks delivered at Various Organizations:

- (i) Visited Ljubljana, Slovenia from September 15-26, 2014 under a bilateral exchange programme between INSA and Slovenia Academy of Sciences and Arts (ii) delivered lectures at National

Institute of Biology, Ljubljana, Institute of Biomedical Research, Slovenia and International Conference of Biomedical Research at the Department of Pharmacology, Ljubljana, Slovenia (iii) chaired a Session in the 2nd International Meet on "Advanced Studies on Cell Signaling Network", December 2014 held at Indian Institute of Chemical Biology.

Dr. Parames C Sil, Senior Professor and Coordinator

Scientific Reports:

Studies on the mechanisms of bio-active molecules in organ pathophysiology:

Main objectives

Research in our laboratory encompasses several major areas of organ pathophysiology (hepatotoxicity, gastropathy, neurotoxicity, and nephrotoxicity), diabetes, cancer and its protection via bio-active molecules.

However, special emphasis is placed upon

- To understand the mechanisms of antioxidant potentials of phytochemicals.
- Chemical and drug induced mechanisms of cell injury/death (both in vivo and in vitro).
- Studies on the signal transduction mechanism of cell death and survival.
- Targeted drug delivery through different nanoparticles to enhance the efficiency.

Curcumin enhances recovery of pancreatic islets from cellular stress induced inflammation and apoptosis in diabetic rats:

Diabetes, an endocrine metabolic disorder is a major cause of morbidity and mortality globally. It mainly occurs either due to the resistance of cells to insulin or inability of pancreatic beta cells to secrete insulin. The phytochemical, curcumin, has been reported to play many beneficial roles. However, under diabetic conditions, the detailed mechanism of its beneficial action in the glucose homeostasis regulatory organ, pancreas, is poorly understood. This study has been designed and carried out to explore the role of curcumin in the pancreatic tissue of STZ induced and cellular stress-mediated diabetes in rats. After inducing diabetes with STZ different molecular and cellular mechanisms were determined. However, treatment with curcumin ameliorated all the adverse changes that were occurred due to diabetes and helped the organ back to its normal physiology. Results suggest that curcumin protects pancreatic beta-cells by attenuating inflammatory responses, and inhibiting ER/mitochondrial-dependent and independent pathways of apoptosis and crosstalks between them. This uniqueness and absence of any detectable adverse effect proposes the possibility of using this molecule as an effective protector in the cellular stress-mediated diabetes mellitus.

Curcumin ameliorates testicular damage in diabetic rats:

In this study, we explored whether curcumin plays any beneficial role against testicular abnormalities in diabetic rats, and if so, what possible mechanism it utilizes to provide protection.



The results suggest that curcumin provides protection against cellular stress-mediated mitochondrial and endoplasmic reticulum-dependent apoptotic death of the testicular cells under diabetic condition and suggests the possibility of using this molecule as a potential therapeutic in the treatment of stress-mediated diabetic testicular dysfunction.

Curcumin protects rat liver from streptozotocin-induced diabetic pathophysiology by counteracting reactive oxygen species and inhibiting the activation of p53 and MAPKs mediated stress response pathways:

Our study indicates that streptozotocin (STZ) induces diabetic pathophysiology and thereby generation of oxidative stress in male wistar rats leading to systematic apoptosis within liver via the activation of p38-ERK1/2 and p53-mediated molecular signaling pathways. In this scenario, a well-known antioxidant curcumin (CUR), protected liver (hepatocytes) by two ways: firstly, it offers protection by the elevation the antioxidant enzyme activities and secondly, it inhibited the activation of p38, ERK1/2 MAPKs, subsequent Bax translocation to mitochondria and mitochondrial permeabilization. So we are hopeful about the promising solution of diabetes-induced liver tissue apoptosis using curcumin.

Role of ferulic acid in STZ induced diabetes:

In this study, we had investigated the beneficial role of Ferulic acid (FA) against STZ induced diabetes. Male Wistar rats were made diabetic after exposing them to STZ at a particular dose for certain period. Alteration in the parameters related to diabetes was observed. Treatment of rats with ferulic acid decreased oxidative stress in pancreas and kidney of diabetic rats by increasing the activities of antioxidant enzymes (SOD, CAT, GPx, GST and GR) and decreasing cellular stress markers (lipid peroxidation, protein carbonylation etc). It reduces the blood glucose level and serum markers of kidney in dose and time dependent manner thereby showing its anti-hyperglycaemic property. FA has also shown antiapoptotic property by inhibiting mitochondria/ER dependent and independent pathways of apoptosis and decreasing expression of caspase 9,3,12 and 8. These results proposed FA as a promising therapeutic against STZ induced diabetes. However, a detail signaling mechanism is yet to be studied.

Hexavalent chromium induces apoptosis in HepG2 cells via redox imbalance:

Hexavalent chromium, Cr(VI), is an environmental toxicant and associated with hepatotoxicity. In this study, we cultured HepG2 cells in the absence or presence of Cr(VI) and determined its effect on cellular oxidative stress, mitochondrial damage, apoptosis and the expression of the transcription factor Nrf2 and the Nrf2-dependent antioxidant enzymes. Our data support the notion that Cr(VI) caused mitochondrial damage, apoptosis, oxidative stress, and subsequently lead to a strong induction of HO1, GCLC and SOD2 via the Nrf-2 signaling pathway in hepatocytes.

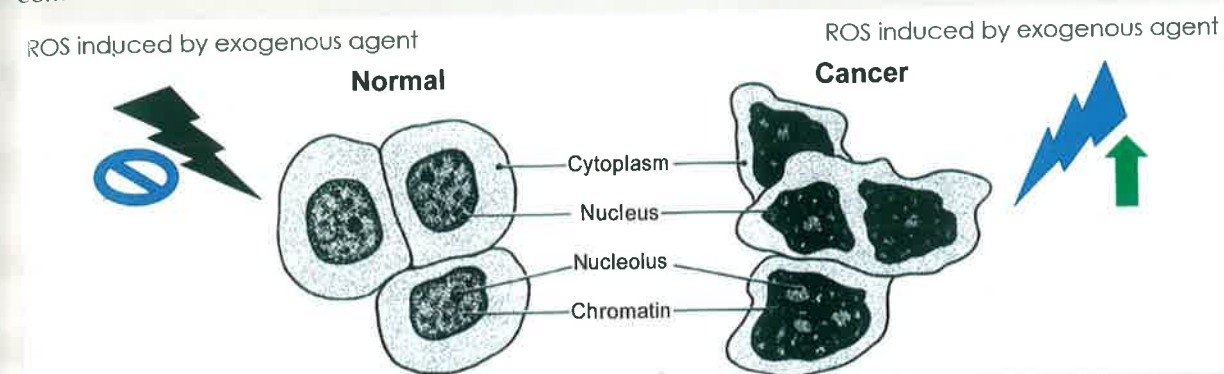
Role of arjunolic acid against atorvastatin induced hepatic and renal pathophysiology:

Atorvastatin (ATO), is a highly effective drug used for the treatment of hypercholesterolemia and hypertriglyceridemia. Its application is restricted now-a-days due to several acute and chronic side effects. This study has been carried out to investigate the protective role of arjunolic acid against ATO induced oxidative impairment and cell death in hepatic and renal tissue in mice. Results

suggest that arjunolic acid could effectively and extensively counteract the adverse effects and might protect liver and kidney from ATO-induced severe tissue toxicity.

Differential effect of ROS on normal and cancer cells:

Cancer is one of the leading cause of death in most of the countries. Cancer develops when somatic cells mutate and escape the restraints that normally restrict them in their problematic expansion. Many signaling pathways that are linked to tumorigenesis can also regulate the metabolism of ROS through direct or indirect mechanisms. High ROS levels are generally detrimental to normal cells, but the redox status of cancer cells usually differs from that of normal cells. Because of metabolic and signaling aberrations, cancer cells exhibit elevated ROS levels. On the contrary, it is also accepted that cancer cells are more vulnerable to exogenous insult of ROS, therefore manipulation of the ROS level may be a way in specifically killing the cancer cells without harming the normal cell.



A series of Bis-lawsone scaffolds have been assayed for their pro-apoptotic activity on six different cell lines (five cancerous and one normal). All of the 23 synthesized derivatives were screened accordingly by studying their pro-apoptotic potential towards cancer cells, using MTT assay. Out of 23, the compound 3i was found to be most effective in inducing apoptosis on human glioma cells, some other compounds are also identified and were found to be effective on other *in vitro* cancer models used in our study. The activity of this compound was also compared to a popular anticancer drug cisplatin, having limitations of use because it causes nephrotoxicity. We found that among these 23 derivative few of it induces cytotoxicity to the normal cells, but most of the compounds are selectively toxic to the cancer cells.

In future we intend to study the detailed mode of action of that different effective compounds on cancer cells. We would also like to extend this study on *in vivo* cancer models, and establish the molecular pathway by which these compounds induce cytotoxicity on cancer cells without affecting the normal cells.

Effect of the water pollutants at molecular level: a prospective model for molecular toxicological study:

Direct or indirect ingestion of contaminants through water is known to cause acute or chronic cellular dysfunction, which leads to the elevation of intracellular ROS. Oxidative stress is the worst outcome for the high level of ROS leading to unfavorable impending health risk. In our present



study, we focus on water contaminants induced different pro-apoptotic stress mechanism involved in hepatic and renal cells in a combination of in vivo and in vitro approach. So far, preliminary in vitro toxicological studies with sodium fluoride have been found to be potentially toxic in normal kidney epithelial cells and human hepatoma cell lines. Preliminary studies with two bioactive polyphenolic compounds, mangiferin and curcumin, are also under study to investigate the action mechanism of their ameliorative activity.

Further studies will be extended on investigation whether these polyphenols could restore the phase II antioxidant enzyme level in the NaF exposed cells, up regulate the different anti-apoptotic proteins and suppress the activation of pro-apoptotic proteins in the fluoride exposed cells. Regulation of the stress induced deleterious pathways will also be examined at the different sub cellular organelles.

Molecular mechanisms of indomethacin-induced gastric mucosal damages and protective effect of morin:

Deregulation in prostaglandin (PG) biosynthesis, severe oxidative stress, inflammation, and apoptosis contribute to the pathogenesis of nonsteroidal anti-inflammatory drug (NSAID)-induced gastropathy. In these scenario, we assessed the anti-ulcerogenic nature of morin. Its effects on the inflammatory (MPO, cytokines, adhesion molecules), ulcer-healing (COXs, PGE(2)), and signaling parameters (NF- κ B and apoptotic signaling) were assessed by biochemical, RP-HPLC, immunoblots, IHC, RT-PCR, and ELISA at the time points of their maximal changes due to IND administration. We have evaluated the effect of morin on the bioavailability of indomethacin by RP-HPLC. IND induced NF- κ B and apoptotic signaling in rat's gastric mucosa. Effect of indomethacin on the gastric emptying and gastric motility were also investigated. We found that morin reversed all the adverse effects to prevent IND-induced gastric ulceration in a PGE2 independent manner. Also, it did not affect the absorption and/or pharmacological activity of IND. Antioxidant and antiinflammatory nature of morinis primarily related to the gastro protective action of morin. For the first time, the study reveals a mechanistic basis of morin mediated protective action against IND-induced gastropathy.

Nanoparticles based targeted delivery of quercetin to breast cancer cells:

Quercetin is a natural flavonoid with poor bioavailability and very low distribution because of its water insoluble nature. It has antioxidant, anti-cancer as well as many other useful effects. Quercetin, as an anti-cancer agent, has been under consideration in research since many years. Poor solubility, as well as less bioavailability, has confined quercetin to be used as a suitable anti-cancer drug. Therefore, profound approach/knowledge is required to deliver the quercetin with better bioavailability to the targeted site of action. In the present study, we have synthesized mesoporous silica nanoparticles which when loaded with quercetin and then functionalized with folic acid, facilitates higher cellular uptake and allows more drug bioavailability to the cancer cells thus enabling it to be a good therapeutic agent against cancer.

Improving in the bioavailability of curcumin by the administration of pegylated Mesoporous silica nanoparticles:

Despite its wide range of pharmacological and therapeutic effects, poor solubility as well as low

bioavailability of curcumin is a major drawback that limits its application as a potential drug. Mesoporous Silica Nanoparticles (MSN) is one of the major emerging drug delivery systems. We have loaded curcumin into the MSNs and studied its effect in breast cancer cell lines. Results showed that MSN mediated delivery of curcumin not only enhance the bioavailability of curcumin but also shows its therapeutic activity at a lower dose than that of free curcumin. The study showed that at the same concentration there was a threefold increase in the percentage of apoptotic cells in case of MSN-Cur compared to free curcumin. In vivo studies also showed improved bioavailability of MSN-Cur. Now we are studying the effect of pegylation of free curcumin and MSN itself loaded with curcumin.

Protective action of mangiferin in response to t-BHP induced nephrotoxicity:

Oxidative stress plays the key role in tBHP induced renal cell damage. In this scenario, mangiferin, a bioactive flavonoid, having antioxidant property is considered as a safe agent against tBHP induced renal cell death. Here, we investigated the signaling mechanisms involved in tBHP induced oxidative stress in normal human kidney epithelial cells (NKE). To explore the mangiferin's action, the cells were exposed to 20 μ M mangiferin followed by 50 μ M tBHP. The effect on endogenous antioxidant status, mitochondrial membrane potential, ROS, proapoptotic (Caspases, Bax, Bad) and anti-apoptotic (Bcl2) signaling molecules were examined using biochemical assays and immunoblot analysis. tBHP exposure decreased the cell viability and increased the intracellular ROS along with other oxidative stress-related biomarkers. However, mangiferin was found to exhibit significant protection against this cellular damage. Mangiferin inhibited tBHP induced activation of different pro-apoptotic signals and thus protected the renal cells against mitochondrial permeabilization. This study establishes the effect of tBHP on the cell proliferative signaling cascade regulated by GSK-3 β , Cyclin D1 and some of their upstream signaling intermediates like AKT and PI3K. It also confirms the potential action of mangiferin to nullify these effects of tBHP on NKE cells. Mangiferin maintains the intracellular anti-oxidant status and shields NKE cells against the tBHP induced cytotoxicity. This protective action of mangiferin primarily attributes to its potent antioxidant and antiapoptotic nature in renal pathophysiology.

Taurine protects cisplatin induced cardiotoxicity by modulating ER-stress and inflammatory responses:

Oxidative stress, ER stress, inflammation and apoptosis contribute to the pathogenesis of cisplatin-induced cardiotoxicity. The objective of the present study was to investigate the signaling mechanisms involved in the ameliorating role of taurine, a conditionally essential amino acid, against cisplatin-induced cardiac ER stress dependent apoptotic death and inflammation in a murine model. It was observed that cisplatin exposure significantly altered serum creatine kinase, lactate dehydrogenase and troponin T levels which were restored in mice treated simultaneously with both taurine and cisplatin than in those treated with only cisplatin. In addition, histological studies revealed disintegration in the normal radiating pattern of cardiac muscle fibers. However, taurine administration could abate such adverse effects of cisplatin. Dihydroethidium staining confirmed that taurine administration significantly mitigated the production of reactive oxygen species. We observed that simultaneous treatment of taurine together with cisplatin inhibited the cisplatin induced upregulation of CHOP and ER stress marker GRP78. We found that taurine could block



cisplatin-induced ER stress mediated apoptosis through the down-regulation of PERK dependent eIF2 α phosphorylation, calpain-1 mediated cleavage and activation of caspase-12. Administration of taurine significantly blocked the overexpression of NF- κ B in cisplatin exposed cardiac tissue and was observed to ameliorate the cisplatin-induced inflammation by suppressing the up-regulation of proinflammatory cytokines, chemokines and cell adhesion molecules, thus resulting in decreased infiltration of neutrophils at the site of heart tissue injury as evident from decreased tissue MPO activity.

These findings suggest that taurine plays a beneficial role in providing protection against cisplatin-induced cardiac damage by modulating ER stress and inflammatory responses.

Phytomedicinal role of *Phyllanthus niruri* protein (PNP) against indomethacin induced hepatic oxidative impairments:

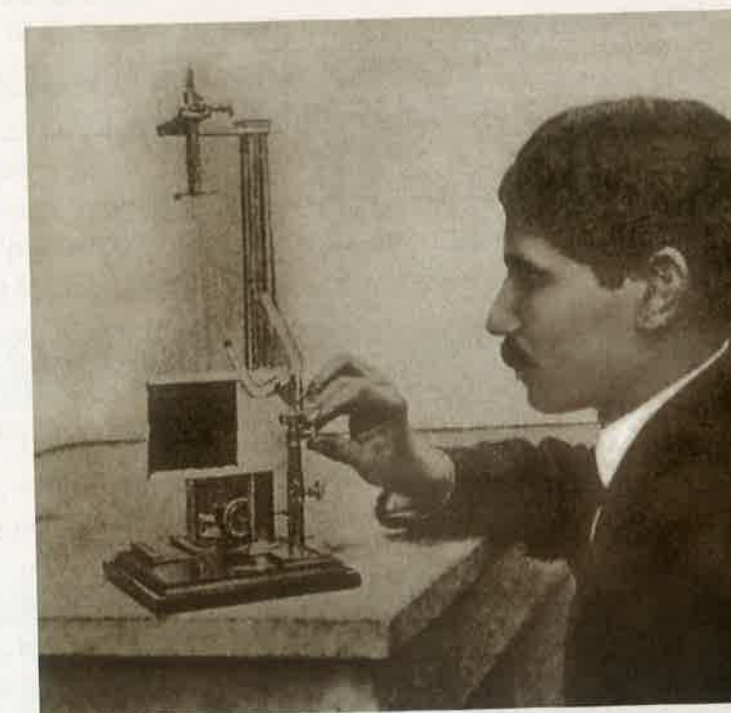
In this study we have investigated the protective action of *Phyllanthus niruri* protein (PNP) against indomethacin induced chronic toxicity in hepatic tissue. The goal of the study was to evaluate whether a 35 kD phyllanthus niruri protein (PNP) possesses any protective role against indomethacin mediated liver toxicity, and if so, what signaling pathways it utilizes to convey its protective action. Indomethacin administration in mice enhanced serum marker (ALT) levels and reactive oxygen species (ROS) formation. Moreover, we observed that indomethacin reduced antioxidant enzyme activities (SOD, CAT, GR, GST, GPx) and altered normal balance of glutathione (GSH/GSSG ratio) in the liver. Even drug exposure causes the phosphorylation of MAPKs, disrupted the normal balance of Bcl-2 family proteins, alters mitochondrial membrane permeability and thereby reduces mitochondrial membrane potential along with ER stress associated apoptotic pathways. Histological assessments and DNA fragmentation analysis also supported that indomethacin induced hepatic damages are apoptotic in nature. It has been also found that indomethacin exposure upregulated i-NOS level and thereby enhance the pro-inflammatory responses (IL-6, IL-1 β , MCP1 etc). On other hand, PNP treatment after indomethacin exposure effectively neutralizes all these abnormalities via the restoration of antioxidant enzyme activities as well as inhibition of apoptotic cell death indices in a prostaglandin (PGE2) independent manner. Combining all, results suggest that PNP could be a potential protective agent to ameliorate the liver from the unfavorable effects of indomethacin.

Beneficial role of carnosine on cisplatin-induced pathophysiology of the spleen:

Cisplatin is a widely used anti-cancer drug. In spite of its wide application as a successful chemotherapeutic agent, severe nephrotoxicity caused by cisplatin limits its use to a great extent. Oxidative stress, inflammation play pivotal role in cisplatin induced pathophysiology. In this study we have clearly elucidated the mechanism of cisplatin induced pathophysiology in spleen and its amelioration by carnosine. Our data suggests that simultaneous administration of carnosine prevented nuclear translocation of NF- κ B and transcription of proinflammatory cytokines, chemokines and cellular adhesion molecules. Activation of MAPK kinase JNK plays a role in cisplatin induced pathophysiology of spleen and carnosine inhibited activation of JNK in the spleen of cisplatin treated animals. So our study gives a vivid idea of molecular mechanisms involved in the protective action of carnosine on cisplatin induced pathophysiology of spleen.

Publications:

1. Ghosh S, Bhattacharyya S, Rashid K, Sil PC (2015) Curcumin protects rat liver from streptozotocin-induced diabetic pathophysiology by counteracting reactive oxygen species and inhibiting the activation of p53 and MAPKs mediated stress response pathways. *Toxicol Reports*. 2:365–376.
2. Pal PB, Sinha K, Sil PC (2014) Mangiferin attenuates diabetic nephropathy by inhibiting oxidative stress mediated signaling cascade, TNF α related and mitochondrial dependent apoptotic pathways in streptozotocin-induced diabetic rats. *PLoS One*. 9(9):e107220.
3. Rashid K, Sil PC (2015) Curcumin ameliorates testicular damage in diabetic rats by suppressing cellular stress-mediated mitochondria and endoplasmic reticulum-dependent apoptotic death. *Biochim Biophys Acta*. 1852(1):70-82.
4. Rashid K, Sil PC (2015) Curcumin enhances recovery of pancreatic islets from cellular stress induced inflammation and apoptosis in diabetic rats. *Toxicol Appl Pharmacol*. 282(3):297-310.
5. Saha S, Sadhukhan P, Sil PC (2014) Genistein: A Phytoestrogen with Multifaceted Therapeutic Properties. *Mini Rev Med Chem*. 14:920-940.
6. Sarkar A, Sil PC (2014) Iron oxide nanoparticles mediated cytotoxicity via PI3K/AKT pathway: role of quercetin. *Food Chem Toxicol*. 71:106-115.
7. Sil PC, Sinha K (2015) Targeting oxidative stress and inflammation in NSAIDs induced gastropathy: A plausible therapeutic approach. *Inflamm cell signal*. 2:e763.



Prof. Bose's assistant studying the similarity of pulsation in leaves of *Desmodium gyrans* with that of animal heartbeat.



V. Basic and Applied Microbiology

Participation of Institutional Project-V for the 12th Five-year Plan (2012-2017)

Dr. Sujoy Dasgupta (Coordinator), Dr. Anuradha Lohia, Dr. Pradeep Parrack, Dr. Subrata Sau, Dr. Tapan Datta, Dr. Wriddhiman Ghosh, Dr. Joyoti Basu, Dr. Manikuntala Kundu, Dr. Srimonti Sarkar.

Introduction:

The objective of Plan Programme V is to investigate microbes using various molecular as well as genomic tools. The microbes being investigated include those which cause diseases, such as *Mycobacterium tuberculosis*, those that can be used to degrade complex environmental pollutants and finally those that are found in various environmental niches such as geothermal vents. A major component of our research is to trace the evolutionary origins of microbes and their genes, particularly those that are associated with novel functions. Using methods that include sequencing of genomes and metagenomes considerable insight into complex metabolic pathways that are environmentally and evolutionary important have been unraveled.

Dr. Joyoti Basu, Senior Professor

Scientific Reports:

Genome-wide analysis of the binding of transcription factor MtrA of *M. tuberculosis*: in collaboration with Dr. Manikuntala Kundu

MtrA is an essential transcription factor of *M. tuberculosis*, and therefore an attractive target for therapeutic intervention. In order to gain insight into the MtrA regulon, we have performed ChIP-seq in MtrA-overexpressing cells and extracted information on the putative repertoire of genes regulated by MtrA. These include members of the resuscitation promoting factors (Rpfs), and genes involved in cell wall biosynthesis. We have validated the ChIP-seq information for a number of these binding sites, and the results are being analyzed in terms of the pathways and processes regulated by MtrA in *M. tuberculosis*.

MicroRNA-17 regulates *M. tuberculosis*-mediated autophagy in macrophages: in collaboration with Dr. Manikuntala Kundu, Dr. Kuladip Jana and Dr. Umesh D. Gupta, CJIMOD, Agra

In our continued attempts to understand how microRNAs regulate the immune response to mycobacterial infection, we have deciphered the role miR-17 during Mtb infection. We observe that miR-17 is downregulated during Mtb infection of macrophages. We further observe that miR-17 regulates the level of expression of the Bcl-2 family member, Mcl-1. This is directly linked to enhanced levels of autophagy in miR-17 overexpressing macrophages during Mtb infection. We suggest that downregulation of miR-17 during the early stages of mycobacterial infection, regulates the extent of autophagy and hence the immune response to Mtb infection.

Dr. Sujoy K Das Gupta, Senior Professor and Coordinator

Scientific Reports:

Single domain RecA core proteins as ancestors of DnaB helicases:

DnaB helicases constitute a distinct clade within the RecA superfamily. Though functionally diverse, members of this family possess a conserved C terminal domain, known as the RecA core. We unearthed a series of mycobacteriophage encoded RecA core proteins in which the NTPase domain alone was present. These proteins were phylogenetically related to each other and formed a distinct clade within the RecA superfamily. A mycobacteriophage encoded protein, Wildcat Gp80 which roots deep in the DnaB family, was found to possess a core domain having significant sequence homology ($E < 10^{-5}$) with members of this novel cluster. This indicated that Gp80, and by extrapolation, other members of the DnaB helicase family, may have evolved from a single domain RecA core polypeptides belonging to this novel group. Biochemical investigations confirmed that Gp80 was a helicase. Surprisingly, our investigations also revealed that a thioredoxin tagged truncated version of the protein in which the N-terminal sequences were removed was fully capable of supporting helicase activity, although its ATP dependence properties were different. DnaB helicase activity is thus primarily a function of the NTPase core although additional N-terminal sequences may be necessary for fine tuning its activity and stability. Based on sequence comparison and biochemical studies we propose that DnaB helicases may have evolved from single domain RecA core proteins having helicase activities of their own, through the incorporation of additional N-terminal sequences.

Publications:

1. Dutta S, Bhawsinghka N and Das Gupta S K (2014) Gp66, a calcineurin family phosphatase encoded by mycobacteriophage D29, is a 2', 3' cyclic nucleotide phosphodiesterase that negatively regulates phage growth; *FEMS Microbiology Letters*, 361: 84-93.
2. Kirtania P, Bhattacharya B and Das Gupta S K (2014) Mycobacteriophage L5Gp56, a novel member of the NrdH family of redoxins, *FEMS Microbiology Letters*, 357: 16-22.

Students Awarded Ph.D.:

Name of Student (University/Year)	Title of Thesis
Prithwiraj Kirtania (C.U., 2014)	A study of mycobacteriophage D29 growth under hypoxic condition

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
Understanding the evolutionary origin and mechanism of action of a putative primase polymerase encoded by the Mycobacterium plasmid pAL 5000	CSIR

**Dr. Tapan K. Dutta**, Professor**Scientific Reports:****Biochemical and molecular characterization of bacterial catabolic potential:**

Isolation and characterization of bacteria belonging to the genus *Sphingobium*, *Burkholderia*, *Cupriavidus* and *Arthrobacter*, are being used for the assimilation of various environmental pollutants including PAHs, nitrobenzoic acids, hydroxy/aminonitriles and estrogenic phthalates. In one of the studies, an exhaustive biochemical and genetic characterization of the metabolic pathway for the assimilation of mono-nitrobenzoic acids have been performed in a soil isolate *Cupriavidus* sp. ST-14. Biochemical studies revealed the assimilation of 2- and 4-nitrobenzoic acids via 3-hydroxyanthranilic acid and protocatechuic acid, respectively. Genetic characterization of the corresponding gene clusters revealed multiple operons viz., *onb*, *pnb* and *hba* responsible for the assimilation of 2- and 4-nitrobenzoic acids. Further to extend the catabolic versatility of *Cupriavidus* sp. ST-14, a functional 3-nitrobenzoic acid dioxygenase from a 3-nitrobenzoic acid degrading *Comamonas* sp. strain JS46 has been incorporated in strain ST-14 which allowed the recombinant strain to utilize 3-nitrobenzoic acid via existing protocatechuate pathway. This has turned out to be the first comprehensive report on the biochemical and molecular characterization of complete metabolic pathways of all three isomers of mononitrobenzoic acid in a single but genetically manipulated strain of *Cupriavidus* sp.

Genetic characterization of a novel 2-naphthol degrading *nol* operon has been revealed in *Burkholderia* sp. strain BC1. Operon analysis showed the presence of a unique ring hydroxylating dioxygenase system which is assumed to be formed as a result of recruitment of different genetic modules from both Gram positive and Gram negative bacteria. Functional characterization of the dioxygenase revealed transformation of 2-naphthol, naphthalene and 2-methoxynaphthalene to their corresponding *cis*-dihydrodiols. A thorough biochemical characterization and kinetic studies have also been performed for 2-hydroxy-1-naphthoic acid decarboxylase, a novel enzyme, phylogenetically affiliated to amidohydrolase superfamily. Site directed mutagenesis further revealed the identification of critical amino acid residues responsible for substrate binding and enzyme catalysis.

In a different study, degradation capability of *Burkholderia* sp. BC1 on various aromatic nitriles have been explored. Preliminary biochemical analysis revealed the degradation of various nitriles via the formation of corresponding amides and acids. Detailed molecular and biochemical characterization of the metabolic pathway is underway to determine the genetic operon as well as important pathway enzymes. In a related metabolic pathway, two spontaneous deletion mutant strains of *Burkholderia* sp. BC1 were characterized showing impaired naphthalene metabolic pathway. Efforts are being made to elucidate the factors affecting such deletion events and the associated mechanism.

In the fish microbiome study, several bacterial species were isolated from the gut, gill and mucus parts of the Hilsa fish and were tested for antimicrobial activity against well-documented fish pathogens like *Aeromonas hydrophila* subsp. *hydrophila* and *Pseudomonas aeruginosa*. Till

now, three *Lactococcus* sp. and two *Enterococcus* sp. obtained from Hilsa microbiome showed antibacterial activity against *Aeromonas hydrophila* subsp. *hydrophila*. Isolation and characterization of the antimicrobial agent derived from the fish isolates is currently underway. In order to unravel the role of fish microbiota in the unique physiology and survival of the anadromous Hilsa fish in marine and fresh water, a proteomic approach was taken to study the differential expression of proteins in several fish isolates grown either in high salt or low salt condition.

Publication:

1. Chowdhury P P, Sarkar J, Basu S and Dutta T K (2014) Metabolism of 2-hydroxy-1-naphthoic acid and naphthalene via gentisic acid by distinctly different sets of enzymes in *Burkholderia* sp. strain BC1. *Microbiology* 160: 892–902.

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
Exploration of promoters of biotechnological importance from metagenomic DNA	DAE
Carbon monoxide conversion using native hydrogenogenic microorganisms for sulphate rich wastewater treatment	DBT

Dr. Abhrajyoti Ghosh, DST-Ramanujan Fellow**Scientific Reports:****Understanding protein translocation under extreme conditions:**

Protein translocation across biological membranes is a prerequisite for the survival of all living organisms. The process of protein translocation has been extensively addressed in bacteria and eukaryotes. Unfortunately, little information is available regarding protein translocation across the archaeal membranes. Analysis of the archaeal protein translocation machinery revealed its hybrid nature comprising of selected features of both bacterial and eukaryotic processes. However, certain aspects of the archaeal protein translocation pathway are apparently unique to the representatives of this domain of life, indicating the distinctive biological strategies developed by archaea during evolution. The Signal Recognition Particle (SRP), a ribonucleoprotein complex, is central to this protein translocation pathway in all three domains of life. During the past years, several interesting aspects with respect to the archaeal protein translocation have been documented. However, the lack of detailed biochemical analysis and limited availability of the genetic and cell-biological tools have restricted our progress in understanding the role of SRP in archaeal cells. Detailed *in-vitro* and *in-vivo* analyses are thus far an important pre-requisite to understand the exact nature of signal recognition particle (SRP) components in archaea and their roles in trafficking membrane and secretory proteins under variety of different environmental conditions. In the present work, we are aiming at detailed



understanding of the biochemical interactions between SRP-components in vitro as well as in vivo using *Sulfolobus acidocaldarius* as a model system.

Understanding archaeal diversity and activity in Sundarbans: in collaboration with Dr. Mairee Bhattacharyya, Dept. of Biochemistry, University of Calcutta

Marine sedimentary microbial communities are key mediators of global biogeochemical cycles. The Domain Archaea accounts for a large portion, perhaps the majority, of deep-subsurface prokaryotic cells and biomass, and by implication, global biomass. Although, the diversity of archaea in marine systems especially deep-subsurface and open ocean environments has been explored extensively, it has rarely been investigated the mangrove wetlands, estuarine or salt marsh habitats, which are some of the most productive ecosystems in the world. The Sundarbans is a tropical mangrove ecosystem which is situated on the delta of three rivers, Ganges, Brahmaputra and Meghna on the Bay of Bengal. In Sundarbans, thus far, only few studies have been carried out to understand the microbial biodiversity and their roles in maintenance of sustainable ecosystem. However, no attempt has been made to analyze the archaeal diversity and their activities in the Sundarbans sediment. The present study aims to focus on analyzing the archaeal diversity and activity in the Sundarbans sediment at a spatial scale. Preliminary studies indicated that local anthropogenic activities influence archaeal diversity in Sundarbans. For example, regions with the history of higher hydrocarbon contamination showed higher abundance of aerobic and anaerobic hydrocarbon degrading haloarchaeal communities, while pristine niches are populated with methanogenic archaeal communities. We propose that archaeal abundance might be used as proxies for hydrocarbon pollution in Sundarbans sediment.

Functional and structural studies on archaeal Actin-like protein: in collaboration with Dr. Gautam Basu

Crenactin is an actin ortholog identified in several crenarchaeal genomes, as well as in *Candidatus Korarchaeum cryptofilum*, and was shown to polymerize into cytoskeletal structure in the hyperthermophilic crenarchaeon *Pyrobaculum calidifontis*. Immunofluorescence microscopy imaging revealed that crenactin formed helical filaments that traversed the length of the rod-shaped cells. In a cell subpopulation, these filaments had been remodeled into band-like structures, presumably in preparation for the cell division, in this respect resembling the bacterial MreB, which belongs to the same ATPase superfamily as actin and crenactin. Identification of crenactin only in the genomes of rod-shaped archaea has led researchers to propose that this protein is involved in cell shape formation. Despite of its identification and preliminary studies; little is known about its biochemical and structural features. Recent structural analysis has confirmed that crenactin forms a helical filament and functions probably like actin/MreB in cytoskeletal assembly. Detailed biochemical analysis, however, an utmost requirement for better understanding of its role within 'Arcade' macromolecular assembly complex, which constitutes crenactin and other arcadin proteins. In the present project, we propose to explore the biochemical nature of crenactin and its interaction with arcadins. We believe that detailed understanding of the role of crenactin might shed light into its evolutionary significance especially in relation to eukaryotic actin.

Publications:

1. Basak P, Majumdar N, Nag S, Bhattacharya A, Roy D, Chakraborty A, Sengupta S, Roy A, Mukherjee A, Ghosh A, Chattopadhyay D, Bhattacharyya M (2015) Spatiotemporal analysis of bacterial diversity in sediments of Sundarbans using parallel 16S rRNA gene tag sequencing. *Microbial Ecology*, 69(3):500-11.
2. Bera A, Ghosh A, Mukhopadhyay A, Chattopadhyay D, Chakrabarti K (2015) Improvement of de-gummed ramie fiber properties upon treatment with cellulase secreting immobilized *A. larrymoorei* A1. *Bioprocess and Biosystems Engineering*, 38(2):341-51.
3. Chakraborty A, Bera A, Mondal A, Mukherjee A, Khan I, Basak P, Bhattacharya A, Roy D, Ghosh A, Chattopadhyay D, Bhattacharyya M (2015) Spatial alteration of the sediment microbial community profile and pollution status of a mangrove under anthropogenic degradation: A case study of Sundarbans, India. *World Journal of Microbiology and Biotechnology* 31(4):593-610.
4. Mahato M, Dey D, Pal S, Saha S, Ghosh A, Harms K and Nayek H P (2014) Syntheses, Structures, Optical Properties and Biological activities of Bimetallic Complexes. *RSC Advances*, 4:64725-64730.

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
Understanding protein translocation under extreme conditions	DST-Ramanujan Fellowship
Investigation of the archaeal diversity and activity in Sundarbans mangrove sediment, India	CSIR
Assessment of plant growth promoting bacteria in the mangrove rhizosphere and evolution of the plant growth promotion activity on rice	Dept. of Biotechnology, West Bengal

Dr. Wriddhiman Ghosh, Assistant Professor

Scientific Reports:

Global association between thermophilicity and vancomycin susceptibility in bacteria:

Exploration of the aquatic microbiota of several circum-neutral (6.0-8.5 pH) mid-temperature (55-85°C) springs revealed rich diversities of phylogenetic relatives of mesophilic bacteria, which surpassed the diversity of the truly-thermophilic taxa. To gain insight into the potentially thermophilic adaptations of the phylogenetic relatives of the Gram-negative mesophiles detected in culture-independent investigations we attempted pure-culture isolation by supplementing the enrichment media with 50 µg ml⁻¹ vancomycin. Surprisingly, this Gram-positive-specific



antibiotic eliminated entire chemoorganotrophic and sulfur-chemolithotrophic culturable diversities in all the tested hot water inocula. Moreover, it also killed all the Gram-negative hot-spring isolates that were obtained in vancomycin-free media. Concurrent literature search for the description of Gram-negative thermophilic bacteria revealed that at least 16 of them were vancomycin-susceptible. While these data suggested that vancomycin-susceptibility could be a global trait of thermophilic bacteria (irrespective of their taxonomy, biogeography and Gram-character), MALDI-MS of peptidoglycans of Gram-negative thermophiles revealed tandem alanines in the fourth and fifth positions of their muropeptide precursors, which again was the reported target of vancomycin in Gram-positive *Firmicutes*. Subsequent phylogenetic analyses revealed a close affinity between the D-alanine-D-alanine ligases (Ddl) of taxonomically-diverse Gram-negative thermophiles and the thermostable Ddl of *Thermotoga maritima*, well-known for its high specificity for alanine over other amino acids. The Ddl tree further illustrated a divergence between the homologs of Gram-negative thermophiles and mesophiles, which again coincided with vancomycin-susceptibility and resistance respectively. It was thus hypothesized that thermophilic Ddls have been evolutionarily selected to favor a D-ala-D-ala bonding and vancomycin-susceptibility was a collateral consequence of this plausible thermodynamic compulsion.

Publication:

1. Ghosh W, Roy C, Roy R, et al. (2015) Resilience and receptivity worked in tandem to sustain a geothermal mat community amidst erratic environmental conditions. *Scientific Reports* 5: 12179.

Students Awarded Ph.D.:

Name of Student (University/Year)	Title of Thesis
Dr. Masrur Alam (C.U., 2015)	

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
Comprehensive Geomicrobiology of two High Temperature Hydrothermal Systems of India: Paradigms of Primitive Metabolisms and Biogeochemical Evolution, Prospects of Biotechnological Resource.	SERB
Understanding the origin(s), evolution and interaction(s) of different molecular mechanisms of chemotrophic sulfur oxidation: Elucidating the metabolic strategies of early Life.	CSIR

Dr. Manikuntala Kundu, Senior Professor

Scientific Reports:

Targeting multiple response regulators of *Mycobacterium tuberculosis*: in collaboration with Dr. Joyoti Basu and Dr. D. Sriram, BITS Pilani

We have attempted to simultaneously target multiple response regulators (transcription factors) of *M. tuberculosis* by analyzing the critical determinants of the DNA binding activities of these response regulators. As a proof of principle study we have focused on the response regulators MtrA, RegX3 and MprA. We have identified critical amino acid residues common to the DNA binding pockets of each of these regulators. In collaboration with BITS Pilani, we used their chemical library and performed docking to the DNA binding pockets of MtrA and RegX3 to identify small molecules which target these response regulators. We have identified two small molecules and shown that these can simultaneously inhibit multiple response regulators of the OmpR family. We propose that this approach of simultaneously targeting multiple response regulators could be value for therapeutic intervention. In vivo studies are under way to demonstrate the effects of this approach on mycobacterial physiology and in the mycobacterium-macrophage interplay.

Dr. Pradeep Parrack, Professor

Scientific Reports:

Investigations into the Function of the ribosome binding protein HflX from *E. coli*

A. Studies on the autophosphorylation activity of *E. coli* HflX

E. coli HflX belongs to a family of translation factor-related GTPases that is widely conserved from bacteria to humans. A 426-residue polypeptide (MW 48.3 KDa) that binds 50S ribosomes, the protein exhibits both GTPase and ATPase activities. We have found that *E. coli* HflX, like other P-loop GTPases, also exhibits autophosphorylation activity in presence of GTP but not in presence of ATP. Further, our experiments show that the C terminal fragment (residues 176-426) of HflX, henceforth designated as HflX(C), exhibits an enhanced autophosphorylation activity than the full length protein. On the other hand, the N terminal part (residues 1-176) i.e HflX(N) has no such activity. Therefore, HflX(C) was used to further characterise the autophosphorylation property of the protein.

We found that the autophosphorylation activity of HflX(C) increases with time, much like for HflX. Further, HflX(C) showed better autophosphorylation activity in the presence of Mg^{2+} and Mn^{2+} ions than with Ca^{2+} . In all cases, the autophosphorylation activity was abolished in the presence of the chelating reagent EDTA, suggesting the importance of divalent cations in the autophosphorylation activity of HflX(C), as was reported earlier from our lab for the full length protein. Another interesting finding is that the rate of HflX(C) autophosphorylation is independent of protein concentration, suggesting that the reaction is intramolecular.

Chemical stability assays of the phospholinked amino acids implied that autophosphorylation of HflX is O-linked (Serine, Threonine or Tyrosine). From Thin Layer Chromatography of digested phosphorylated protein it was found that phosphorylation is occurring at a Serine residue. Mutations at several Serine residues of the C terminal region of HflX were carried out and studied. Our results suggest that autophosphorylation in HflX is occurring probably at S211, which belongs to the G1 motif.

B. The role of hflX in stressed environments

The role of the hflX gene under various kinds of environmental stress was studied by observing growth kinetic profiles of wild type *E. coli* (MG1655) and mutant Δ hflX cells, under the following stressed environments: heat shock (55°C), UV irradiation, low temperature (psychrotropic environment), osmotic stress (2.5 M NaCl) and the presence of heavy metal compounds (FeCl₃, CoCl₂·6H₂O and HgCl₂). No change was observed in the presence or absence of the gene.

C. Possible role of HflX in cell division

Chemical synthetic lethality experiments were carried out via MIC value determination of wild type and the mutant Δ hflX. These experiments were aimed at identifying which of the various cellular processes may be depending upon HflX. To this end, different classes of antibiotics which inhibit cellular functions like protein synthesis, cell wall biosynthesis, DNA replication, or RNA polymerase-directed transcription were used. A significant decrease in the MIC values for the mutant was observed only in the presence of cell wall biosynthesis inhibitors that affect cell division. This further implies, in accordance with previously reported studies, that the gene hflX has a role to play in cell division or in an event of cell division (such as cell segregation/septum formation) which is linked to Mn and probably to the autophosphorylation activity of HflX.

Publication:

1. Saha A, Mukhopadhyay J, Datta A B, and Parrack P (2015) Revisiting the mechanism of activation of cyclic AMP receptor protein (CRP) by cAMP in *Escherichia coli*: Lessons from a subunit-crosslinked form of CRP. *FEBS Lett.* 589, 358-363.

Dr. Srimonti Sarkar, Associate Professor

Scientific Reports:

Study of the protein degradation machinery of *Giardia lamblia*:

Giardia lamblia is a parasitic protist that is the causative agent for the diarrhoeal disease giardiasis. Current knowledge of the biology of *Giardia* indicates that it is highly diverged from its higher eukaryotic hosts. The focus of my research group is to understand the vital cellular process of protein degradation of this protist (both proteasomal and lysosomal) with the aim of

uncovering unique parasite-specific cellular machinery that may be targeted for therapeutic purposes. Our studies of the giardial proteasomal machinery indicate that it may be much simpler than that of the hosts'; not only is the parasite's proteasome composed of fewer subunits (orthologues of Rpn12 and Rpn13 could not be detected by bioinformatic approaches), even individual subunits may have undergone truncations. So even though *Giardia* encodes a functional ubiquitin receptor, GIRPN10, it is smaller compared to that of higher eukaryotic orthologues. Interestingly, in contrast to the minimalization observed for most giardial cellular pathways, *Giardia* encodes multiple orthologues of certain proteins involved in endosomal sorting; we could identify three orthologues of Vps4 and two of Vps46; both proteins perform crucial roles in the endosomal sorting processes. Given that this extracellular gut parasite's sole avenue of obtaining nutrition is via endocytosis of food ingested by the host, presence of multiple orthologues of the endosomal sorting machinery indicates that this process plays a vital role in this parasite.

Publications:

1. Das B, Ray T, Panda K K, Maiti A, Sarkar S, and Sil A K (2014) Leucine and its transporter provide protection against cigarette smoke-induced cell death: A potential therapy for emphysema. *Toxicology Reports* 1: 752-763.
2. Sinha A, Datta S P, Ray A, and Sarkar S (2015) A reduced VWA domain-containing proteasomal ubiquitin receptor of *Giardia lamblia* localizes to the flagellar pore regions in microtubule-dependent manner. *Parasites & Vectors* 8: 120.

Students Awarded Ph.D.:

Name of Student (University/Year)	Title of Thesis
Abhishek Sinha (IISER-Kolkata 2014)	Identification and characterization of genes that play a role in the trophozoite to cyst transition of <i>Giardia lamblia</i>

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
Identification and characterization of a 19S proteasomal component of the early diverging eukaryote <i>Giardia lamblia</i>	DBT
Functional characterization of the lipid-binding FYVE protein from <i>Giardia lamblia</i>	CSIR
Host for ASM-IUSSTF Indo-US Teaching Professorship for course entitled Molecular Genetic Analysis of Signaling Pathways to be taught by Prof. Ralph Keil of Pennsylvania State University, USA	Indo-US Science and Technology Forum & American Society for Microbiology

**Participation in Conferences / Symposia / Workshops & Invited Talks Delivered at Various Organizations :**

Delivered invited talks at (i) Anitafest held on June 13, 2014, at Ohio State University, Columbus, OH, U.S.A. (ii) One day symposium organized by the Department of Genetics, Calcutta University on February 21, 2015 (iii) 5th Annual General Meeting of the DNA Society of India on November 27, 2014.

Dr. Subrata Sau, Professor

Scientific Reports:**Characterization of some DNA/drug binding proteins:**

FKBP22, a peptidyl-prolyl *cis-trans* isomerase (PPIase) expressed by *Escherichia coli*, harbors two domains, forms dimers in solution and binds some immunosuppressive drugs such as FK506 and rapamycin. The C-terminal domain (CTD) of this PPIase acts as the drug binding site. Interestingly, the Mip-like virulence factors those share considerable identity with FKBP22 also bind the above drugs and possess PPIase activity. To determine the effects of these drugs on the structure and stability of the Mip-like proteins, a recombinant FKBP22 (rFKBP22) and a CTD variant (CTD⁺) were investigated in the presence and absence of rapamycin using different *in vitro* probes. We report that rapamycin binding causes small structural changes of both rFKBP22 and CTD⁺. The urea-induced and thermal unfolding of the rapamycin-equilibrated proteins proceeded through the formation of intermediates. The intermediates carried substantial extents of secondary and tertiary structures. In spite of the generation of intermediates, the thermal or urea-induced unfolding of proteins occurred by a reversible pathway. Unfolding studies also suggested the rapamycin-mediated stabilization of rFKBP22 and CTD⁺. Taken together, rFKBP22 or CTD⁺ could be employed for screening the rapamycin-like inhibitors in the future.

Bacteriophage $\phi 11$ uses *Staphylococcus aureus* as its host and encodes repressor CI for its lysogenic development. Previously, CI showed binding to two adjacent operators with variable affinity. The CI is composed of an N-terminal domain (NTD), a hinge, and a C-terminal domain (CTD). A computational study indicates that the CTD is possibly involved in the dimerization of CI. In contrast, the NTD may be involved in the DNA binding ability of CI as it harbors a putative helix-turn-helix motif. To understand the structure and function of NTD at length, we studied a recombinant NTD (rNTD) using various tools. We have shown that the secondary and tertiary structures of the rNTD are different from those of rCI, a recombinant $\phi 11$ CI. Interestingly, rNTD dimerized in the aqueous solution and bound to the operators with the affinities, which were similar to those of rCI. In addition, the operator base specificity, binding stoichiometry, and binding mechanism of this domain are nearly identical to those of the rCI. Both rCI and rNTD also significantly dislodged a RNA polymerase from a $\phi 11$ DNA fragment carrying a promoter overlapped with two operators. Unlike rCI, the binding of rNTD to two

adjacent operators was not cooperative in nature. The dimerization and DNA binding abilities of the NTD of $\phi 11$ CI are, therefore, distinct from those of the DNA binding domains of other phage repressors.

Staphylococcus aureus, a disease-causing Gram-positive bacterium, synthesizes a plethora of virulence factors for successful infections. Two global regulatory loci, *agr* (accessory gene regulator) and *sar* (staphylococcal accessory regulator), control the expression of the majority of virulence factors in *S. aureus*. SarA, a *S. aureus*-specific DNA binding protein, is encoded by the *sar* locus. Interestingly, *S. aureus* produces multiple SarA paralogs to optimize the synthesis of its virulence factors. To obtain clues about the domain structure and the folding/unfolding mechanism of the SarA protein family, a recombinant SarA (rSarA) was investigated using different biochemical and biophysical probes. Limited proteolysis of rSarA shows that it is a single-domain protein with a long, flexible C-terminal end. The unfolding of rSarA occurred differently in the presence of different denaturants. Although two rSarA intermediates were formed in the presence of urea or GdnCl, their surface hydrophobicity, oligomeric status and the structures were not identical and differed significantly from those of native rSarA. Of the intermediates, the GdnCl-generated intermediates not only possessed a molten globule-like structure but also exhibited resistance to dissociation during their unfolding. Compared to the native rSarA, the intermediate originated at lower GdnCl concentration carried a compact shape, whereas, other intermediates owned a swelled shape. The chemical-induced unfolding, unlike the thermal unfolding of rSarA, was completely reversible in nature.

Publications:

1. Biswas A, Mandal S, Sau S. (2014) The N-terminal domain of the repressor of *Staphylococcus aureus* phage $\phi 11$ possesses an unusual dimerization ability and DNA binding affinity. *PLoS One*. 9: e95012.
2. Mahapa A, Mandal S, Biswas A, Jana B, Polley S, Sau S, Sau K. (2015) Chemical and thermal unfolding of a global staphylococcal virulence regulator with a flexible C-terminal end. *PLoS One*. 10: e0122168.
3. Polley S, Jana B, Chakrabarti G, Sau S. (2014) Inhibitor-induced conformational stabilization and structural alteration of a mip-like peptidyl prolyl *cis-trans* isomerase and its C-terminal domain. *PLoS One*. 9: e102891.

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
with Dr. T. K. Dutta (Co-PI)	
Studies on the DNA binding mechanism of a global virulence regulator SarA of <i>Staphylococcus aureus</i> . (started 01-11-2013)	DAE

**Participation in Conferences / Symposia / Workshops & Invited Talks Delivered at Various Organizations:***with Mr. Anindya Biswas*

(i) presented a poster entitled "Purification and Characterization of the N-Terminal Domain of the Repressor of *Staphylococcus aureus* Phage f11" at the 83rd Annual Meeting of the Society of Biological Chemists held at the KIIT University, Bhubaneswar, on 18th-21st December 2014.

with Soumitra Polley

(i) presented a poster entitled "Rapamycin binding-mediated stabilization of a Mip-like peptidyl prolyl cis-trans isomerase and its C-terminal domain" at the 83rd Annual Meeting of the Society of Biological Chemists held at the KIIT University, Bhubaneswar, on 18th-21st December 2014.

with Sukhendu Mandal

(i) presented a poster (entitled "Purification and characterization of a global virulence regulator from *Staphylococcus aureus*") along with Avisek Mahapa and Keya Sau (Haldia Institute of Technology) at the 83rd Annual Meeting of the Society of Biological Chemists held at the KIIT University, Bhubaneswar, on 18th-21st December 2014.



Gallery at the First Floor of J.C. Bose Museum featuring self-explanatory panels on Biography of J.C. Bose and the Demonstration Room

VI. Systems Biology:**Participation of Institutional Project-VI for the 12th Five-year Plan (2012-2017)**

Dr. Joyoti Basu (Coordinator), Dr. Indrani Bose, Dr. Manikuntala Kundu, Dr. Jayanta Mukhopadhyay, Dr. Suman Kr. Banik and Dr. Zhumur Ghosh

Introduction:

In this programme scientists are working on various aspects of understanding disease processes and infections using Systems Biology approaches. Specifically, high throughput approaches have been taken to understand pathogen-tuned signaling networks in host cells. Mathematical modeling has been employed to understand stress responses in mammalian cells and in bacterial pathogens.

Dr. Suman K Banik, Associate Professor

Scientific Reports:**Effect of relaxation time scale in signal transduction:**

Intra-cellular fluctuations, mainly triggered by gene expression, are an inevitable phenomenon observed in living cells. It influences generation of phenotypic diversity in genetically identical cells. Such variation of cellular components is beneficial in some contexts but detrimental in others. To quantify the fluctuations in a gene product, we undertake an analytical scheme for studying few naturally abundant linear as well as branched chain network motifs. We solve the Langevin equations associated with each motif under the purview of linear noise approximation and derive the expressions for Fano factor and mutual information in a close analytical form. Both quantifiable expressions exclusively depend on the relaxation time (decay rate constant) and steady state population of the network components. We investigate the effect of relaxation time constraints on Fano factor and mutual information to identify a time scale domain where a network can recognize the fluctuations associated with the input signal more reliably. We also show how input population affects both quantities. We extend our calculation to long chain linear motif and show that with increasing chain length, the Fano factor value increases but the mutual information processing capability decreases. In this type of motif, the intermediate components act as a noise filter that tune up input fluctuations and maintain optimum fluctuations in the output. For branched chain motifs, both quantities vary on a large scale due to their network architecture and facilitate survival of living system in diverse environmental conditions.

Publications:

1. Maity A K, Chaudhury P and S K Banik (2015) Role of relaxation time scale in noisy signal transduction. *PLOS One*. 10: e0123242.
2. Sarkar P, Maity A K, Shit A, Chattopadhyay S, Ray Chaudhuri J and Banik S K (2014) Controlling mobility via rapidly oscillating time-periodic stimulus. *Chem. Phys. Lett.*, 602: 4.

**Book Chapter:**

1. Bandyopadhyay A, Fenley A T, Banik S K and Kulkarni R V (2015) Theoretical modeling of signal transduction in the quorum-sensing pathway in the Vibrios in *The Physical Basis of Bacterial Quorum Communication*, Springer series in Biological and Medical Physics, Biomedical Engineering, Ed. by Stephen J Hagen: pp. 7-18 (Springer, New York)

Students Awarded Ph.D:

Name of Student (University/Year)	Title of thesis
Arnab Bandyopadhyay (C.U, 2014)	Theoretical and Computational Study of Biochemical Signaling Pathways.

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
"In Vitro study of input-output robustness of MprAB signaling pathway in Mycobacterium tuberculosis"	DBT

Dr. Joyoti Basu, Senior Professor and Coordinator

Scientific Reports:

The role of M. tuberculosis mannoseylated lipoarabinomannan in macrophage signaling: in collaboration with Dr Manikuntala Kundu and Dr. Zhumur Ghosh

Macrophages play an important role in the establishment of infection by intracellular pathogens. *Mycobacterium tuberculosis* (Mtb) ManLAM subverts the host immune response by activation of PPAR γ . We have used global gene expression profiling to understand (a) how ManLAM regulates host cell immune responses, and (b) the role of PPAR γ in modulating ManLAM-induced host cell signaling. We establish that ManLAM dependent inhibition of macrophage apoptosis is mediated by the upregulation of the anti-apoptotic Bcl2 family member A1. *In silico* analyses suggested that ManLAM mediated PPAR signaling is linked to processes such as phagocytosis, cytoskeleton remodelling, cell survival and autophagy.

Publications:

1. Halder P, Datta C, Kumar R, Sharma AK, Basu J, and Kundu M (2015) The secreted antigen, HP0175, of *Helicobacter pylori* links the unfolded protein response (UPR) to autophagy in gastric epithelial cells. *Cell Microbiol.* 17: 714-729.
2. Kumar M, Sahu S K, Kumar R, Subuddhi A, Maji RK, Jana K, Gupta P, Raffetseder J, Lerm M, Ghosh Z, van Loo G, Beyaert G, Gupta UD, Kundu M, and Basu J (2015) MicroRNA let-7 modulates the immune response to *Mycobacterium tuberculosis* infection via control of A20, an inhibitor of the NF-kappa B pathway. *Cell Host and Microbe*, 17:345-356.

Grants-In-Aid Schemes:

Title of the Scheme	Schemes funded by
Role of microRNAs in the immune response to mycobacterial infection (1.7.2011-31.6.2014)	CSIR
Sys TB: A Network Programme for Resolving the Intracellular Dynamics of Host Pathogen Interaction in TB Infection (09.01.2012-08.01.2017)	DBT
Mycobacterium tuberculosis infection: understanding the role of microRNAs in regulating the immune response of macrophages (23.8.2011-22.8.2014)	Indo-Korean collaborative programme (DST)

Participation in Conferences / Symposia / Workshops & Invited Talks Delivered at Various Organizations:

(i) Delivered a lecture in the 9th International Conference on the Pathogenesis of Mycobacterial Infections held in Stockholm, Sweden from June 26 to 29, 2014. (ii) Delivered a lecture at the Foundation Day Symposium on "Preventive Medicine; Current Perspective" organized by Central Calcutta Society for Advancement of Human Development and Research at CGCRI, Kolkata on 21st July, 2014. (iii) Participated in the Guha Research Conference held in Khajuraho in December, 2014. (iv) Delivered a lecture in the Indo French Women In Science Seminar, held in the Indian Institute of Science, Bangalore, India from March 3 to 5 2015, organized jointly by CEFIPRA, the Indian Academy of Sciences, and the Embassy of France in India.

Honours Received:

(i) Member, Editorial Board, PLoS One; (ii) Member of the ICMR Expert Committee on Cellular and Molecular Biology

Dr. Indrani Bose, CSIR-Emeritus Scientist

Scientific Reports:**Interdisciplinary Physics/Systems Biology:**

We have completed a study on the functional characteristics of gene expression motifs with single and dual strategies of regulation of gene expression. The dual strategies of regulation include transcriptional regulation by transcription factors and post-transcriptional regulation by microRNAs. We have investigated both the deterministic and stochastic dynamics of a two-gene motif with dual strategies of regulation. We have also considered two one-gene motifs with single strategies of regulation, transcriptional regulation in one case and post-transcriptional regulation in the case of the other motif. The gene regulation in the two motifs has been analysed from the perspective of information theory. The regulatory module is represented as an



input-output device with the regulatory molecules defining the input and the gene expression levels constituting the output. In the presence of noise, the input and output are represented in terms of the probability distributions of the appropriate protein levels. The transmission of information through an input-output device can equivalently be represented as information flow through a channel. We have calculated the channel capacity for both transcriptional and post-transcriptional regulation and shown that the channel capacity is considerably enhanced in the latter case. We have also initiated a study on the growth and extinction of tumours and the early signatures for the extinction of tumours.

Publications:

1. Bose I and Pal M (2015) Early signatures of regime shifts in complex dynamical systems. *Pramana*, 84: 193-202.
2. Pal M, Ghosh S and Bose I (2015) Non-genetic heterogeneity, criticality and cell differentiation. *Physical Biology* 12: 016001, 16 pages.

Students Awarded Ph.D:

Name of Student (University/Year)	Title of thesis
Sayantari Ghosh (C.U., 2014)	Deterministic and Stochastic Dynamics of Model Gene Circuits.

Participation in Conferences / Symposia / Workshops & Invited Talks delivered at Various Organizations:

(i) Delivered on invitation a talk on "Cell differentiation, non-genetic heterogeneity and criticality" at the International Conference on Mathematical Biology organized by the Department of Mathematics, IIT, Kanpur during February 28- March 3, 2015 (ii) a talk on "Criticality in the living cell" at the Physics and Applied Mathematics Researchers' Meet, Indian Statistical Institute, Kolkata during March 18-20, 2015 (iii) a talk on "Mathematical models of cell differentiation" at National Seminar on Recent Trends in Applied Mathematics and its Computational Aspects, Department of Applied Mathematics, University of Kolkata during March 25-27, 2015 (iv) delivered on invitation a lecture titled "Magnetism: basics and phenomena" at the Science Academies' Lecture Workshop on Physics of Electronic Materials at St. Xavier's College, Kolkata during August 8-9, 2014.

Dr. Zhumur Ghosh, Assistant Professor

Scientific Reports:

Micro-regulatory networks in Mycobacterium tuberculosis: in collaboration with Dr. Joyoti Basu and Dr. Manikuntala Kundu

We performed an integrated analysis of microRNA and mRNA expression of murine macrophages infected with Mycobacterium tuberculosis (M.tb). Interestingly, the let-7 family of

miRNAs, specially mmu-let-7f was significantly down regulated at different time points of post infection. We proceeded to create an interacting network based on linking let-7 family of miRNAs and their corresponding target mRNA expression data. We hereby employed an integrative analysis of target prediction as well as miRNA and mRNA expression data by using the tool MAGIA2 (Bisognin et al. 2012) to facilitate the prediction of possible interactions. Correlated miRNA-mRNA interactions were visualised as a network using Cytoscape (<http://www.cytoscape.org/>). Among the predicted targets, Tnfaip3 was validated and was found to have a significant impact on the system. We proceeded to map the Tnfaip3 interacting network which gets affected by mmu-let-7f. The interactors of Tnfaip3 (target of mmu-miR-let-7f) were retrieved using **STRING 9.1** (<http://string-db.org/>). This resulted in the selection of 129 interacting genes. To analyze functional association of the selected genes, **EnrichNet** (<http://www.enrichnet.org/>) was used on the aforementioned genes. Tissue-specific enrichment analysis was carried out. Thereafter the six highly enriched processes (involving 72 genes) which are mostly affected after *M.tb* infection are selected for further experimental validation. This network provides a theoretical outline of the concerted action of the significantly downregulated miRNA, mmu-let-7f and its target Tnfaip3 in mycobacterial infection of murine macrophages.

Elucidating the key hubs that are different in metastatic state and cancer stem cell state:

My lab has developed a novel approach to track the genes participating in ovarian cancer progression based on shortest path analysis. We are further looking into how the system (involving key hub genes) moves towards metastatic state vis-à-vis cancer stem cell state. This investigation will point out the dynamics of gene crosstalk from a network-based analysis of the cellular system and will successfully highlight the key players and their specific location and contribution in the multi-layered, interconnected regulome of ovarian cancer. Furthermore, shaping the roadmap of tumor progression from its initiation to its malignancy may also contribute to the annotation of novel biomarkers that would help in the development of faster preclinical and clinical therapeutic modalities.

Understanding the role of PPAR γ in ManLAM induced macrophage cell signaling: in collaboration with Dr. Joyoti Basu and Dr. Manikuntala Kundu

Mannose-capped lipoarabinomannans (ManLAMs) are members of the family of Mycobacterium tuberculosis effectors that regulate signalling in host immune cells. ManLAM is one of the bacterial effectors that plays a role in bacterial subversion of host immunity. Analysis of the global transcriptomic data suggested that LAM regulates the apoptosis in J774A.1 macrophages. Our results demonstrate that ManLAM regulates host cell apoptosis which likely favours survival of the pathogen and limits the proinflammatory response. Our insilico analyses suggest that PPAR γ signaling likely influences pathways which are critical to infection, including phagocytosis, internalization and autophagy.

Publication:

1. Kumar M, Sahu SK, Kumar R, Subuddhi A, Maji RK, Jana K, Gupta P, Raffetseder J, Lerm M, Ghosh Z, van Loo G, Beyaert R, Gupta UD, Kundu M, Basu J (2015) MicroRNA let-7 modulates the immune response to Mycobacterium tuberculosis infection via control of A20, an inhibitor of the NF- κ B pathway. *Cell Host Microbe*, 17(3):345-56.

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
Micro-regulatory networks in leukemia stem cells	DBT-RGYI
Epigenetic alteration inducing oncogenicity in stem cell derivatives	ICMR Task Force for Stem Cell research
Jointly with Dr. Sudipto Saha Systematic identification of regulatory networks in pluripotent cells integrating coding and noncoding world	ICMR

Participation in Conferences / Symposia / Workshops & Invited Talks delivered at Various Organizations:

- (i) Delivered a talk at 25th Mid-year meeting of Indian Academy of Science at IISc Bangalore in July 2014 on *Regulatory Networks Modulating Stem cell biology- Key players behind the Screen*.

Participation of Group Members:

- (i) Ranjan Kumar Maji presented a poster at CIIB-2014 in Dec 2014 on PVT: A Cloud adaptable protocol for efficient Next-generation Sequence Analysis (ii) Aritra Deb presented a poster at CIIB-2014 in Dec 2014 on Substates of pluripotency - Elucidating the key Determinants.

Honours Received:

Elected (i) Associate Fellow, Indian Academy of Science (2011-2014) (ii) Editorial Board Member, Current Bioinformatics

Symposia and Seminar Organized:

BIC organized a 3 day international conference - "International Conference on Informatics & Integrative Biology (CIIB-2014) - during December 17-19, 2014, to celebrate twenty-five years of existence of the Bioinformatics Centre at Bose Institute. Dr. Zhumur Ghosh and Dr. Sudipto Saha were the Joint Secretaries and Dr. Shubhbra Ghosh Dastidar was the Convener of Scientific Programme. The keynote address was delivered by Prof. Tom Blundell, FRS. Among other notable speakers was Dr. Frank Eisenhaber, Director, A*Star, Singapore.

Dr. Manikuntala Kundu, Senior Professor

Scientific Reports:

Global expression profile of miRNA of epithelial cells infected with *Helicobacter pylori*: in collaboration with Dr. Jhumur Ghosh and Dr. Joyoti Basu

In order to gain insight into *Helicobacter pylori*-mediated pathogenesis, we focused on microRNA mediated modulation of gene expression during infection of the gastric cell line AGS with *Helicobacter pylori*. Infection was carried out at MOI 50 and 100 for two different time points. Global expression profiling of microRNAs showed modulation of several key miRNAs in a time- and dose-dependent manner. In silico analysis was carried out to identify the putative targets of these miRNAs. Validation of these targets by the generation of 3'UTR constructs is under currently under way. Modulation of expression of the miRNAs as well as their targets has been observed in infected cells by quantitative RT-PCR as well as by immunoblotting. The implications of these observations are being studied.

Functional analysis of mycobacterial response regulators: in collaboration with Dr. Joyoti Basu and Dr. Ramandeep Singh, THSTI

Mycobacterium tuberculosis uses two component signal transduction systems (TCSs) for sensing environmental signals and responding to these signals. Two component systems consist of paired histidine kinases and response regulators (RRs). Understanding how TCSs respond to stress will provide detailed understanding of the mechanisms used by the bacterium to survive within its host. We observed the involvement of the two component system (TCS), SenX3-RegX3 in the survival of mycobacteria under phosphate depletion. Microarray analysis has been completed using the knock out and wild type strains grown in the presence and absence of phosphate. Attempts are being made to develop a network encompassing the genes modulated in the knockout strain compared to the wild type. Validation of RegX3-dependent transcriptional regulation of genes likely to be involved in mycobacterial survival within the host, is under progress.

Publications:

1. Halder P, Datta C, Kumar R, Sharma A K, Basu J and Kundu M (2015) The secreted antigen, HP0175, of *Helicobacter pylori* links the unfolded protein response (UPR) to autophagy in gastric epithelial cells. *Cell Microbiol.* 17: 714-729.
2. Kumar M, Sahu S K, Kumar R, Subuddhi A, Maji R K, Jana K, Gupta P, Raffetseder J, Lerm M, Ghosh Z, van Loo G, Beyaert G, Gupta UD, Kundu M and Basu J (2015) MicroRNA let-7 modulates the immune response to *Mycobacterium tuberculosis* infection via control of A20, an inhibitor of the NF-kappa B pathway. *Cell Host and Microbe*, 17: 345-356.

Students Awarded Ph.D:

Name of Student (University/Year)	Title of thesis
Sourav Sanyal (C.U., 2014)	Regulation of stress response factors and their roles in mycobacteria

**Grants-In-Aid Schemes:**

Title of the Scheme	Scheme funded by
With Dr. J. Basu (Co-PI) The role of two component systems and cell division proteins in mycobacterial physiology (29.09.2012-28.03.2016)	DBT
With Dr. J. Basu (Co-PI) Stress induced regulation of extracytoplasmic sigma factors of mycobacteria (21.10.2010 to 20.10.2014)	DST

Participation in Conferences / Symposia / Workshops & Invited Talks delivered at Various Organizations:

(i) Delivered an invited in the 83rd meeting of the Society of Biological Chemists (India) held in KIIT University, Bhubaneswar from 18th to 21st December, 2014. (ii) Delivered an invited lecture in the DAE-BRNS life Sciences Symposium (LSS-2015) on Advances in Microbiology of Food, Agriculture, Health and Environment organized by Bhaba Atomic Research Centre at BARC, Mumbai from February 3 to 5, 2015.

Dr. Jayanta Mukhopadhyay, Assistant Professor

Scientific Reports:**High throughput approach to identify genes regulated by each sigma factor of *M.tuberculosis*:**

In this project, we propose to determine the consensus sequence of each σ factor by SELEX method and identify the promoters in the *M. tuberculosis* genome. Subsequently, we would test the ability of each σ factor to initiate transcription from those promoters. In conclusion, we would identify the genes regulated by each σ factor. This approach would help us to build a transcriptional network of *M. tuberculosis*.

In the preliminary work, we have generated approximately 400 bps random DNA fragments from *M. tuberculosis* Genomic DNA. We have labelled the 400 bps DNA fragments with Cy5 using a Cy5 labelled primer during PCR amplification of the DNA. Upon performing EMSA of the complexes formed with Cy5 labelled DNA fragments and RNAP (containing $\sigma^\wedge$), we have observed that a part of the DNA fragments are able to form complex with RNAP. Sequence of the DNA fragments would identify the genes recognized by $\sigma^\wedge$. Identical approach would be followed for each of the 13 σ factors.

In vitro study of input-output robustness of MprAB signaling pathway in *Mycobacterium tuberculosis*:

One of the important functional aspects of living organisms is to respond to the sudden changes made in their environment, and to make appropriate changes in the cellular or sub-cellular level

for survival. Direct manifestations of such changes at the sub-cellular level are the regulation of single or multiple genes controlling different functional behavior of an organism. The human pathogen *Mycobacterium tuberculosis*, causative agent for the disease tuberculosis, is no exception to this behavior. *M. tuberculosis* while responding to a particular external stimulus utilizes its machinery of two component systems (TCSs) each comprising a paired sensor kinase and its cognate response regulator. One of such TCS in *M. tuberculosis* is MprAB having the sensor kinase MprB and the response regulator MprA, encoded by the operon *mprAB*. In presence of external stimulus MprB shows bi-functional behavior by acting as kinase as well as phosphatase towards its cognate response regulator MprA. The pool of phosphorylated MprA acts as a transcription factor for expression of *sigE*. *SigE*, in turn, activates the operon *mprAB*. Measurement of *sigE* levels following the application of an external stimulus could therefore serve as an indirect measure of the pool of MprA-P generated due to induction. Considering the influx of the external stimulus and the consequent outflux via the formation of phosphorylated response regulator, one can define an input-output relation using the framework of bacterial TCS. This phosphorelay based signalling machinery is likely to be insensitive to the variation in systems components that eventually leads to a robust signalling framework. Keeping this in mind we plan to address validation of input-output relation in MprAB TCS of *M. tuberculosis* utilizing the *in vitro* reconstitution of the signal flow network in *E. coli*.

In our preliminary work, we have cloned *M. tuberculosis mprA* and *mprB* gene and purified the recombinant proteins by expressing them in *E. coli*. For studying MprAB dependent gene expression *in vivo*, we have used the recombinant *M. tuberculosis* reporter assay in *E. coli*. For this assay, we have cloned the *mprAB* genes under an inducible promoter and in the same plasmid we have introduced a mCherry cassette under the control of a MprA dependent promoter DNA.

Publications:

1. Banerjee, R, Rudra, P, Saha, A, and Mukhopadhyay, J (2015) Recombinant Reporter Assay Using Transcriptional Machinery of *Mycobacterium tuberculosis*, *Journal of bacteriology*, 197: 646-653.
2. Saha A, Mukhopadhyay J, Datta AB, Parrack P, (2015) Revisiting the mechanism of activation of cyclic AMP receptor protein (CRP) by cAMP in *Escherichia coli*: Lessons from a subunit-crosslinked form of CRP. *FEBS Letters*, 589 (2015): 358-363.

Students Awarded Ph.D:

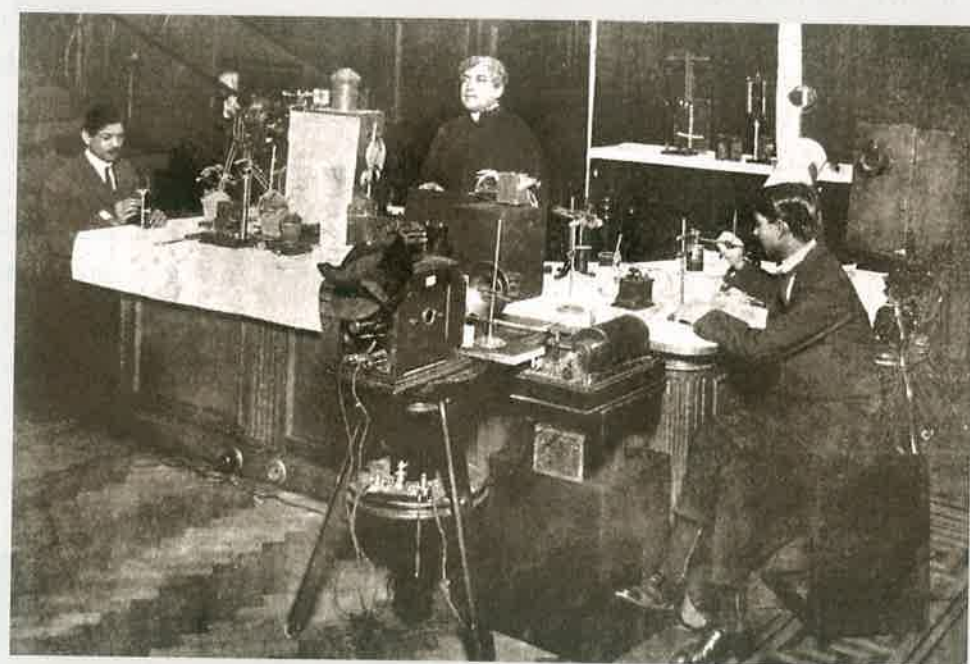
Name of Student (University/Year)	Title of thesis
Rajdeep Banerjee (C.U., 2015)	Mechanism of Gene Regulation in <i>Mycobacterium tuberculosis</i>

**Grants-In-Aid Schemes:**

Title of the Scheme	Scheme funded by
With Dr. S. Banik (PI) and Dr. M.Kundu In vitro study of input-output robustness of MprAB signalling pathway in Mycobacterium tuberculosis Jointly with Dr. R.Sen, CDFD	DBT
Characterization and design of inhibitors of Mycobacterium tuberculosis transcription	DBT

Participation in Conferences / Symposia / Workshops & Invited Talks delivered at Various Organizations:

Participated at (i) Total Transcription, Wellcome Trust Genome Campus, Hinxton, Cambridge, UK, 1-5 Sept, 2014. Mechanism of inhibition of transcription by Rv1222 from Mycobacterium tuberculosis.



Acharya J.C. Bose demonstrating his research findings at the Royal Institution of Great Britain

Silver Jubilee Celebration of Bioinformatics Centre

BIC organized a 3 day international conference - "International Conference on Informatics & Integrative Biology (CIIB-2014)" - during December 17-19, 2014, to celebrate twenty-five years of existence of the Bioinformatics Centre at Bose Institute. Dr. Zhumur Ghosh and Dr. Sudipto Saha were the Joint Secretaries and Dr. Shubhra Ghosh Dastidar was the Convener of Scientific Programme. The keynote address was delivered by Prof. Tom Blundell, FRS. Among other notable speakers was Dr. Frank Eisenhaber, Director, A*Star, Singapore.



VII. Basic and Applied Problems in Physical and Environmental Sciences:

Participation of Institutional Project-VII for the 12th Five-year Plan (2012-2017)

Dr. D. Home (Coordinator), Dr. S. Raha, Dr. B. K. Chatterjee, Dr. Indrani Bose, Dr. Sanjay Kr. Ghosh, Dr. S. K. Saha, Dr. T. P. Sinha, Dr. Pradeep Das, Dr. Somsuhro Bandyopadhyay, Dr. Dhruva Gupta, Dr. Rajarshi Ray, Dr. Amitabha Mitra, Dr. Achintya Singha, Dr. Abhijit Chatterjee, Dr. Supriya Das, Dr. P. S. Joardar and Dr. Soumen Roy

Introduction:

The Institutional project VII contributes both to fundamental knowledge as well as applications relevant to industry and society in general. The current research activities under this project are in the areas of Atmospheric Sciences, Radiation Physics; Statistical Mechanics; Foundations of Quantum Mechanics and Quantum Entanglement; Astrophysics of Strongly Interacting Matter; Characterization of Detector Materials for Heavy Ions; Preparation and Characterization of Dielectric Materials, Condensed Matter Physics, Nano-Science, Image processing and Differential networks, Nuclear and High Energy Physics, Astroparticle Physics and Cosmology, Physics of Relativistic Heavy Ion Collisions and Millimeter Wave & Microwaves.

Dr. Somshubhro Bandyopadhyay, Associate Professor

Scientific Reports:

I. Theoretical Research

A. Excessive distribution of quantum entanglement:

Jointly with Tomek Paterek group at NTU, Singapore, Kavam Modi, Monash University, Mauro Paternostro, Queen's University, Belfast

We classify protocols of entanglement distribution as excessive and non-excessive ones. In a non-excessive protocol, the gain of entanglement is bounded by the amount of entanglement being communicated between the remote parties, while excessive protocols violate such bound. We first present examples of excessive protocols that achieve a significant entanglement gain. Next we consider their use in noisy scenarios, showing that they improve entanglement achieved in other ways and for some situations excessive distribution is the only possibility of gaining entanglement.

B. Reciprocal ontological models show indeterminism of the order of quantum theory:

Jointly with M. Banik, S.S. Bhattacharya, A. Roy, A. Mukherjee, G. Kar, ISI, Kolkata and Sibasish Ghosh, IMSc. Chennai

The question whether indeterminism in quantum measurement outcomes is fundamental or is there a possibility of constructing a finer theory underlying quantum mechanics that allows no

such indeterminism, has been debated for a long time. We show that within the class of ontological models due to Harrigan and Spekkens, those satisfying preparation-measurement reciprocity must allow indeterminism of the order of quantum theory. Our result implies that one can design quantum random number generator, for which it is impossible, even in principle, to construct a reciprocal deterministic model.

II. Quantum Optics Laboratory:

We are continuing our progress on various experiments using our single photon set up. Parametric down conversion was established with both lasers, and coincidence experiments were carried out. We are also happy to report that the second batch of our Integrated M.Sc. - Ph.D. students did experiments in this lab as part of their M.Sc. curriculum. We have also procured few new optimal elements for advanced experiments.

Publications:

1. Bandyopadhyay S (2014) Unambiguous discrimination of linearly independent pure quantum states: optimal probability of success. *Physical Review, A* 90:030301 (Rapid Communication).
2. Bandyopadhyay S, Cosentino A, Johnston N, Russo V, Watrous J, and Yu N (2015) Limitations on separable measurements by convex optimization. *IEEE Transactions on Information Theory*, 61(6): 3593-3604.
3. Pal R, Bandyopadhyay S, and Ghosh S (2014) Entanglement sharing through noisy qubit channels: one-shot optimal singlet fraction. *Physical Review, A* 90:052304.

Participation in Conferences /Symposia /Workshops & Invited Talks delivered at Various Organizations:

(i) Delivered talk on Local distinguishability of quantum states, Department of Physics, NTU, Singapore, October 2014; (ii) delivered talk on Local distinguishability of quantum states: Introduction and Overview, Physical Research Laboratory, Ahmedabad, February, 2015; (iii) visited Institute of Quantum Computing, University of Waterloo, Canada in June 2014 (3 weeks) (iv) visited National University of Singapore, and Nanyang Technological University, Singapore in October 2014 (one week) (v) visited Physical Research Laboratory, Ahmedabad in February 2015 (one week); (vi) acted the Resource person at the NESST-BASE held at Bose Institute's Mayapuri Campus at Darjeeling in the summer of 2014.

Dr. Indrani Bose, CSIR-Emeritus Scientist

Scientific Reports:

Interdisciplinary Physics :

The research studies carried out are at the interface between statistical physics, non-linear dynamics and biology (a summary of the work done is given under Programme-VI). We have initiated a new study on information transmission in a gene regulatory module for which the



distribution of the input regulatory molecules is exactly known. Our major motivation is to obtain new insight on information transmission in cell biological processes and to ascertain whether such transmission occurs at an optimal level.

Dr. Barun K. Chatterjee, Senior Professor

Scientific Reports:

Studying the variation of amplitude of emitted acoustic signals from bubble nucleation at various pressures:

The ambient pressure increases the velocity of sound wave in a superheated liquid, affects the dynamics of the growing bubble and causes the amplitude of the emitted sound wave to decrease, during liquid-vapour nucleation. It was observed that the fraction of the bubbles nucleated, with an emission amplitude above a certain threshold value, decreases exponentially with pressure. This indicates that, for a fixed threshold, at higher pressures, fewer droplet nucleations are detected acoustically. From this, we obtained a pressure dependent detection threshold to maintain uniformity in the count rate in the superheated emulsion detector, in a limited range of pressures.

Publication:

1. Chatterjee T, Chatterjee BK, Majumdar D, and Chakrabarti P (2015) Antibacterial effect of silver nanoparticles and the modeling of bacterial growth kinetics using a modified Gompertz model. *Biochim. Biophys. Acta.*, 1850: 299-306.

Participation in Conferences /Symposia /Workshops & Invited Talks delivered at Various Organizations:

- (i) Acted as a judge at the Young Scientists' Colloquium 2014 YSC14 (September 12, 2014), at the Saha Institute of Nuclear Physics, Kolkata.

Dr. Pradip Das, Professor

Scientific Reports:

Relation between short-range and long-range order in Liquid Crystals (LC):

Experimental proof of complementary short-range ordering mechanisms, e.g. non-polar ordering of molecular cores and dipole ordering, enhancing long-range order has been obtained in cholesterol esters. Thermodynamic stabilization of chiral smectic phase in a mixture of smectogen-A* materials has been shown experimentally, and being explored theoretically. Membrane phospholipids such as dimyristoyl phosphatidyl-choline and -ethanolamine are being looked into in the neat and aqueous gel states to obtain clues as to their LC behaviour and functions like solitary wave propagation.

Students awarded Ph.D:

Name of Student (University/Year)	Title of thesis
Joyes De (J. U. 2014)	Mesomorphism in Cholesteryl Esters and Membrane Phospholipids: Calorimetry, XRD, NMR, and Theoretical/Computational Studies

Socially Relevant:

Liquid crystals are useful in many materials of everyday use. Besides they are biologically relevant, being present in membranes, muscles and other living structures.

Dr. Sanjay K. Ghosh, Professor

Scientific Reports

Physics of strongly interacting matter:

- I. With Rajarshi Ray, Anirban Lahiri (TIFR), Sarbani Majumder (SINP), Munshi G. Mustafa (SINP)

Fluctuations of conserved quantum numbers are associated with the corresponding susceptibilities because of the symmetry of the system. The underlying fact is that these fluctuations as defined through the static correlators become identical to the direct calculation of these susceptibilities defined through the thermodynamic derivatives, due to the fluctuation-dissipation theorem. Through a rigorous exercise we explicitly show that a diagrammatic calculation of the static correlators associated with the conserved quark number fluctuations and the corresponding susceptibilities are possible in the case of mean field theories, if the implicit dependence of the mean fields on the quark chemical potential are taken into account appropriately. As an aside we also give an analytical prescription for obtaining the implicit dependence of the mean fields on the quark chemical potential.

- II. With Supriya Das, Rajarshi Ray and Subhasis Samanta and Abhijit Bhattacharyya (CU)

We have studied the temperature and baryonic chemical potential dependence of higher-order fluctuations and the correlation between conserved charges in an excluded-volume hadron resonance gas model. Products of moments, such as the ratio of variance to mean, product of skewness and standard deviation, product of kurtosis and variance, for the net proton, net kaon, and net charge have been evaluated on the phenomenologically determined freeze-out curve. Further, products of moments for net proton and net charge have been compared with the experimental data measured by the STAR experiment. The dependence of the model result on the hadronic radius parameter has also been discussed.



III. With Sibaji Raha and Rajarshi Ray, External Collaborators: Abhijit Bhattacharyya (CU), Anirban Lahiri (TIFR), Sarbani Majumder (SINP)

We have studied the 1+1 flavor system of strongly interacting matter in terms of the Polyakov–Nambu–Jona-Lasinio model. We have found that, although the small isospin-symmetry breaking brought in through unequal light quark masses is too small to affect the thermodynamics of the system in general, it may have a significant effect in baryon-isospin correlations and have a measurable impact in heavy-ion collision experiments.

Publications:

1. Adak A, Chatterjee A, Singh AK, Sarkar C, Ghosh S K, Raha S (2014) Atmospheric fine mode particulates at eastern Himalaya, India: Role of meteorology, long-range transport and local anthropogenic sources, *Aerosol and Air Quality Research*, 14(1) 440.
2. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2015) Production of $\Sigma(1385)^\pm$ and $\Xi(1530)0$ in proton-proton collisions at $\sqrt{s_{NN}} = 7$ TeV, *Eur.Phys.J. C75* 1, 1
3. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Freeze-out radii extracted from three-pion cumulants in pp, p–Pb and Pb–Pb collisions at the LHC, *Phys.Lett. B739* 139-151
4. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Production of charged pions, kaons and protons at large transverse momenta in pp and Pb–Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV, *Phys.Lett. B736* 196-207.
5. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Transverse momentum dependence of inclusive primary charged-particle production in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, *Eur. Phys. J. C74* 9, 3054.
6. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2015) Charged jet cross sections and properties in proton-proton collisions at $\sqrt{s_{NN}} = 7$ TeV, *Phys.Rev. D91* 11, 112012.
7. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2015) Elliptic flow of identified hadrons in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV, *JHEP* 1506 190.
8. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2015) Inclusive photon production at forward rapidities in proton-proton collisions at $\sqrt{s_{NN}} = 0.9, 2.76$ and 7 TeV, *Eur.Phys.J. C75* 4, 146.
9. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Beauty production in pp collisions at $\sqrt{s_{NN}} = 2.76$ TeV measured via semi-electronic decays *Phys.Lett. B738* 97-108.
10. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Exclusive J/Ψ photoproduction off protons in ultra-peripheral p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, *Phys.Rev.Lett. 113* (2014) 23, 232504.

11. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Measurement of visible cross sections in proton-lead collisions at $\sqrt{s_{NN}} = 5.02$ TeV in van der Meer scans with the ALICE detector, *JINST* 9 11, P11003
12. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Neutral pion production at midrapidity in pp and Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV, *Eur.Phys.J. C74* 10, 3108.
13. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Performance of the ALICE Experiment at the CERN LHC, *Int.J.Mod.Phys. A29* 1430044.
14. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Suppression of $Y(1S)$ at forward rapidity in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV, *Phys.Lett. B738* 361-372.
15. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Suppression of $\psi(2S)$ production in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, *JHEP* 1412 (2014) 073.
16. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2015) Event-by-event mean pT fluctuations in pp and Pb-Pb collisions at the LHC, *Eur.Phys.J. C74* (2014) 10, 3077.
17. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2015) $K^*(892)0$ and $\phi(1020)$ production in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV, *Phys. Rev. C91* 2, 024609.
18. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2015) Measurement of electrons from semileptonic heavy-flavor hadron decays in pp collisions at $\sqrt{s_{NN}} = 2.76$ TeV, *Phys.Rev. D91* 1, 012001
19. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2015) Multiplicity dependence of jet-like two-particle correlations in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, *Phys.Lett. B741* 38-50.
20. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2015) Production of inclusive $Y(1S)$ and $Y(2S)$ in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, *Phys.Lett. B740* 105-117.
21. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Measurement of prompt D-meson production in p–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, *Phys. Rev. Lett. 113* 23, 232301.
22. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Azimuthal anisotropy of D meson production in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV, *Phys.Rev. C90* 3, 034904.
23. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Measurement of quarkonium production at forward rapidity in pp collisions at $\sqrt{s_{NN}} = 7$ TeV *Eur.Phys.J. C74* 8, 2974.
24. ALICE Collaboration (J. Adam et al.) (2015) Two-pion femtoscopy in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, *Phys.Rev. C91* . 034906.
25. ALICE Collaboration (Jaroslav Adam et al.) (2015) Coherent p_0 photoproduction in ultra-peripheral Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV, *JHEP* 1509 095.



26. ALICE Collaboration (Jaroslav Adam et al.) (2015) Measurement of jet suppression in central Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV, *Phys.Lett.* B746 1-14.
27. ALICE Collaboration (Jaroslav Adam et al.) (2015) Measurement of charged jet production cross sections and nuclear modification in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, *Phys.Lett.* B749 68-81.
28. ALICE Collaboration (Jaroslav Adam et al.) (2015) Forward-backward multiplicity correlations in pp collisions at $\sqrt{s_{NN}} = 0.9, 2.76$ and 7 TeV, *JHEP* 1505 097.
29. ALICE Collaboration (Jaroslav Adam et al.) (2015) Measurement of dijet kT in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, *Phys.Lett.* B746 385-395.
30. ALICE Collaboration (Jaroslav Adam et al.) (2015) Rapidity and transverse-momentum dependence of the inclusive J/ψ nuclear modification factor in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, Published in *JHEP* 1506 055.
31. ALICE Collaboration (Jaroslav Adam et al.) (2015) Centrality dependence of particle production in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, *Phys.Rev.* C91 6, 064905.
32. Bhattacharyya A, Das S, Ghosh S K, Ray R, and Samanta S (2014) Fluctuations and correlations of conserved charges in an excluded-volume hadron resonance gas model, *Phys. Rev. C* 90 034909.
33. Bhattacharyya A, Ghosh S K, Lahiri A, Majumder S, Raha S and Ray R (2014) Isospin-symmetry breaking and baryon-isospin correlations from the Polyakov-Nambu-Jona-Lasinio model, *Phys. Rev. C* 89 (2014) 064905.
34. Das S K, Chatterjee A, Ghosh S K and Raha S (2015) Fog-induced changes in optical and physical properties of transported aerosols over Sunderban, India, *Aerosol and Air Quality Research* 15(4) 1201.
35. Ghosh S K and Raha S (2014) The Darjeeling facility: Cosmic rays and Atmospheric Sciences (Review article), *Proc. Indian Natl. Sci. Acad.* 80, 791.
36. Ghosh S K, Lahiri A, Majumder S, Mustafa M G, Raha S, Ray R (2014) Quark Number Susceptibility : Revisited with Fluctuation-Dissipation Theorem in mean field theories, *Phys. Rev. D* 90 054030.
37. Ghosh S K, Raha S, Ray R, Saha S and Upadhaya S (2015) Shear viscosity and phase diagram from Polyakov-Nambu-Jona-Lasinio model, *Phys. Rev. D* 91 054005.
38. Multiparticle azimuthal correlations in p-Pb and Pb-Pb collisions at the CERN Large Hadron Collider, ALICE Collaboration (Betty Bezverkhny Abelev et al.), *Phys. Rev. C* 90 (2014) 5, 054901
39. Sarkar C, Chatterjee A, Majumdar D, Ghosh S K, Srivastava A, and Raha S (2014) Volatile organic compounds over Eastern Himalaya, India: temporal variation and source characterization using Positive Matrix Factorization. *Atmospheric Chemistry and Physics Discussions*, 14(23), 32133-32175.

40. Sarkar C, Chatterjee A, Singh A K, Ghosh S K and Raha S (2015) Characterization of Black Carbon Aerosols over Darjeeling-A High Altitude Himalayan Station in Eastern India. *Aerosol and Air Quality Research*, 15(2), (2015) 465-478.
41. Sen A, et al. (2014) Atmospheric fine and coarse mode aerosols at different environments of India and the Bay of Bengal during winter – 2014: Implication of coordinated campaign, Mapan – Journal of Indian Meteorological Society of India, 29(4) 273.

Conference Proceedings:

1. Bhattacharyya A, Das S, Ghosh S K, R Ray, Samanta S (2015) Study of fluctuations in excluded volume hadron resonance gas model. *Proc.Indian Natl.Sci.Acad.*, 81 1: 51-55.
2. Bhattacharyya A, Das S, Ghosh S K, Raha S, Ray R, Saha K, Upadhaya S (2015) Study of D- measure from Polyakov-Nambu-Jona-Lasinio model. *Proc.Indian Natl.Sci.Acad.*, 81 1: 152-157.
3. Bhattacharyya R, Dey S, Ghosh S K, Maulik A, Raha S and Syam D (2015) Strangelet search at mountain altitudes. *Proc.Indian Natl.Sci.Acad.*, 81 1: 165-168.
4. Prasad S K, Das S, Ghosh S K, Ghosh P, Muhuri S, Nayak T K, Ray R (2015) "Soft" and "hard" interactions in proton-proton collisions at LHC energies, *Proc. Indian Natl.Sci.Acad.* 81 1: 213-216.

Symposia and Seminar Organized:

- (i) Member, Organizing Committee of NESST-BASE 2014, a summer training programme for North-East students in basic sciences held at Bose Institute, Darjeeling;
- (ii) Member, Organizing committee for International conference on Physics and Astrophysics of Quark Gluon Plasma, February 2 – 6, 2015, VECC, Kolkata.

Dr. A. Chatterjee, Assistant Professor

Scientific Reports:

Campaign study over Sundarban island:

A field campaign was conducted over Kalas island, Sundarban for studying the effect of transport of gaseous and carbonaceous pollutants from Indo-Gangetic Plain regions to Bay of Bengal. It was observed that Black Carbon aerosols were transported significantly from IGP regions over Bay of Bengal. Black carbon particles were also found to be scavenged significantly by fog events which enhanced BC concentration to several folds.

Biosphere-Atmosphere Exchange of Greenhouse Gases and Energy over High Altitude Forest :

The study has been started over a forest called Selimbong under Dhotrey range of Darjeeling Division of Forest department, Govt of West Bengal. A 50 m tall tower has been erected in the forest equipped with several sensors at different heights. CO₂/H₂O analyzers have been



installed on the tower below and above the canopy. Four automated weather stations have been installed on the tower at four different heights. Measurements are also being carried out for Photosynthetic Active Radiation, incoming solar radiation, three direction wind etc. The fluxes of greenhouse gases are being measured using Eddy Covariance method. Four automated soil CO₂/H₂O flux systems have been installed at four places at the forest floor to measure the forest emitted green house gas fluxes. All the sensors have been installed and the site has been operational since March, 2015.

The primary objective of the study is to find out whether biosphere acts as a net source or sink for greenhouse gases over a high altitude forest at eastern Himalaya.

Real-time measurements of Greenhouse Gases over eastern Himalaya: A collaboration with Massachusetts Institute Technology, US:

An online GC is running over our Darjeeling campus for measurement of major GHG like CH₄, SF₆, N₂O etc. It was observed that GHG concentrations were maximum during summer when westerly air masses bring those pollutants from western and central Indo Gangetic Plain regions over eastern Himalaya.

Black Carbon particles over eastern Himalaya

A study was performed on Black Carbon (BC) aerosol measured and characterized over a high altitude (2200 m amsl) hill station Darjeeling over eastern Himalaya in India. High average annual concentration of $3.4 \pm 1.9 \mu\text{gm}^{-3}$ for BC was observed. BC was found to be maximum during summer (March-May). The major source of BC over Darjeeling was investigated. The concentration levels of these pollutants were comparable or even higher than those in some of the metro cities in India and abroad. It was observed that ~17 % BC was driven by up-slope valley wind from low land foothill regions whereas ~27 % BC was transported from long distant regions, mainly Nepal. Rest was contributed by the local sources like vehicular exhaust, biomass burning etc.

VOCs over eastern Himalaya

A study was performed on the most important gaseous carbonaceous pollutant Volatile Organic Compounds (VOCs). Temporal variation shows that VOC was maximum during autumn (Oct-Nov). The main reason of high emission of VOCs over Darjeeling was anthropogenic or man made activities. Significant amount of VOCs were also emitted in to the atmosphere during tourist season i.e. summer. But the VOC concentration was mainly governed by the meteorological parameters. Solar radiation played the major role. It helped in destruction of VOCs in the atmosphere and thus VOCs were minimum during summer with high solar radiation although the emission strength was more or less equal with that in autumn. The average concentration of VOC over Darjeeling was $376.3 \pm 857.2 \mu\text{gm}^{-3}$. While carbonaceous aerosol (BC) was well correlated with the emissions, gaseous compounds were mainly governed by both the emissions and photochemical loss under high solar insolation during premonsoon. This resulted to very low VOCs of $35.9 \pm 9.7 \mu\text{gm}^{-3}$ and carbonyl compounds of $73.5 \pm 38.3 \mu\text{gm}^{-3}$ during premonsoon when solar radiation was maximum. The major local sources of these

pollutants in the atmosphere are the vehicular exhaust, biomass burning, solvent evaporation etc.. Nepal was also found to be the major long-distant source for VOCs contributing ~50 % to the total VOCs over Darjeeling.

Carbonyl compounds over eastern Himalaya

Study was also performed on another important gaseous carbonaceous compound called Carbonyl Compounds. This was also measured over Darjeeling. The average concentration of Carbonyl Compound was found to be $293.3.5 \pm 463.9 \mu\text{gm}^{-3}$. The maximum concentration of Carbonyl Compounds was found in autumn. Carbonyl was also found to be governed by the meteorological parameters, solar radiation. It helped carbonyl compounds to be destructed due to high solar radiation.

Overall, it was found that of the measured carbonaceous pollutants over Darjeeling, VOCs contributed by ~56 %, carbonyl compounds contributed by ~43 % whereas particulate carbonaceous compounds, i.e. BC contributed by ~1%. From the Himalayan perspective, such high loading of atmospheric carbonaceous pollutants draws serious attention not only for their acute health effect but also for climate related issues as they could significantly affect atmospheric energy balance, modulate cloud microphysical properties and hence precipitation, tropospheric ozone budget etc. The data of carbonaceous pollutants is of paramount interest and importance for various regional climate models over such geographically important region in India.

Rain chemistry studies:

Rainwater samples have been chemically analyzed for several water soluble ionic species. The acidity was measured of the samples which showed high acidic rain over Darjeeling, moderately over Falta and highly alkaline over Kolkata. It was observed that the neutralizing alkaline species Ca²⁺ over Kolkata was maximum which neutralized the rainwater acidity. On the other hand, the concentrations of alkaline species were minimum over Darjeeling compared to anthropogenic acidic species. Positive Matrix Factorization model was used to apportion the sources of several chemical species scavenged by rain.

Ground-based and Space-borne Observations of Black Carbon Trapped by Fog over Sundarban: with Dr. S. K. Das, Dr. S. K. Ghosh and Dr. S. Raha

Aerosol measurements were conducted in campaign mode at Kalas Island, Sundarban to address fog-induced changes in aerosols properties during 11–16 January 2014. The extreme south-most island in Sundarban was selected for observations as it has no local source of anthropogenic aerosols and is far from urban region. Two fog events occurred over Sundarban during our campaign period. Satellite observations suggest that these two fog events were confined over Sundarban and its surroundings. This localized fog trapped the fine-mode aerosols (>1.0 micron) that came from near-by urban region. As a result, Black Carbon (BC), mainly coming into the atmosphere by incomplete combustion of carbonaceous materials and known as a tracer for fine-mode anthropogenic aerosols, was found to be increased by 30% during foggy period and became $15.2 \pm 1.3 \mu\text{g.m}^{-3}$. Such enhancement of fine-aerosols resulted in an increase in Aerosol Optical Depth (AOD) by a factor of three (1.6 ± 0.4) from its "background" of $0.5 \pm$

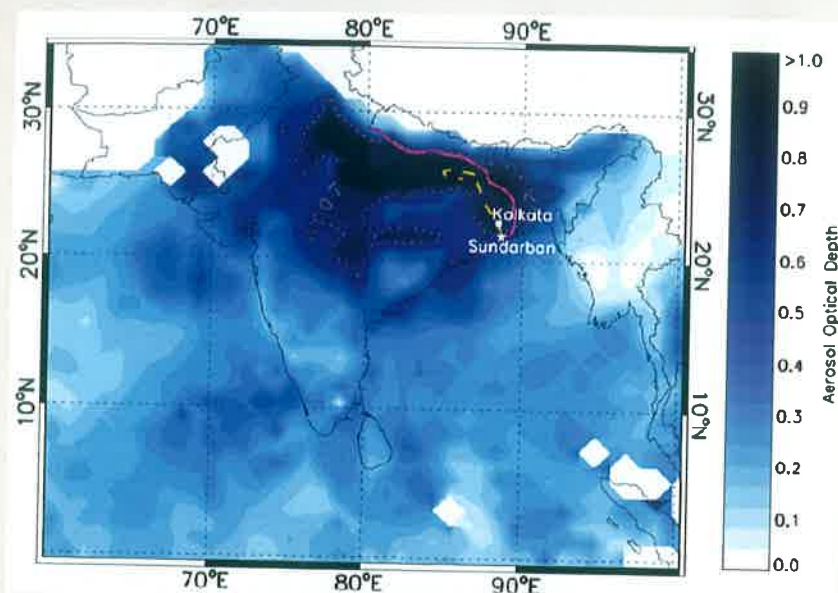


Figure shows aerosol loading over Indo-Gangetic Basin within the Indian Subcontinent in terms of Aerosol Optical Depth obtained from NASA sensor MODIS onboard AQUA satellite. The curves (magenta solid and yellow dashed) present pathway of air carrying anthropogenic aerosols to Sundarban from central Indo-Gangetic Basin via Kolkata and nearby urban regions, captured in HySPLIT model simulations.

and those particles were arriving at Sundarban region within a day. Dominance of such high BC aerosols during foggy environment indicates high risk for health and climate change.

Simulation of Winter-time haze effect on Earth's Radiation Budget: with Dr. S. K. Das, Dr. S. K. Ghosh and Dr. S. Raha

An integrated winter-time campaign was organized to investigate continental haze over Indian Subcontinent during December 2013–February 2014 at source and remote regions within Indo-Gangetic Basin (IGB) to quantify its effects on Earth's radiation budget. Measurements were carried out at three locations in eastern India; 1) Kolkata (22.57°N, 88.42°E) — an urban source region 2) Kalas Island, Sundarban (21.68°N, 88.57°E) — a downwind transported region along the north-east coast of BoB, and 3) Siliguri (26.70°N, 88.35°E) — a rural region at the foothills of eastern Himalayas.

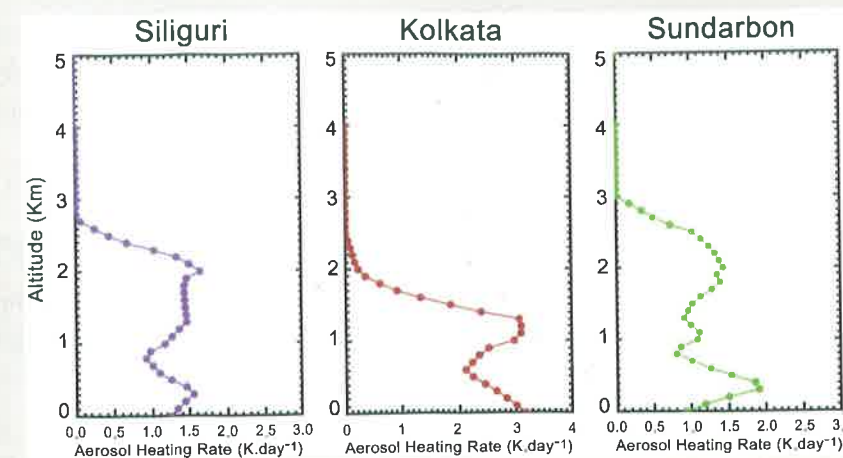
Aerosol loading in the atmosphere is observed to be maximum in terms of AOD (1.25 ± 0.18) over Kolkata followed by Siliguri (0.60 ± 0.17) and minimum over Sundarban (0.53 ± 0.18). Black carbon concentration is found to be maximum at Kolkata ($21.6 \pm 6.6 \mu\text{g}\cdot\text{m}^{-3}$) with almost equal concentrations at Siliguri ($12.6 \pm 5.2 \mu\text{g}\cdot\text{m}^{-3}$) and Sundarban ($12.3 \pm 3.0 \mu\text{g}\cdot\text{m}^{-3}$). Combination of space-borne sensor MODIS observed AOD and back-trajectories analysis shows an outflow of winter-time continental haze originating from central IGB and venting out through Sundarban towards Bay of Bengal (BoB). Observations from space-borne lidar on-board CALIPSO satellite suggest winter-time haze confined within 3 km from surface over IGB and contribute to two thirds of total aerosol loading over central BoB while transported. Considering

0.2 on a normal winter day. Analysis of meteorological parameters indicates that low ventilation due to calm and cool atmosphere with a shallow boundary layer during foggy days could have 'trapped' BC over Sundarban and resulted in such an aerosol enhancement over remote coastal region. Further, detail spectral investigations of aerosol absorption coefficients indicated the BC aerosols during foggy period were mostly associated with fossil-fuel combustion like urban vehicular emissions

the ground-based measured and satellite retrieved aerosol parameters as input to radiative transfer model, a simulation was carried out to estimate the effects of winter-time continental haze on the perturbation of regional climate change parameters and found that this haze causes significant amount of solar energy to be stored within the atmosphere that is parameterized as aerosol atmospheric radiative forcing. Large solar energy is stored over Kolkata (75.4 Wm^{-2}) as well as over Siliguri and Sundarban (40 Wm^{-2}) indicating large forcing over entire IGB, from foothills of the Himalayas to coastal region. This winter-time continental haze also causes similar high radiative heating ($1.5 \text{ K}\cdot\text{day}^{-1}$) from Siliguri to Sundarban which is enhanced over Kolkata ($3 \text{ K}\cdot\text{day}^{-1}$) due to large emission of local urban aerosols. Such high aerosol heating over entire IGB and coastal region of BoB can have considerable impact on the monsoonal circulation and more importantly, such haze transported over to BoB can significantly affect the marine hydrological cycle.

Instrumentation Development for Aerosol Hygroscopic Growth measurement in cloudy and humid environment: with Dr. S. K. Das, S. Singh, Dr. S. K. Ghosh, Dr. A. Mitra and Dr. S. Raha

Recent ground-based experiments and satellite observations indicate increasing aerosol loading over Eastern Himalayas and demand continuous monitoring to predict future climate variability. However, prolonged wet atmospheric conditions over the mountains interrupt the observations of aerosol optical and physical properties. In addition, cloud coverage and complex terrain produce large uncertainties in satellite retrieved parameters. A project has been initiated to investigate the alteration of aerosol properties in wet conditions that will be able to provide uninterrupted aerosol observations for long-term studies. We set up a laser system in open air condition using a 10 mw CW red laser of wavelength 680 nm with a line-of-sight link to a spectrometer at 100 m at our Shyamnagar campus during December 2014. The changes in humidity of ambient air can be studied by analysing the received signal. Our measurements indicate 90% signal attenuation in a dense foggy environment when relative humidity is 100%. In such high humid condition, aerosols grow hygroscopically by absorbing moisture and this causes increased backward scattering of solar radiation to space and results in low visibility near the surface. For more detailed long-term observations required for in-depth investigations, another laser at green (532 nm) wavelength is included. Measurements are proposed at Darjeeling and Kolkata. The received attenuated signals provide changes in aerosol properties



Vertical distribution of aerosol heating rate is simulated within very fine atmospheric layer of 100 meters over Siliguri, Kolkata and Sundarban representing significantly high warming effect by continental haze confined within 3 km over Indo-Gangetic Basin.



due to changes in humidity under both cloudy and clear sky conditions. Therefore, complete information of aerosol properties (optical as well as physical) will be derived and further used for simulation of aerosol radiative forcing and heating rate over Eastern Himalayas during cloudy and humid conditions.

Publications:

1. Sarkar C, Chatterjee A, Majumdar D, Ghosh S K, Srivastava A and Raha S (2014) Volatile organic compounds over Eastern Himalaya, India: temporal variation and source characterization using Positive Matrix Factorization. *Atmospheric Chemistry and Physics Discussions*, 14(23), 32133-32175.
2. Sarkar C, Chatterjee A, Singh A K, Ghosh S K and Raha S (2015) Characterization of Black Carbon Aerosols over Darjeeling-A High Altitude Himalayan Station in Eastern India. *Aerosol and Air Quality Research*, 15(2), 465-478.
3. Das S K, Chatterjee A, Ghosh S K and Raha S (2015) Fog-Induced Changes in Optical and Physical Properties of Transported Aerosols over Sundarban, India. *Aerosol and Air Quality Research*, 15 (4), Pages 1201-1212.

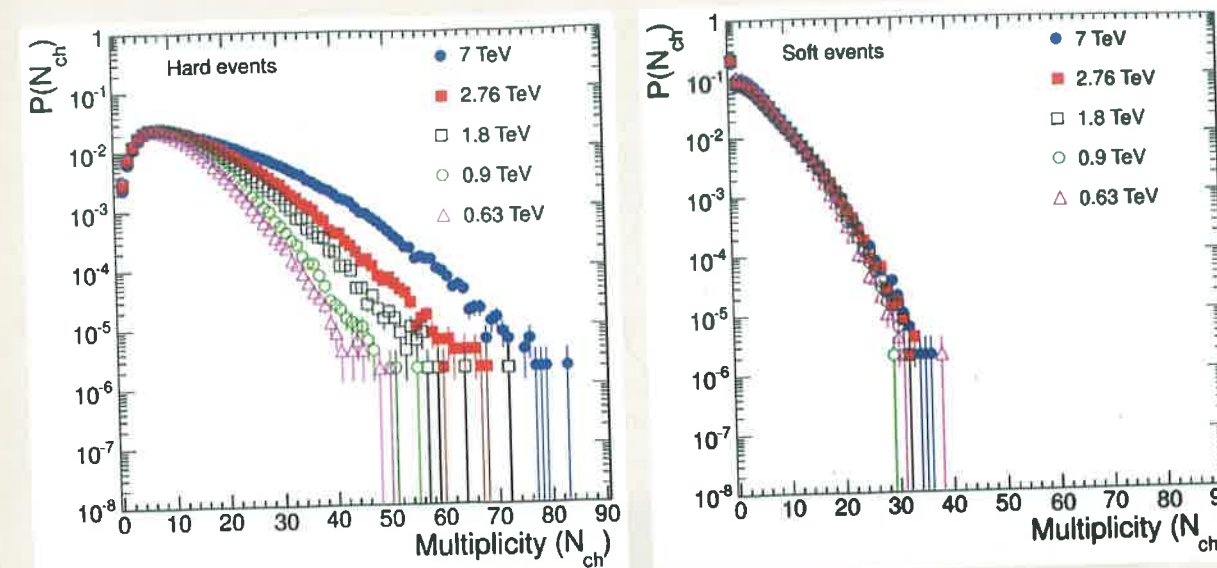
Dr. Supriya Das, Associate Professor

Scientific Reports:

Soft and hard interactions in proton-proton collisions at LHC energies: with Dr. Sidharth K. Prasad, Rajarshi Ray, Sanjay K. Ghosh. External collaborator: Premomoy Ghosh (VECC, Kolkata)

Non-diffractive proton-proton collisions can be classified into "soft" and "hard" (or "semi-hard") interactions, with hard (or semi-hard) interactions involving hard parton-parton interactions due to large momentum transfer resulting into jets, whereas interactions without a jet (or minijet) can be considered as soft interactions. Energy invariance in the properties of soft events (e.g. multiplicity, transverse momentum, and mean transverse momentum distributions) is observed at lower centre-of-mass energies. The unprecedented centre-of-mass energy achieved at the LHC provides us an opportunity to further extend this study to the highest available $\sqrt{s}$. This study can further be extended to investigate the possibility of collectivity in proton-proton collisions at the LHC. The study is already in the advance stage and the results obtained so far using simulations are presented in various national/international meetings/conferences and published as a conference proceeding.

In figure above, the multiplicity distributions of charged particles at midrapidity are shown for various centre-of-mass energies in the range 0.63 TeV to 7 TeV obtained using PYTHIA6. The left hand side panel shows the distributions for hard events whereas right hand side panel shows distributions for soft events. One observes that the multiplicity distributions do not change with change in centre-of-mass energy in PYTHIA6 simulation for soft events following the trend as reported by experiments at lower energies.



Study of jet properties in high multiplicity proton-proton collisions: with Dr. Sidharth K. Prasad

High multiplicity proton-proton events at very large centre-of-mass energies such as $\sqrt{s} = 7$ and 13 TeV are of special interest. The multiplicities and thereby the energy densities achieved in these collisions are comparable to that obtained in peripheral heavy ion collisions. Several surprising results, both from theory and experiment side, are already in the public domains, which are yet to be understood. Formation of medium in these collisions is a debatable subject at this moment. Jets are among the best probes to understand the medium in heavy-ion collisions. Our aim therefore is to study jet properties in high multiplicity pp events compared to minimum bias events, which will eventually help us understand such pp events.

Charged jet measurement in p-p collisions at 2.76 TeV with ALICE: with Dr. Rathijit Biswas, Sidharth K. Prasad, Sanjay K. Ghosh and Sibaji Raha (as part of ALICE collaboration)

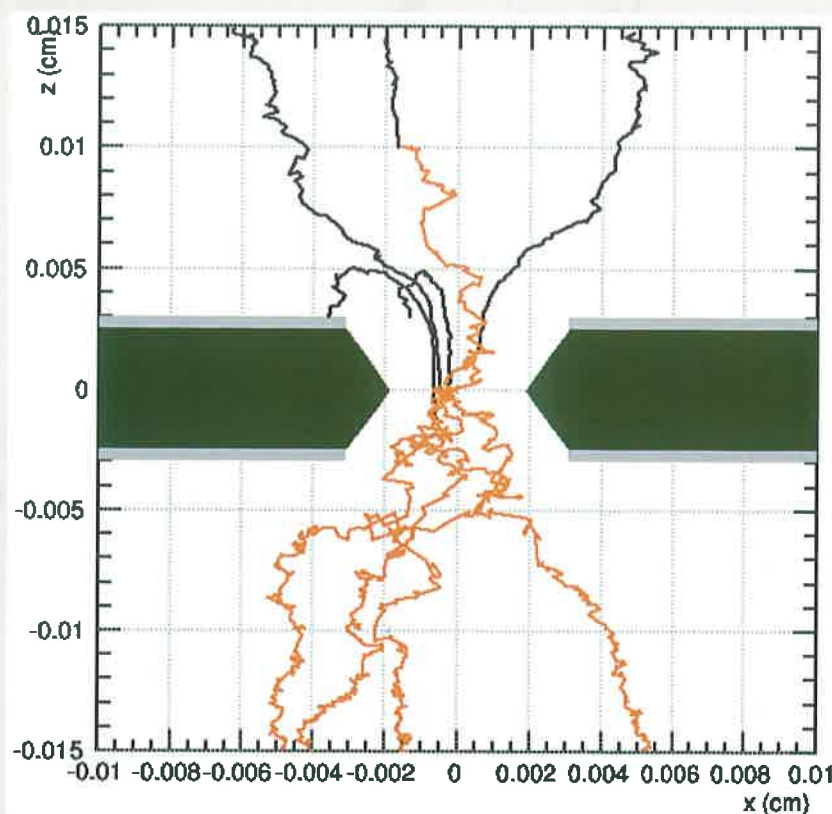
Jets are collimated showers of particles those are produced due to fragmentation of hard partons (quarks and gluons). Study of jets in terms of production cross section, shape observables, fragmentation functions etc. likely to provide insight to the collision dynamics in case of ultrarelativistic hadronic collisions. Jets are also considered to constitute important probe to study hot and dense QCD matter produced in high energy collisions of heavy nuclei.

In this work we are studying the jet properties considering only the charged jets in pp collisions at $\sqrt{s} = 2.76$ TeV. In ALICE experiment the charged jets are reconstructed using the charged particle tracks recorded in the TPC and the ITS detector systems. Once the charged tracks in an event are selected for analysis, a jet finding algorithm ("anti k_T " in this case) is applied to identify the jets in that event. The parameters of the jets are then extracted and analysed. We also need to evaluate the effect of the underlying events to disentangle the contribution of the jets from the background measurements. The analysis is underway and the evaluation of the systematic uncertainties is still to be completed.



Study of Gain variation as a function of physical parameters of GEM foil: for the ALICE collaboration

The ALICE experiment at LHC has planned to upgrade the TPC by replacing the MWPC with GEM based detecting elements to restrict the IBF to a tolerable value. However the variation of



Simulated electron multiplication through double mas GEM hole. Electrons (yellow) and ions (dark brown) are shown separately

the gain as a function of physical parameters of industrially produced large size GEM foils is needed to be studied as a part of the QA procedure for the detector. The size of the electron avalanche and consequently the gain for GEM based detectors depend on the electric field distribution inside the holes. Geometry of a hole plays an important role in defining the electric field inside it. In this work we have studied the variation of the gain as a function of the hole diameters using Garfield++ simulation package. The results reveal that this variation may reach up to 17-18% for a variation of 5mm in the hole diameter. However, it is important to be mentioned here that we have not taken care of the charging up effect which may have its contribution to the final results.

This work has been reported at the 13th. Pisa Meeting on Advanced Detectors, La Biodola, Isola d' Elba, Italy (arXiv : 1506.06520)

Participation in Conferences / Symposia / Workshops & Invited Talks delivered at Various Organizations:

Participated in (i) "High Energy Strong Interactions: A School for Young Asian Scientists" on September 22 – 27, 2014, at Central China Normal University, Wuhan (CHINA) (ii) "ALICE India Collaboration meeting", January 31, 2015, Bose Institute, Kolkata, (INDIA) (iii) 7th International Conference on Physics and Astrophysics of Quark Gluon Plasma", February 02-06, 2015, Kolkata, (INDIA) (iv) "ALICE India Collaboration meeting", July 22 - 24, 2015, IOP Bhubaneswar (INDIA).

Participation by Group Members:

Rathijit Biswas (i) presented in Measurement of Charged Jet properties in pp collisions at 2.76 TeV – during July 22, 2015 at ALICE-INDIA Collaboration Meeting, Institute of Physics, Bhubaneswar (ii) attended Lecture Series on Micro-Pattern Gaseous Detectors during October 20–22, 2014 at Saha Institute of Nuclear Physics, Kolkata (iii) presented in International Workshop on Advanced Detectors during October 27 – 31, 2014 at Variable Energy Cyclotron Center, Kolkata (iv) presented in ALICE-INDIA Collaboration Meeting during January 31, 2015 at Bose Institute, Kolkata (v) presented in ALICE-INDIA Collaboration Meeting during July 22 – 24, 2015 at Institute of Physics, Bhubaneswar.

Dr. Sidharth K. Prasad : (i) visited CERN, Geneva, Switzerland November 18 – December 6, 2014 to participate in testing of TPC prototype using high energy beams at PS and SPS (ii) visited CERN, Geneva, Switzerland during May 19 – 22, 2015 for work related to ALICE TPC upgrade programme (iii) attended the 13th Pisa meeting on Advanced Detectors at La Biodola, Isola d' Elba, Italy during May 23 – 30, 2015 (iv) presented in Jet measurements in pp, p-Pb and Pb-Pb collisions with ALICE at the LHC during September 23, 2014 and delivered invited talk (i) High Energy Strong Interactions: A School for Young Asian Scientists, CCNU (CHINA) (ii) High Multiplicity Task Force Meeting, CERN (Geneva) (v) presented in "Jet properties in high multiplicity pp collisions at 7 TeV", December 15, 2014 and delivered talk in High Multiplicity Task Force Meeting, CERN (Geneva) (vi) presented in "Jet measurements in pp collisions using ALICE", January 01, 2015, presented Seminar at Bose Institute Kolkata (India) (vii) presented in "Jets: High multiplicity vs Minimum Bias events", January 31, 2015, (viii) delivered talk in ALICE-India Collaboration meeting Bose Institute Kolkata (India) (ix) presented in "Jet measurements in pp, p-Pb and Pb-Pb collisions with ALICE at the LHC", February 04, 2015 delivered talk in 7th International Conference on Physics and Astrophysics of Quark Gluon Plasma, Kolkata (India) (x) presented in "PMD data in pp collisions at 13 TeV: A quick look", June 08, 2015, delivered talk in Physics working group (PWG-GEO) at CERN, (Geneva) (xi) attended Seminar on "Exploring Quark Gluon Plasma using jets" at Bose Institute, Kolkata on July 09, 2015 (xii) presented in "PMD in Run-II (pp collisions at 13 TeV): Status of data and plan for analysis" during July 22, 2015 (xiii) delivered talk in ALICE-INDIA Collaboration meeting IOP, Bhubaneswar (xiv) attended meetings at High Energy Strong Interactions: A School for Young Asian Scientists during September 22 – 27, 2014, Central China Normal University, Wuhan (CHINA) (xv) presented in "ALICE India Collaboration meeting", January 31, 2015 at Bose Institute, Kolkata (xvi) presented in "7th International Conference on Physics and Astrophysics of Quark Gluon Plasma" from February 02 – 06, 2015, Kolkata (xvii) presented in ALICE India Collaboration meeting" during July 22 – 24, 2015 at IOP Bhubaneswar.

Symposia and Seminar Organized:

Dr. Sidharth K. Prasad was the Member of the Local Organizing Committee for "International Workshop on Advanced Detectors" held at Variable energy Cyclotron Center, Kolkata during October 27 – 31, 2014.

Publications:

1. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2015) Production of $\Sigma(1385)_{\pm}$ and $\Xi(1530)0$ in proton-proton collisions at $\sqrt{s_{NN}} = 7$ TeV, *Eur. Phys. J. C* 75 1, 1
2. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Freeze-out radii extracted from three-pion cumulants in pp, p-Pb and Pb-Pb collisions at the LHC, *Phys.Lett. B* 739 139-151
3. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Production of charged pions, kaons and protons at large transverse momenta in pp and Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV, *Phys.Lett. B* 736 196-207.
4. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Transverse momentum dependence of inclusive primary charged-particle production in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, *Eur. Phys. J. C* 74 9, 3054.
5. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2015) Charged jet cross sections and properties in proton-proton collisions at $\sqrt{s_{NN}} = 7$ TeV, *Phys.Rev. D* 91 11, 112012.
6. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2015) Elliptic flow of identified hadrons in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV, *JHEP* 1506 190.
7. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2015) Inclusive photon production at forward rapidities in proton-proton collisions at $\sqrt{s_{NN}} = 0.9, 2.76$ and 7 TeV, *Eur.Phys.J. C* 75 4, 146.
8. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Beauty production in pp collisions at $\sqrt{s_{NN}} = 2.76$ TeV measured via semi-electronic decays *Phys.Lett. B* 738 97-108.
9. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Exclusive J/ψ photoproduction off protons in ultra-peripheral p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, *Phys.Rev.Lett.* 113 (2014) 23, 232504.
10. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Measurement of visible cross sections in proton-lead collisions at $\sqrt{s_{NN}} = 5.02$ TeV in van der Meer scans with the ALICE detector, *JINST* 9 11, P11003
11. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Neutral pion production at midrapidity in pp and Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV, *Eur.Phys.J. C* 74 10, 3108.
12. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Performance of the ALICE Experiment at the CERN LHC, *Int.J.Mod.Phys. A* 29 1430044.
13. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Suppression of $Y(1S)$ at forward rapidity in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV, *Phys. Lett. B* 738 361-372.
14. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Suppression of $\psi(2S)$ production in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, *JHEP* 1412 (2014) 073.
15. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2015) Event-by-event mean pT fluctuations in pp and Pb-Pb collisions at the LHC, *Eur.Phys.J. C* 74 (2014) 10, 3077.
16. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2015) $K^*(892)0$ and $\phi(1020)$ production in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV, *Phys.Rev. C* 91 2, 024609.
17. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2015) Measurement of electrons from semileptonic heavy-flavor hadron decays in pp collisions at $\sqrt{s_{NN}} = 2.76$ TeV, *Phys.Rev. D* 91 1, 012001
18. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2015) Multiplicity dependence of jet-like two-particle correlations in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, *Phys. Lett. B* 741 38-50.
19. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2015) Production of inclusive $Y(1S)$ and $Y(2S)$ in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, *Phys. Lett. B* 740 105-117.
20. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Measurement of prompt D-meson production in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, *Phys. Rev. Lett.* 113 23, 232301.
21. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Azimuthal anisotropy of D meson production in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV, *Phys. Rev. C* 90 3, 034904.
22. ALICE Collaboration (Betty Bezverkhny Abelev et al.) (2014) Measurement of quarkonium production at forward rapidity in pp collisions at $\sqrt{s_{NN}} = 7$ TeV *Eur. Phys. J. C* 74 8, 2974.
23. ALICE Collaboration (J. Adam et al.) (2015) Two-pion femtoscopy in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, *Phys. Rev. C* 91 . 034906.
24. ALICE Collaboration (Jaroslav Adam et al.) (2015) Coherent p_0 photoproduction in ultra-peripheral Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV, *JHEP* 1509 095.
25. ALICE Collaboration (Jaroslav Adam et al.) (2015) Measurement of jet suppression in central Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV, *Phys.Lett. B* 746 1-14.
26. ALICE Collaboration (Jaroslav Adam et al.) (2015) Measurement of charged jet production cross sections and nuclear modification in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, *Phys.Lett. B* 749 68-81.
27. ALICE Collaboration (Jaroslav Adam et al.) (2015) Forward-backward multiplicity correlations in pp collisions at $\sqrt{s_{NN}} = 0.9, 2.76$ and 7 TeV, *JHEP* 1505 097.
28. ALICE Collaboration (Jaroslav Adam et al.) (2015) Measurement of dijet kT in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, *Phys.Lett. B* 746 385-395.



29. ALICE Collaboration (Jaroslav Adam et al.) (2015) Rapidity and transverse-momentum dependence of the inclusive J/ψ nuclear modification factor in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, Published in JHEP 1506 055.
30. ALICE Collaboration (Jaroslav Adam et al.) (2015) Centrality dependence of particle production in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV, Phys.Rev. C91 6, 064905.
31. Bhattacharyya A, Das S, Ghosh S K, Ray R, and Samanta S (2014) Fluctuations and correlations of conserved charges in an excluded-volume hadron resonance gas model, Phys. Rev. C 90 034909.

Dr. Dhruba Gupta, Associate Professor

Scientific Reports:

Search for higher excited states of $^8\text{Be}^*$ to study the cosmological ^7Li problem: with Dr. S. K. Saha

We continued the study of ^7Li abundance anomaly by considering the destruction channel of ^7Be . The existing contradiction between theory and observation demands more study on the resonances in $^7\text{Be}(d,d)$ and $^7\text{Be}(d,p)$ reactions, before invoking physics beyond the standard Big Bang Nucleosynthesis. This would be tested in our experiment (IS 554) at HIE-ISOLDE at CERN, Geneva, Switzerland. We are carrying out extensive Geant4 simulations of this experiment involving the T-REX detector array geometry.

Breakup of ^7Be in presence of heavy targets: with Dr. S. K. Saha

We continued the study of ^7Li abundance anomaly by considering also the production channel of ^7Li which is linked to the production of ^7Be . This in turn, is related to the reaction $^3\text{He} + ^4\text{He} \rightarrow ^7\text{Be} + \gamma$. A new approach to measuring the reaction rate could be measuring the reverse reaction of Coulomb dissociation of ^7Be , preferably in the presence of a heavy target. Currently we are involved in the theoretical calculations of the above breakup reaction in the framework of prior-form DWBA.

Study of resonance states of ^{15}Be with isospectral bound state microscopic potential: with Dr. S. K. Saha and Dr. S. K. Dutta (B. G. College, Berhampore, Murshidabad)

We continued our investigation of quasi-bound states of weakly bound nuclear systems using microscopic potential by the theoretical procedure of supersymmetric quantum mechanics (SQM). A two-body potential is generated microscopically in a single folding model using the density dependent M3Y (DDM3Y) effective interaction. From this potential, SQM generated a family of isospectral potentials. Earlier we could successfully reproduce the ^{11}Be resonances and we continued our study on the ^{15}Be ($^{14}\text{Be} + n$) nucleus. We could reproduce the $5/2^+$, $3/2^-$ resonance states of ^{15}Be in good agreement to the experimental data.

Publication:

1. Dutta S K, Gupta D, Das D and Saha S K (2014) Study of resonance states of ^{11}Be with isospectral bound state microscopic potential. *Jour. Phys. G: Nucl. Part. Phys.*, 41: 095104

Participation in Conferences / Symposia / Workshops & Invited Talks delivered at Various Organizations:

(i) Participated in an experiment devoted to the study of neutron proton pairing in exotic nuclei with $N=Z$ at the GANIL laboratory, Caen, France during April 11-18, 2014 (ii) visited the Institut de Physique Nucleaire, Orsay, France, December 8-14, 2014 for collaborative research (iii) participated and presented a poster titled "Breakup and transfer reactions with ^7Be to study ^7Li abundance anomaly" at the ISOLDE Workshop and Users Meeting 2014 "50th Anniversary Edition", CERN, Geneva, Switzerland, December 15-17, 2014.

Dr. Dipankar Home, Senior Professor and Coordinator

Scientific Reports:

Foundations of Quantum Mechanics and Quantum Information:

1. Wigner's form of the local realist inequality is used to derive its temporal version for an oscillating two-level system involving two-time joint probabilities. Such an inequality may be regarded as a form of the Leggett-Garg inequality (LGI) constituting a necessary condition for macrorealism. The robustness of its quantum mechanical (QM) violation against unsharpness of measurement is investigated by using a suitable model of unsharp measurements. It is found that there exists a range of values of the sharpness parameter (characterizing precision of the relevant measurements) for which the usual LGI is satisfied by QM, but Wigner's form of the LGI (WLGI) is violated. This implies that for such unsharp measurements, the QM violation of macrorealism cannot be tested using the usual LGI, but can be tested using WLGI.

2. We explore the use of the resource of intra-particle entanglement for secure quantum key distribution in the device-independent scenario. By virtue of the local nature of such entanglement, Bell tests must be implemented locally, which leads to a natural decoupling of device errors from channel errors. We consider a side-channel attack on the sender's state preparation device, for which the intra-particle entanglement-based scheme is shown to be more secure than the one that uses separable states. Of practical relevance is the fact that such entanglement can be easily generated using linear optics.

3. Wigner's argument inferring a Bell-type inequality for the Einstein-Podolsky-Rosen-Bohm entangled state is generalized here for any N -partite state. This is based on assuming for the relevant dichotomic observables the existence of the overall joint probability distributions, satisfying the locality condition, which would yield the measurable marginal probabilities. For any N , such a generalized Wigner inequality (GWI) is violated by quantum mechanics for all pure entangled states. The efficacy of GWI is probed, comparing with the Seevinck-Svetlichny

multipartite Bell-type inequality, by calculating threshold visibilities for the quadripartite Greenberger–Horne–Zeilinger, Cluster, and W states that determine their respective robustness with respect to the quantum-mechanical violation of GWI in the presence of white noise.

Publications:

1. Adhikari S, Home D, Majumdar A S, Pan A K, Shenoy H A and Srikanth R (2015) Toward secure communication using intra-particle entanglement. *Quantum Information Processing*, 14: 1451.
2. Saha D, Mal S, Panigrahi P K and Home D (2015) Wigner's form of the Leggett-Garg inequality, No-Signaling-in-time condition, and unsharp measurement. *Physical Review A* 91:032117.
3. Home D, Saha D and Das S (2015) Multipartite Bell-type Inequality by Generalizing Wigner's Argument. *Physical Review A* 91: 012102.

Dr. Parthasarathi Joarder, Associate Professor

Scientific Reports:

Multifragmentation model for the production of astrophysical strangelets : Collaborators- Mr. Sayan Biswas (Ph.D student, Department of Physics, Bose Institute), Dr. Sibaji Raha (Senior Professor and Director, Bose Institute), Dr. Debapriyo Syam (CAPSS, Bose Institute) with external collaborations

Determination of baryon number (or mass) distribution of the strangelets, that may fragment out of the warm and excited strange quark matter ejected in the merger of strange stars in compact binary stellar systems in the Galaxy, has been attempted by using a statistical disassembly model. Finite mass of strange quarks is taken into account in the analysis. Resulting charges of the strangelets and the corresponding Coulomb corrections have also been included to get a plausible size distribution of those strangelets at their source. The baryon number distribution, thus obtained, is now being used as the source function in rigorous galactic propagation model to predict the differential flux of astrophysical strangelets of various sizes at solar neighbourhood as an aid to the observational efforts to detect those strangelets in primary cosmic rays by AMS-02, PAMELA and other potential space-based observing stations.

Problems in High Energy Astrophysics: Collaborators- Ms. Pooja Bhattacharjee (First year Ph.D student, Department of Physics/CAPSS, B.I.) with external collaborations.

We are currently analysing gamma-ray data in the energy range 100 MeV-300 GeV from various astrophysical sources. Attempts to fit the observed gamma-ray spectra with theoretical/empirical models are in order. Hopefully, we would be in a position to report some of the scientific conclusions arrived at from these investigations in early 2016. Collaborators:

3.High-Resolution, Multidimensional Numerical methods for Wave Propagation problems in Hydrodynamics and Magnetohydrodynamics: Collaborators: Ms. Sananda Raychaudhuri (First year Ph.D student, Department of Physics/CAPSS, B.I.), Ms. Riya De (Final year M.Sc., Integrated Ph.D student at CAPSS/Department of Physics, B.I.) with external collaborations.

One dimensional and two dimensional computer simulation programs in CFD have been written that are based on finite volume TVD schemes. These programs are now being tested on various benchmark cases suggested by earlier authors. We have several astrophysical and solar-terrestrial problems in mind that are to be solved with the aforesaid computer codes.

4.Working on problems of "Highly Relativistic Magnetohydrodynamic Accretion Flows in AGNs" in collaboration with Dr. Subharnghu Ghosh, Research Associate, Department of Physics/CAPSS (staff ID 5371), B.I., Kolkata.

Publications:

1. Biswas S, De J N, Joarder P S, Raha S, Syam D (2015) Disassembly Model for the Production of Astrophysical Strangelets, *Proc. Indian National Science Academy (INSA)*, 81: 277.
2. Biswas S, Bhadra A, De J N, Joarder P S, Raha S and Syam D (2015) A Production Scenario of the Galactic Strangelets and an Estimation of their Possible Flux in the Solar neighborhood, *Proc. Science (POS)*, <http://pos.sissa.it/archive/conferences/236/504/icrc>.

Participation in Conferences / Symposia / Workshops & Invited Talks delivered at Various Organizations:

(i) Delivered four lectures on "Basic plasma/magnetohydrodynamic processes in the Sun" at the High Energy and Cosmic ray Research (HECRRC), North Bengal University (NBU), Siliguri, West Bengal during May 12, 2014 to May 15, 2013 on invitation from Dr. Arunava Bhadra, Director, HECRRC, Siliguri as a part of the Ph.D course work for the research students at HECRRC. This visit was a part of the Visiting Faculty Programme at HERRC, NBU, Siliguri.

Dr. Probir Roy, INSA Senior Scientist

Scientific Reports:

On a non-thermal two-component dark matter model: in collaboration with A. Biswas and D. Majumdar of Saha Institute

A model of the above type is formulated to simultaneously explain the gamma-ray excess from the Galactic Centre, observed by Fermi-LAT in the 1–3 GeV energy range, and the X-ray line at 3.55 keV from extragalactic sources observed by the XMM Newton Observatory. Two additional singlet scalars, introduced into the Standard model and protected by a $Z_2 \times Z_2$ symmetry breaking softly into a remnant Z_2 symmetry, do the job with one of the new scalars developing a VEV of order MeV. The Higgs portal comprises the Standard Model Higgs



accompanied by the extra physical scalars weighing 50–80 GeV and ~ 7 keV. The condition ensuring the lack of domain wall formation is worked out.

Published reference: JHEP, vol. 1504, page no. 065 (2015).

in collaboration With A. Biswas and D. Majumdar of Saha Institute

Recent data on the dwarf spheroidal galaxy RetII have increased the energy range of the Fermi-LAT gamma excess from 1–3 GeV to 2–10 GeV with a peak around 7 GeV. In order to fit this new range, a modification is required of the above model. The mass of one of the extra scalars has to be increased from 50–80 GeV to 250–300 GeV, thereby changing both the seed mechanism for the gamma-excess and the Boltzmann equations for the generation of the Dark Matter relic density. However, with this increased scalar mass, all concerned data for RetII and the X-ray line can be well-understood.

Dr. S.K.Saha, Professor

Scientific Reports

Search for higher excited states of ${}^8\text{Be}^*$ to study the cosmological ${}^7\text{Li}$ problem: with Dr. Dhruba Gupta

We continued the study of ${}^7\text{Li}$ abundance anomaly by considering the destruction channel of ${}^7\text{Be}$. The existing contradiction between theory and observation demands more study on the resonances in ${}^7\text{Be}(d,d)$ and ${}^7\text{Be}(d,p)$ reactions, before invoking physics beyond the standard Big Bang Nucleosynthesis. This would be tested in our experiment (IS 554) at HIE-ISOLDE at CERN, Geneva, Switzerland. We are carrying out extensive Geant4 simulations of this experiment involving the T-REX detector array geometry.

Breakup of ${}^7\text{Be}$ in presence of heavy targets: with Dr. Dhruba Gupta

We continued the study of ${}^7\text{Li}$ abundance anomaly by considering also the production channel of ${}^7\text{Li}$ which is linked to the production of ${}^7\text{Be}$. This in turn, is related to the reaction ${}^3\text{He} + {}^4\text{He} \rightarrow {}^7\text{Be} + \gamma$. A new approach to measuring the reaction rate could be measuring the reverse reaction of Coulomb dissociation of ${}^7\text{Be}$, preferably in the presence of a heavy target. Currently we are involved in the theoretical calculations of the above breakup reaction in the framework of prior-form DWBA.

Study of resonance states of ${}^{15}\text{Be}$ with isospectral bound state microscopic potential: with Dr. Dhruba Gupta and Dr. S. K. Dutta (B. G. College, Berhampore, Murshidabad)

We continued our investigation of quasi-bound states of weakly bound nuclear systems using microscopic potential by the theoretical procedure of supersymmetric quantum mechanics (SQM). A two-body potential is generated microscopically in a single folding model using the density dependent M3Y (DDM3Y) effective interaction. From this potential, SQM generated a

family of isospectral potentials. Earlier we could successfully reproduce the ${}^{11}\text{Be}$ resonances and we continued our study on the ${}^{15}\text{Be}$ (${}^{14}\text{Be} + n$) nucleus. We could reproduce the $5/2^+$, $3/2^-$ resonance states of ${}^{15}\text{Be}$ in good agreement to the experimental data.

Publication:

1. Dutta S K, Gupta D, Das D and Saha S K (2014) Study of resonance states of ${}^{11}\text{Be}$ with isospectral bound state microscopic potential. *Jour. Phys. G: Nucl. Part. Phys.*, 41: 095104.

Participation in Conferences / Symposia / Workshops & Invited Talks delivered at Various Organizations:

Participated in an experiment devoted to the study of neutron proton pairing in exotic nuclei with $N=Z$ at the GANIL laboratory, Caen, France during April 11-18, 2014

Dr. Achintya Singha, Assistant Professor

Scientific Reports:

Study of the surface oxides present on edge-burst hot-rolled steel coils: Ms. Dipanwita Majumdar and Dr. Anirban Chowdhury (IIT Patna)

Detailed structural and spectroscopic characterizations have been carried out on the inclusions and the surface oxides present on edge-burst hot-rolled steel coils using X-ray diffraction (XRD), scanning electron microscopy (SEM) and Raman spectroscopy. Evidence of different types of regular and non-stoichiometric Fe-oxides was found on the cracked surface of the steel wire. The usefulness of Raman spectroscopy has been explored in detail for the characterization of these inclusions; especially when XRD information ceases to be a limiting tool.

Study of the interaction between Peanut proteins and metal particles: Ms. Dipanwita Majumdar, Mr. Sumanta Kumar Ghatak (Calcutta University) and Dr. Kamalika Sen (Calcutta University)

We have studied the interaction between Peanut proteins, which cause strong allergic reactions, and Fe(III). We have shown that due to Fe(III) complexation, the proteins conarachin I and arachin lose their allergic response to a certain extent.

Tuning optical properties in few-layer MoS_2 by the decoration of Gold nanoparticles: Mr. Shib Shankar Singha

In mono/few-layer MoS_2 , due to the presence of strong Coulomb interactions, optically generated electron-hole pair forms stable exciton states even at room temperature. So, the carrier density plays a significant role in determining the optical properties of mono/few-layer MoS_2 . Doping is one of the effective techniques to control the carrier density in a material. Here, we have shown an easy and inexpensive chemical route for the doping of few-layer MoS_2 .



with Au nanoparticles (NPs). The Au-NPs are formed on the defective sites of the MoS₂ and localized by a non-covalent bond. The NPs act as a p-type dopant in the MoS₂ layer. An enhancement in the photoluminescence (PL) intensity of the Au-MoS₂ composite with respect to bare few-layer MoS₂ has been observed. We also systematically observed a blueshift in the excitonic emission as the number and size of the Au-NPs on MoS₂ increases. Both phenomena have been understood to result from the switching between charged exciton (trion) recombination and neutral exciton recombination.

Publications:

1. Chowdhury A, Iyyappan R, Majumdar D, Singha A (2014) Structural and spectroscopic characterisations of the surface oxide scales and inclusions present on edge-burst hot-rolled steel coils. *Materials Chemistry and Physics*, 148: 276-283.
2. Ghatak S K, Majumdar D, Singha A, Sen S, Das D, Chakrabarti A, Mukhopadhyay C, Sen K (2015) Peanut protein sensitivity towards trace iron: A novel mode to ebb allergic response. *Food Chemistry*, 176: 308-313.
3. Majumdar D, Basu A, Mukherjee G D, Ercolani D, Sorba L, Singha A (2014) Raman scattering study of InAs nanowire under high pressure. *Nanotechnology* 25: 465704 (8pp).
4. Singha S S, Nandi D, Singha A (2015) Tuning the photoluminescence and ultrasensitive trace detection properties of few-layer MoS₂ by decoration with gold nanoparticles. *RSC Advances*, 5: 24188-24193.

Participation in Conferences / Symposia / Workshops & Invited Talks delivered at Various Organizations:

(i) Delivered an invited talk in C. K. Majumdar Memorial Summer Workshop in Physics 2015, organized by Indian Association of Physics Teachers (IAPT), during May 26 to June 05, 2015 (ii) delivered an invited talk in NANO DAYS-2015, organized by S. N. Bose National Centre for Basic Sciences, Kolkata during February 16-18, 2015 (iii) delivered Oral presentation in the International Conference on Raman Spectroscopy (ICORS2014), organized by IPHT, ABBE center of photonics, Jena, Germany during August 10-15, 2014.

Participation of Group Members:

(a) Ms Dipanwita Majumder attended and presented a poster in the International Conference on Raman Spectroscopy (ICORS2014) organized by IPHT, ABBE center of photonics, Jena, Germany during August 10-15, 2014. b) Mr. Shib Shankar Singha attended and delivered a talk in Fundamentals and Advances of Solid State Matters for Technological Applications (FASSMTA 2015), organized by RCC Institute of Information Technology, Kolkata, during 6th July-10th July 2015.

Dr. Rajarshi Ray, Associate Professor

Scientific Reports:

Soft and hard interactions in proton-proton collisions at LHC energies: with Dr. Sidharth K. Prasad, Dr. Sanjay K. Ghosh, Dr. Supriya Das and Premomoy Ghosh (VECC, Kolkata)

Non-diffractive proton-proton collisions can be classified into ``soft'' and ``hard'' (or ``semi-hard'') interactions, with hard (or semi-hard) interactions involving hard parton-parton interactions due to large momentum transfer resulting into jets, whereas interactions without a jet (or minijet) can be considered as soft interactions. Energy invariance in the properties of soft events (e.g. multiplicity, transverse momentum, and mean transverse momentum distributions) is observed at lower centre-of-mass energies. The unprecedented centre-of-mass energy achieved at the LHC provides us an opportunity to further extend this study to the highest available $\sqrt{s}$. This study can further be extended to investigate the possibility of collectivity in proton-proton collisions at the LHC. The study is already in the advance stage and the results obtained so far using simulations are presented in various national/international meetings/conferences and published as a conference proceeding.

Physics of strongly interacting matter:

1. with Dr. Sanjay K. Ghosh, Anirban Lahiri (TIFR), Sarbani Majumder (SINP) and Munshi G. Mustafa (SINP)

Fluctuations of conserved quantum numbers are associated with the corresponding susceptibilities because of the symmetry of the system. The underlying fact is that these fluctuations as defined through the static correlators become identical to the direct calculation of these susceptibilities defined through the thermodynamic derivatives, due to the fluctuation-dissipation theorem. Through a rigorous exercise we explicitly show that a diagrammatic calculation of the static correlators associated with the conserved quark number fluctuations and the corresponding susceptibilities are possible in the case of mean field theories, if the implicit dependence of the mean fields on the quark chemical potential are taken into account appropriately. As an aside we also give an analytical prescription for obtaining the implicit dependence of the mean fields on the quark chemical potential.

2. with Dr. Supriya Das, Dr. Sanjay K. Ghosh and Subhasis Samanta and Abhijit Bhattacharyya (CU)

We have studied the temperature and baryonic chemical potential dependence of higher-order fluctuations and the correlation between conserved charges in an excluded-volume hadron resonance gas model. Products of moments, such as the ratio of variance to mean, product of skewness and standard deviation, product of kurtosis and variance, for the net proton, net kaon, and net charge have been evaluated on the phenomenologically determined freeze-out curve. Further, products of moments for net proton and net charge have been compared with the experimental data measured by the STAR experiment. The dependence of the model result on the hadronic radius parameter has also been discussed.



3. with Dr.Sanjay K. Ghosh and Dr.Sibaji Raha and Abhijit Bhattacharyya (CU), Anirban Lahiri (TIFR) and Sarbani Majumder (SINP)

We have studied the 1+1 flavor system of strongly interacting matter in terms of the Polyakov–Nambu–Jona-Lasinio model. We have found that, although the small isospin-symmetry breaking brought in through unequal light quark masses is too small to affect the thermodynamics of the system in general, it may have a significant effect in baryon-isospin correlations and have a measurable impact in heavy-ion collision experiments.

Publications:

1. Bhattacharyya A, Das S, Ghosh S K, Ray R, and Samanta S (2014) Fluctuations and correlations of conserved charges in an excluded-volume hadron resonance gas model, *Phys. Rev. C* 90 034909.
2. Bhattacharyya A, Ghosh S K, Lahiri A, Majumder S, Raha S and Ray R (2014) Isospin-symmetry breaking and baryon-isospin correlations from the Polyakov–Nambu–Jona-Lasinio model, *Phys. Rev. C* 89 (2014) 064905.
3. Ghosh S K, Lahiri A, Majumder S, Mustafa M G, Raha S, Ray R (2014) Quark Number Susceptibility : Revisited with Fluctuation-Dissipation Theorem in mean field theories, *Phys. Rev. D* 90 054030.
4. Ghosh S K, Raha S, Ray R, Saha S and Upadhaya S (2015) Shear viscosity and phase diagram from Polyakov–Nambu–Jona-Lasinio model, *Phys. Rev. D* 91 054005.

Note: Abbreviations: CU (Calcutta University), SINP (Saha Institute of Nuclear Physics), TIFR (Tata Institute of Fundamental Research)

Dr. Soumen Roy, Assistant Professor

Scientific Reports:

A fresh route to feature extraction in image processing:

In 2005, the Association of Computing Machinery (ACM), examining the future of multimedia research identified three grand challenges, one of which is to “make capturing, storing, finding, and using digital media an everyday occurrence in our computing environment”. Content Based Multimedia Information Retrieval (CBMIR), a field, which started with retrieval of specific images and videos from large arrays of images or videos, is essentially based on feature extraction. At present, the basic problem is the creation of powerful content-based methods in order to enable or improve multimedia retrieval.

We propose a fresh route to feature extraction and construct a device based on our method. At the heart of our method is a novel and efficient dimension reduction technique. We reduce the videos by frame wise decomposition into a time series, which can be further transformed into a graph. We identify important topological measures in these transformed graphs, which would serve as discriminators. A copyright has been applied for the feature extraction software associated with this method.

Fluctuation based devices:

We construct a hardware device based upon the aforementioned method and show that this device can successfully distinguish between healthy individuals and patients with ADDE, via the use of thermal imaging. We also show the applications of our method in biometrics. As with most other feature extraction methods, our method can be used in an array of applications ranging from real-time electronic surveillance to diagnostics in biomedical videos. A patent has been filed on this device and method.

Differential networks and Dark-Light transition in photoreceptors:

Designing modules of short or long signaling state lifetime is very important to achieve good control over precise cellular events in optogenetics. We introduce the method of differential networks and use crystal structures of all organisms whose dark and light state crystal structure are simultaneously known. These networks help us in finding important residues and key interactions governing the light-dark transition. Our findings are in complete agreement with experimental findings from literature. Using sequence structure alignment, we predict functional significance of important residues and interaction for experimental validation. Our approach not only helps in minimising extensive photo-cycle kinetics but is also extremely helpful in providing first-hand information on rational design of synthetic photoreceptors in optogenetics and fundamentals of photo-adaptation

Publication:

1. Banerjee SJ, Sinha S and Roy S (2015) Slow poisoning and destruction of networks: Edge proximity and its implications for biological and infrastructure networks. *Physical Review*, E 91: 022807.

Book Chapter:

1. Roy U, Grewal RK and Roy S (2015) Complex networks and systems biology. Systems and Synthetic Biology, Springer, New York, Ed. Singh and Dhar

Grants-In-Aid Schemes:

Title of the Scheme	Scheme funded by
Harnessing cheater cells for probiotics: applying game theory for nutrition and health	BIRAC
(This is also the first BIG BIRAC to be incubated in West Bengal)	
Propagation of fronts in cooperative Microbial populations	Indo-French Centre for Applied Mathematics

Participation in Conferences / Symposia / Workshops & Invited Talks delivered at Various Organizations:

Delivered invited talks at (i) Indo-French workshop in Statistics held at Indo-French Centre for Applied Mathematics, Indian Institute of Science, Bangalore during July 28 - 31, 2014 (ii) Course



on Computational Systems Biology, organised jointly by Dept of Computer Science and Engineering and Dept of Electronics and Electrical Communication Engineering, IIT Kharagpur during March 31 - April 4, 2014.

Honours received:

Joined the editorial board of Frontiers in (i) Physics (section of interdisciplinary physics) as review editor in November 2014 (ii) Bioengineering and Biotechnology (section of bioinformatics and computational biology) as review editor in November 2014.

Dr. T. P. Sinha, Senior Professor

Scientific Reports:

Multiferroicity in perovskite oxides:

The magnetic and dielectric properties of rare earth based LaFeO_3 have been investigated at various temperatures. The antiferromagnetic nature of the samples is explained using zero field cooled and field cooled magnetization and the corresponding hysteresis loop. A signature of weak ferromagnetic phase is observed in the samples at low temperature due to the canting of the iron sublattices.

Electronic structure and Optical properties of perovskite oxides:

The interband contribution to the optical properties of various perovskite oxides has been investigated using first-principles calculations. The valence-band density-of-states spectra are generated to analyze the experimental X-ray photoemission spectra. The Born effective charges of the materials have been calculated to elucidate the nature of cation-oxygen bonds in the material.

Publications:

1. Bharti C, Das M K, Sen A, Chanda Sadhan and Sinha T P (2014). Cationic ordering, relaxation dynamics and polaron hopping in a new double perovskite oxide BaPrCoTaO_6 , *Journal of Alloys and Compounds*, 617, 677-682.
2. Chanda S, Saha S, Dutta A and Sinha T P (2015). Structural and transport properties of double perovskite $\text{Dy}_2\text{NiMnO}_6$, *Materials Research Bulletin*, 62, 153-160.
3. Chanda S, Saha S, Dutta A, Mahapatra A S, Chakrabarti P K, Kumar U and Sinha T P (2014). Multiferroicity in $\text{La}_{1/2}\text{Nd}_{1/2}\text{FeO}_3$ nanoparticles, *Solid State Sciences*, 37, 55-63.
4. Das S, Dutta Alo, Ghosh B, Banerjee S and Sinha T P (2014). Dielectric relaxation of CdSe nanoparticles, *Journal of Physics and Chemistry of Solids*, 75, 1245-1251.
5. Ghimire M P, Thapa R K, Rai D P, Sandeep, Sinha T P and Hu X (2015). Half metallic ferromagnetism in tri-layered perovskites $\text{Sr}_4\text{T}_3\text{O}_{10}$ (T = Co, Rh), *Journal of Applied Physics*, 117, 063903-1-6.

6. Ghosh B, Dutta A, Brajesh K and Sinha T P (2015). Dielectric relaxation in double-perovskite $\text{Ca}_2\text{GdTaO}_6$, *Indian Journal of Pure and Applied Physics*, 53, 125-133.
7. Ghosh B, Halder S and Sinha T P (2014). Dielectric relaxation and collective vibrational modes of double-perovskites A_2SmTaO_6 (A = Ba, Sr and Ca), *Journal of the American Ceramic Society*, 97, 2564-2572.
8. Ghosh S K, Ganguly M, Rout S K and Sinha T P (2014). Structural and dielectric relaxor properties of A-site deficient samarium-doped $(\text{Ba}_{1-x}\text{Sm}_{2x/3})(\text{Zr}_{0.3}\text{Ti}_{0.7}\text{O}_3)$ ceramics, *Journal of Materials Science*, 49, 5441-5453.
9. Ghosh S K, Ganguly M, Rout S K, Chanda S and Sinha T P (2014). Structural, optical and dielectric relaxor properties of neodymium doped cubic perovskite $(\text{Ba}_{1-x}\text{Nd}_{2x/3})(\text{Zr}_{0.3}\text{Ti}_{0.7}\text{O}_3)$, *Solid State Sciences*, 30, 68-77.
10. Kumari P, Dutta Alo, Prasad S and Sinha T P (2014). Dielectric relaxation of double perovskite $\text{Ba}_2\text{LaSbO}_6$, *Science and Culture*, 80, 31-35.
11. Mukherjee R, Ghosh B, Saha S, Bharti C and Sinha T P (2014). Structural and electrical transport properties of a rare earth double perovskite oxide: $\text{Ba}_2\text{ErNbO}_6$, *Journal of Rare Earths*, 32, 334-342.
12. Rajesh A, Dutta Alo, Gurunathan K and Sinha T P (2014). Spin relaxation of $\text{Gd}_2\text{O}_3/\text{NiFe}_2\text{O}_4$ core-shell nanoparticles, *Nanoscience and Nanotechnology Letters*, 6, 450-455.
13. Rajesh A, Dutta Alo, Gurunathan K and Sinha T P (2015). Dielectric relaxation of $\text{NiFe}_2\text{O}_4/\text{Gd}_2\text{O}_3$ core-shell nanoparticles, *Journal of Nanoscience and Nanotechnology*, 15, 6082-6087.
14. Rajesh A, Manivel Raja M, Saha Sujoy, Sinha T P and Gurunathan K (2014). Synthesis, physico-chemical and electrical characterizations of graphene oxide-hydroxyapatite nanocomposites, *Advanced Science, Engineering and Medicine*, 6, 1076-1081.
15. Sakhya A P, Dutta A, Shannigrahi S and Sinha T P (2015). Electronic structure and optical properties of orthorhombic and rhombohedral RAIO_3 (R = Sm, Nd), *Solid State Sciences*, 42, 37-44.
16. Sakhya A P, Maibam J, Saha S, Chanda S, Dutta A, Sharma B I, Thapa R K and Sinha T P (2015). Electronic structure and elastic properties of ATiO_3 (A = Ba, Sr, Ca) perovskites: A first principles study, *Indian Journal of Pure and Applied Physics*, 53, 102-109.
17. Tiwari R C, Pau K S and Sinha T P (2014). Study of reproducibility of the sensitivity of the natural salt (NaCl: Cu, Mg, O, As, Mn) by thermoluminescence (TL), *Science and Technology Journal*, 2, 53-56.

Conference/Symposia publications:

1. Badapanda T, Sarangi S, Behera B, Anwar S and Sinha T P (2014). Effect of samarium doping on the dielectric behavior of barium zirconium titanate ceramic, *AIP Conference Proceedings*, 1591, 46-47.



2. Halder S, Agrawal L, Dutta A, Sheikh M S and Sinha T P (2015). T. P. Sinha, Structural and Dielectric Characterization of Complex Perovskite $\text{AFe}_{1/4}\text{In}_{1/4}\text{Nb}_{1/2}\text{O}_3$ (A = Ba, Sr, Ca)", *IISRR-International Journal of Research*, 1, 55-58.
3. Kumari P, Dutta A, Prasad S and Sinha T P (2014). Structural and dielectric properties of $\text{Ba}_2\text{LaSbO}_6$ ceramics, *AIP Conference Proceedings*, 1591, 1289-1291.
4. Ray R, Himanshu A K, Brajesh K, Bandyopadhyay S K, Kumar U and Sinha T P (2014). Phase transitions in double perovskite $\text{Sr}_2\text{ScSbO}_6$: an Ab-initio study, *AIP Conference Proceedings*, 1591, 1167-1169.
5. Ray R, Himanshu A K, Brajesh K, Choudhary B K, Bandyopadhyay S K, Sen P, Kumar U and Sinha T P (2014). Electronic structure of ordered double perovskite Ba_2CoWO_6 , *AIP Conference Proceedings*, 1591, 1155-1157.

Students Awarded Ph.D:

Name of Student (University/Year)	Title of thesis
(As Co-supervisor) Premalata Kumari (T.M.Bhagalpur Univ., 2014)	Dielectric spectroscopy studies of some complex perovskite oxides.
(As Co-supervisor) Lata Agrawal (T.M.Bhagalpur Univ., 2014)	Dielectric relaxation in some complex perovskite oxides.

Participation in Conferences /Symposia /Workshops & Invited Talks delivered at Various Organizations:

(i) Delivered an invited talk on "Optical response function of perovskite oxides" in the International Workshop/Conference on Computational Condensed Matter Physics and Materials Science (IWCCMP-2014) at ABV-Indian Institute of Information Technology and Management, Gwalior during 25-30 November 2014 (ii) presented a paper on "Structural and transport properties of CdSe nanorods" in the DAE-Solid State Physics symposium at Vellore Institute of Technology, Vellore during 16-20 December 2014.

Participation of Group Members:

Mr. Sujoy Saha presented a paper on (i) "Structural and Dielectric Properties of NdMnO_3 nanoparticles" in the Condensed Matter Days 2014 at Centre for Research in Nanoscience and Nanotechnology, University of Calcutta, Kolkata during 27-29 August 2014 (ii) "Dielectric Relaxation of PrFeO_3 nanostructures" in the 18th National Seminar on Ferroelectrics & Dielectrics (NSFD-XVIII) at Manipur University, Imphal during 3-5 November 2014 (iii) "Ground State Properties of NdMnO_3 " in the International Workshop/Conference on Computational Condensed Matter Physics and Materials Science (IWCCMP-2014) at ABV-Indian Institute of

Information Technology and Management, Gwalior during 25-30 November 2014 (iv) attended a Workshop on Current Trends in Research on Electron Microscopy in Materials Science at CSIR-Central Glass and Ceramic Research Institute, Kolkata on 22 December 2014.

Mr. Sadhan Chanda presented a paper on (i) "Structural and transport properties of double perovskite $\text{Dy}_2\text{NiMnO}_6$ " in the Condensed Matter Days 2014 at Centre for Research in Nanoscience and Nanotechnology, University of Calcutta, Kolkata during 27-29 August 2014 (ii) "Structural, dielectric and magnetic properties of $\text{Lu}_2\text{NiMnO}_6$ " in the National Seminar on Ferroelectrics & Dielectrics (NSFD-XVIII) at Manipur University, Imphal during 3-5 November 2014 (iii) "Electronic structure of double perovskite $\text{Lu}_2\text{CoMnO}_6$ " in International Workshop/Conference on Computational Condensed Matter Physics and Materials Science (IWCCMP-2014) at ABV-Indian Institute of Information Technology and Management, Gwalior during 25-30 November 2014 (iv) oral presentation on "Structural and transport properties of double perovskite $\text{Dy}_2\text{NiMnO}_6$ " in MRSI Young Scientist Colloquium 2014 at Saha Institute of Nuclear Physics, Kolkata on 12 September 2014.

Mr. Anup Pradhan Sakhya presented a paper on (i) "Impedance spectroscopy, ac conductivity and electronic structure of NdAlO_3 : Experimental and First-Principles Approaches" in the Condensed Matter Days 2014 at Centre for Research in Nanoscience and Nanotechnology, University of Calcutta, Kolkata during 27-29 August 2014 (ii) "Electronic structure, X-ray photoemission spectroscopic and dynamical property studies of RAIO_3 (R = Sm, Nd)" in the 18th National Seminar on Ferroelectrics & Dielectrics (NSFD-XVIII) at Manipur University, Imphal during 3-5 November 2014 (iii) "Optical properties of SmAlO_3 from first Principles Calculation" in the International Workshop/Conference on Computational Condensed Matter Physics and Materials Science (IWCCMP-2014) at ABV-Indian Institute of Information Technology and Management, Gwalior during 25-30 November 2014 (iv) "Dielectric relaxation and conduction mechanism in NdAlO_3 ceramics" in MRSI Young Scientist Colloquium 2014 at Saha Institute of Nuclear Physics, Kolkata on 12 September 2014 (v) attended a Workshop on Current Trends in Research on Electron Microscopy in Materials Science at CSIR-Central Glass and Ceramic Research Institute, Kolkata on 22 December 2014.

Mr. Saswata Halder presented a paper on (i) "Dielectric relaxation of $\text{BaFe}_{1/4}\text{In}_{1/4}\text{Ta}_{1/2}\text{O}_3$ " in Condensed Matter Days 2014 at Centre for Research in Nanoscience and Nanotechnology, University of Calcutta, Kolkata during 27-29 August 2014 (ii) "Dielectric relaxation of $\text{AFe}_{1/4}\text{In}_{1/4}\text{Nb}_{1/2}\text{O}_3$ (A = Ba, Sr, Ca)" in the National Seminar on Ferroelectrics & Dielectrics (NSFD-XVIII) at Manipur University, Imphal during 3-5 November 2014 (iii) "Structural and dielectric characterization of complex perovskite $\text{AFe}_{1/4}\text{In}_{1/4}\text{Nb}_{1/2}\text{O}_3$ (A = Ba, Sr, Ca)" in the National Symposium on Recent Trends in Instrumentation Science and Technology at Department of Instrumentation Science, Jadavpur University, Jadavpur during 19-21 March 2015 (iv) "Dielectric relaxation of $\text{A}(\text{In}_{1/4}\text{Fe}_{1/4})\text{Ta}_{1/2}\text{O}_3$ [A = Ba, Ca]" in MRSI Young Scientist Colloquium 2014 at Saha Institute of Nuclear Physics, Kolkata on 12 September 2014 (v) "Electronic structure and magnetic properties of $\text{Ba}_2\text{LnMoO}_6$ [Ln = Nd, Gd and Y]" in the International Workshop/Conference on Computational Condensed Matter Physics and Materials Science (IWCCMP-2014) at ABV-Indian Institute of Information Technology and Management, Gwalior during 25-30 November 2014.



Mr. Rajesh Mukherjee presented a paper on (i) "Structural, vibrational and dielectric relaxation study of $\text{Ba}_2\text{ErSbO}_6$ double perovskite" in the Condensed Matter Days 2014 at Centre for Research in Nanoscience and Nanotechnology, University of Calcutta, Kolkata during 27-29 August 2014 (ii) "Structural and ac electrical properties of a rare earth double perovskite oxide: $\text{Ca}_2\text{ErNbO}_6$ " in the National Seminar on Ferroelectrics & Dielectrics (NSFD-XVIII) at Manipur University, Imphal during 3-5 November 2014.

Mrs. Sayantani Das presented a paper on (i) "Dielectric relaxation and phonon modes study of CdSe Nanorods" in International Conference on Electron Microscopy Society of India (EMSI-2014) at Delhi University during 7-11 July 2014 (ii) "Transport properties of CdSe Nanorods" in the Condensed Matter Days 2014 at Centre for Research in Nanoscience and Nanotechnology, University of Calcutta, Kolkata during 27-29 August 2014 (iii) "Raman analysis of CdSe Nanorods" in MRSI Young Scientist Colloquium 2014 at Saha Institute of Nuclear Physics, Kolkata on 12 September 2014 (iv) "Transport properties of CdSe" in National conference on Current Trends in Advanced Materials (CTMat-2014) at Variable Energy Cyclotron Centre, Kolkata during 19-21 November 2014 (v) "Structural and transport properties of CdSe nanorods" in the DAE-Solid State Physics symposium at Vellore Institute of Technology, Vellore during 16-20 December 2014.

Md. Sariful Sheikh presented a paper on (i) "Structural and dielectric characterization of complex perovskite $\text{AFe}_{1/4}\text{In}_{1/4}\text{Nb}_{1/2}\text{O}_3$ (A=Ba, Sr, Ca)" in the National Symposium on Recent Trends in Instrumentation Science and Technology at Department of Instrumentation Science, Jadavpur University, Jadavpur during 19-21 March 2015.



Sir J.C. Bose at University convocation 1926

OUTREACH AND MAN POWER DEVELOPMENT

Dissemination of knowledge has been an integral part of the charter of Bose Institute as proclaimed by J. C. Bose in his foundation speech in 1917. In recent years many outreach programmes have been undertaken to acquaint the school children's with the wonders of science and encourage them to pursue a career in science. Hands-on training of students from North-East states has become an annual event of Bose Institute for last nine years. Training programmes for the students of school students of Darjeeling is held regularly at the Darjeeling campus of Bose Institute. The faculties working at Darjeeling campus interact with the school students in regular intervals. Moreover, school students participating in the children's science congress interact with our faculties for their project work. Bose Institute also collaborates with other organizations for organizing science camps for school students in and around Kolkata. Hands-on training camps has also been organized for the school teachers of North-Eastern states as well as Darjeeling to help them in integrating the experiment based teaching with their regular class room teaching.

In order to extend the benefit of the advancement of our knowledge to rural sectors Bose Institute is running a rural biotechnology programme at Falta Experimental Farm. Under this programme the people from rural sector/scheduled caste/scheduled tribe are given training on various income generation schemes. Bose Institute helped scheduled caste & scheduled tribe people to implement the scheme in their own land. In the current year under the DST-SEED project 80 scheduled caste people were given training through 4 training programmes on mushroom cultivation, vermicompost production, apiculture and sericulture and out of the 80 trainees 40 were provided with facilities for mushroom cultivation, vermicompost production and apiculture. Under "Scheduled Tribe-Specific Rural Biotechnology Programme" Bose Institute has started implementing various income generation schemes directly through departmental machinery and through some NGOs in five districts of West Bengal.

Bose Institute also organizes a Winter School in Astroparticle Physics (WAPP) every year in collaboration with Cosmic Ray Laboratory (CRL), TIFR as a part of man power development programme at Ooty and Darjeeling in alternate years. Under this programme M.Sc students as well as fresh research scholar students are given hand-on training on the different aspects of Astroparticle Physics. WAPP 2014 was organized by CRL, Ooty and Bose Institute will organize WAPP 10th during December 2015 in Darjeeling.

A major step for the development of trained man power was taken in 2006 when Bose Institute started M.Sc courses in Physical and biological sciences. Physical Science course was initiated in collaboration with St. Xavier's College, Kolkata, Calcutta University being the degree granting Institute. Biological Science course was started in collaboration with Calcutta University. The



success of both of these courses were encouraging. So keeping in view the Institute's objective of creating man power for research, new plans were formulated to initiate M.Sc-Ph.D integrated course and subsequently M.Sc-Ph.D integrated course in life sciences was started in 2011 and Physical Science course was initiated in 2012.

Hand-on training programmes:

(a) NESST-BASE 2014: May 18 – June 1, 2014

The Eighth North-East Students' Summer Training programme on BAasic SciEnces (NESST-BASE) was held at Darjeeling during May 18 – June 1, 2014. This year, 24 students from north-east states as well as Sikkim and Darjeeling, along with one science teacher from each place, participated in this programme. The students were selected by the state authorities. These students were given hands-on training on physical, chemical and biological sciences. There were also sessions with the aim to introduce the students with the fun of mathematics. One day popular lecture was arranged on May 24, 2014. The school children from Darjeeling were also invited on this occasion.

(b) Rural Biotechnology programmes:

All sorts of knowledge are there in the literature for improvement of rural economy but in reality very little is translated in the rural India. So instead of conducting training within the four walls of the Institute we planned to conduct onsite training directly through the implementation of the programme. In five districts of West Bengal namely Purulia, Bankura, Birbhum, West Medinipore and South 24-Parganas we selected some villages, made some stake in some villages, our staff stayed with them throughout the year, organized tribal people through group meeting, aware them about different income generation programmes, implemented each and every programme with the villagers in their own land with full or partial financial support and guide them up to marketing. Our training programme goes on throughout the year along with their daily life and we will be along with them as long as the "Scheduled Tribe-Specific Rural Biotechnology Programme" will exist at Bose Institute. The tribal people who are generally known as lazy are working hard for their own development. Bose Institute is proud to be associated with the distressed scheduled tribe people of the backward regions of our state.

Integrated M.Sc – Ph.D programme (Dean – Prof. S. Ray)

The M.Sc. - Ph.D. course has been formulated as a combination of two year (four semester) Post-graduate M.Sc. Curriculum and a four year (approximately) Ph.D. programme with the objective to develop human resource with expertise in the broader areas of research interests and to motivate students to choose a career in basic and applied sciences.

The admission in the M.Sc course is based on written test followed by interview of the candidates short listed on the basis of their marks obtained in the secondary examination onwards. The intake of students, depending on the performance, varies between 6-10 in Physical Sciences and 14-20 in biological sciences.

(a) Physical Sciences

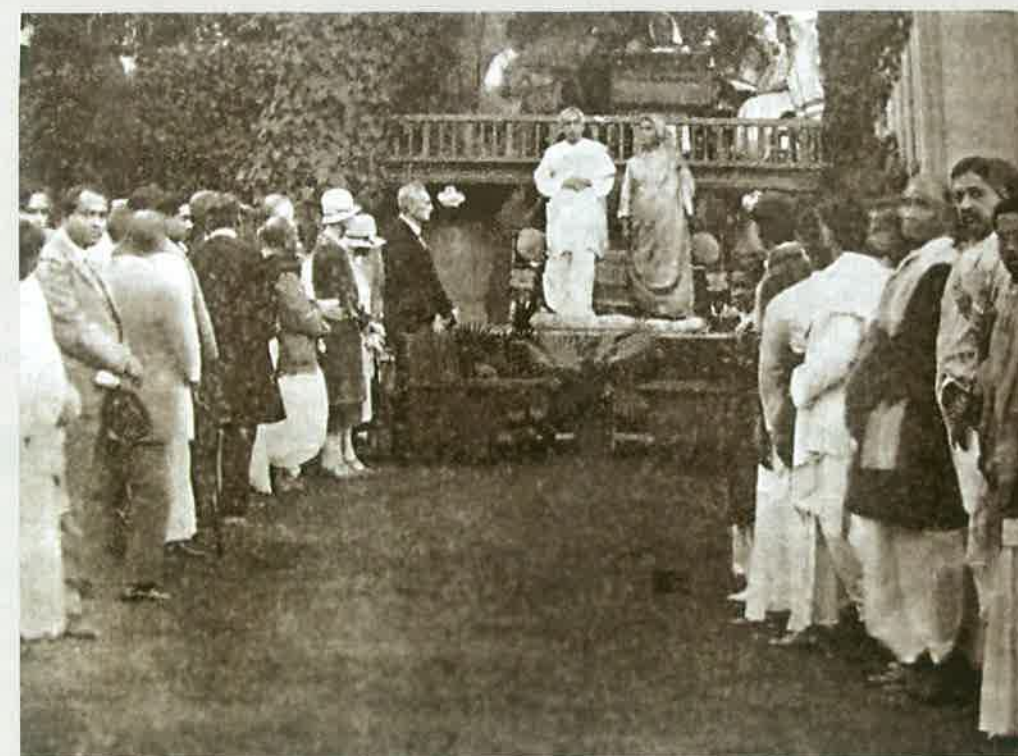
Course Coordinator: Dr. Rajarshi Ray

In 2014, around 140 students applied from all over India. 90 students were shortlisted for written test and then 40 students were called for interview based on their performance in the written test. Finally 6 students were selected and all of them joined the M.Sc course. The first semester classes for this batch commenced in the first week of August.

(b) Biological Sciences :

Course Coordinator: Dr. Gautam Basu, Dr. Tanya Das, Dr. Suman Kr. Banik and Dr. Sampa Das

A total of 305 valid applications were received from which 211 candidates were shortlisted for the Written Exam, based on the criteria that the average marks in Science subjects (in Class X and XII) be more than equal to 78.5%. Based on the written test, 42 candidates were interviewed of which 12 candidates were finally selected. Classes started from August 2015.



Septuagenary celebration of Acharya J.C.Bose on the grounds of Bose Institute in the year 1928. Lady Abala Bose was also felicitated.

SERVICE DEPARTMENTS

Acharya J.C. Bose Biotechnology Innovation Centre (Madhyamgram Experimental Farm)

The following scientists utilized the facilities of the farm for growing their crops.

Name of the Scientists	Name of the crops grown / facility availed by the Scientist
1. Prof. P. K. Saha	sesame
2. Prof. Sampa Das	Rice, Mustard, chickpea, Pigeon pea, Garlic
3. Prof. Amita Pal	Vigna mungo
4. Prof. D. N. Sengupta	Rice
5. Prof. S. R. Sikder	Mustard, Sesame
6. Prof. A. N. Lahiri Majumder	Rice
7. Prof. Debabrata Basu	Mustard, tomato, Chick Pea
8. Dr. Pallob Kundu	Tomato, Tobacco
9. Dr. Subha Chowdhury	Rice, Tobacco
10. Dr. Swati Gupta Bhattacharya	Pollen trapper

The following scientists utilized the facilities of the Transgenic Green Houses for growing their crops:

Name of the Scientists	Name of the crops grown by the Scientists
1. Prof. A.N. Lahiri Majumder	Rice
2. Prof. Sampa Das	Rice, Mustard, chickpea, Pigeon pea, Tobacco
3. Prof. Debabrata Basu	Mustard
4. Prof. S. R. Sikder	Mustard, Tobacco
5. Dr. Pallob Kundu	Tomato, Tobacco
6. Dr. Subho Chowdhury	Tobacco

Central Instruments Facility

The Central Instruments facility (which includes the DST/IRHPA sponsored National center for proteomics and genomics) is an independent unit within the institute which houses a large number of sophisticated instruments required for advanced research in biological and chemical sciences. The facility is run by a group of highly trained technicians who not only look after the instruments but also advise research students about how to use them effectively. The most frequently used equipment is the DNA sequencer (ABI 3500XL and 3130XL) which handles on an average 8000 samples every year. The MALDI-TOF/TOF (Bruker Daltonics, Autoflex II) spectrophotometer is used extensively for proteomic research. Last year nearly 700 samples were analyzed in this equipment. Previously most of the samples analyzed in the MALDI-TOF/TOF were either proteins or peptides. However in recent times we have been using this equipment for analyzing non-protein samples such as oligonucleotides, polysaccharides etc.

A new confocal microscope (Leica Microsystems TCS SP8) has been installed in the CIF. It is currently being used extensively by cell biologists at Bose Institute. The CIF has two Fluorescence assisted Cell Sorters (FACS, Becton Dickinson), FACS verse and FACS aria. On an average about 100 samples are analyzed daily. Earlier these were used mainly for studying eukaryotic cells. However in recent times it is being used to investigate bacterial samples as well.

The CIF has several HPLCs. In most cases natural products are separated using these equipments. Many external users use the HPLCs, on a chargeable basis. Last year about 800 samples were analyzed out of which more than 50% belonged to researchers from neighboring institutes.

The CD spectrometer is another highly used equipment in the Institute. It is used extensively by those who work in the area of protein as well as nucleic acid structure and

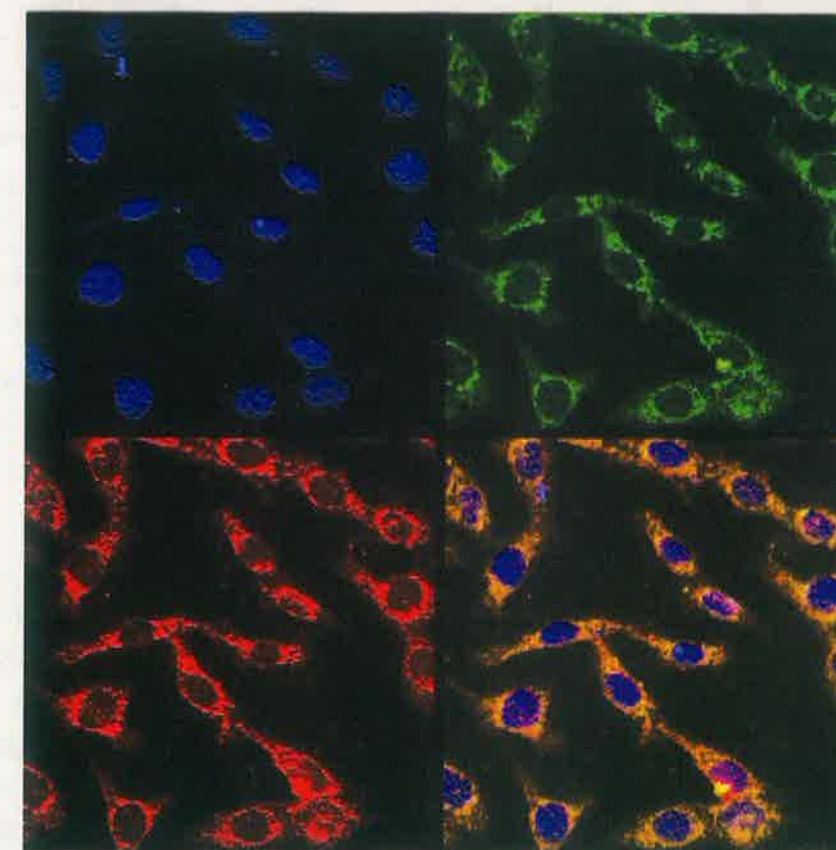
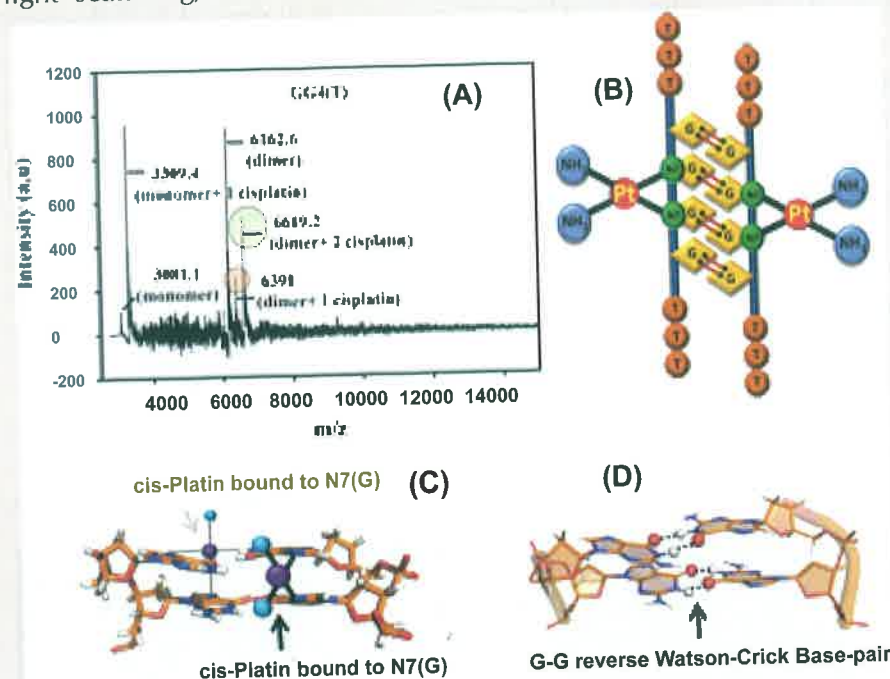


Image acquired by the newly installed Leica Microsystem Confocal Microscope. Lung Carcinoma cells (A549) stained with nucleus (Blue, DAPI); Fibrous – actin (Green, Alexa488 phalloidin); P53w+ (Red, Alexa-546). Point studied: Localization of p53 in A549 in doxorubicin treated condition



function. Most of the equipments are housed in this Centenary building at the CIF. However in the main campus too there are a large number of sophisticated equipments are present particularly in SAIF (Sophisticated analytical instrumental facility). These include DLS (Dynamic light scattering) SPR (Surface Plasmon resonance) and Fluorescence spectrophotometer. An



(A)MALDI of GG4(T) with cisplatin (B)Model structure of cisplatin bound to dimeric structure of GG4(T) (C)cisplatin bound to N7 of guanine (D)G-G reverse Watson-Crick base pairA 10 nucleotide long oligomer (5'-TTTGGGGTTT-3') forms reverse Watson-Crick bonded dimer. The G-G dimer arrested by cisplatin was observed in MALDI-TOF spectrometry.

NMR facility (500 Mhz) is available at the centenary building. On an average about 250 samples are analyzed annually. Recently an NMR having a higher capacity (Ascend 700, Bruker) has been procured. It has been installed at the Unified academic campus of Bose Institute which is under construction at the Bidhan nagar (Salt lake).

The CIF is frequently visited by student groups from colleges and universities from various parts of the country particularly the

North East. The Msc-PhD students are given special training as a part of their curriculum so that they can use these instruments productively.

Centre for Astroparticle Physics & Space Science

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.
- Dual frequency radiometer has been installed for the measurements of column-integrated amounts of water vapor and liquid water.
- Vertical profile of rain rates, drop size distributions, radar reflectivity, fall velocity of hydro meteors and other rain parameters are being measured using Micro Rain radar (MRR).
- Vertical profile of water vapour mixing ratio and many other aerosol and cloud related quantities are being measured using Rama Lidar.
- Several automated online atmospheric trace gas analyzers e.g. SO_2 , NO_x , CO , O_3 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.

Major findings (2014-15)

- A study was carried out on the temporal (seasonal and diurnal) variation of Black Carbon (BC) particles over Darjeeling. The study shows that the concentration of BC particles over Darjeeling is comparatively higher than any other high altitude stations in India. BC over Darjeeling can also be compared with some of the metro cities in India. Major sources were identified for BC particles and how it varies seasonally, was also investigated. In addition to the local sources, investigation was also done on transport of BC pollutants from other long distant regions.
- A Study was carried out on Volatile Organic Compounds (VOCs) over Darjeeling. The major sources of VOCs over Darjeeling were investigated. It was observed that meteorological parameters played major role in governing the concentration of VOCs



rather than their emission strength. Investigation was also done that how the VOCs played role in destruction and formation of tropospheric ozone.

- Rainwater samples were collected and a comprehensive study was made on rainchemistry. Studies are being carried out on the interaction between aerosols and rain drops. Investigation on the way of scavenging of aerosol particles by rain drops are on the process.
- Study on atmospheric carbonyl compounds have been made over Darjeeling. The major anthropogenic sources were found out. It was investigated that how major carbonyl compounds interact with trace gas NO_x and in turn how they play role in formation and destruction of tropospheric ozone.

Environmental Sciences Section

The section was established in the year of 1992. Earlier, the section used to carry out several activities related to environmental impact assessment, preparation of environmental management plan, environmental audit, environmental budget, toxicological evaluations, and carcinogenicity assessment for several industries at the local and national level. From 2002, this section started measurements of atmospheric pollutants and set up a wet laboratory for the National Facility on Astroparticle Physics and Space Science, Bose Institute campus in Darjeeling. Later on, this section has been equipped with several analytical instruments related to atmospheric monitoring studies. The major analytical instruments in this section are High Pressure Liquid Chromatography, Atomic Absorption Spectrophotometer, Ion Chromatograph etc.

Environmental Sciences Section is now fully engaged in chemical characterization of several particulate and gaseous pollutants collected from Darjeeling, Kolkata and Falta campuses on regular basis. The above mentioned instruments are fully used to characterize the chemical components of the atmospheric particulate pollutants. In addition to those instruments, several desiccators, pH and conductivity meter, temperature controlled digestion system, rotary evaporator are installed in this section. The sampling of atmospheric pollutants over Kolkata and Falta campuses are fully controlled by this section. This section is also carrying out chemical analysis of several samples from other departments of the Institute along as well different academic institutes and universities. Some of the studies in which this section is involved in are:

Black Carbon particles over eastern Himalaya:

A study was performed on Black Carbon (BC) aerosol measured and characterized over a high altitude (2200 m amsl) hill station Darjeeling over eastern Himalaya in India. High average annual concentration of $3.4 \pm 1.9 \mu\text{gm}^{-3}$ for BC was observed. BC was found to be maximum during summer (March-May). The major source of BC over Darjeeling was investigated. The

concentration levels of these pollutants were comparable or even higher than those in some of the metro cities in India and abroad. It was observed that $\sim 17\%$ BC was driven by up-slope valley wind from low land foothill regions whereas $\sim 27\%$ BC was transported from long distant regions, mainly Nepal. Rest was contributed by the local sources like vehicular exhaust, biomass burning etc.

VOCs over eastern Himalaya:

A study was performed on the most important gaseous carbonaceous pollutant Volatile Organic Compounds (VOCs). Temporal variation shows that VOC was maximum during autumn (Oct-Nov). The main reason of high emission of VOCs over Darjeeling was anthropogenic or man made activities. Significant amount of VOCs were also emitted in to the atmosphere during tourist season i.e. summer. But the VOC concentration was mainly governed by the meteorological parameters. Solar radiation played the major role. It helped in destruction of VOCs in the atmosphere and thus VOCs were minimum during summer with high solar radiation although the emission strength was more or less equal with that in autumn. The average concentration of VOC over Darjeeling was $376.3 \pm 857.2 \mu\text{gm}^{-3}$. While carbonaceous aerosol (BC) was well correlated with the emissions, gaseous compounds were mainly governed by both the emissions and photochemical loss under high solar insolation during premonsoon. This resulted to very low VOCs of $35.9 \pm 9.7 \mu\text{gm}^{-3}$ and carbonyl compounds of $73.5 \pm 38.3 \mu\text{gm}^{-3}$ during premonsoon when solar radiation was maximum. The major local sources of these pollutants in the atmosphere are the vehicular exhaust, biomass burning, solvent evaporation etc.. Nepal was also found to be the major long-distant source for VOCs contributing $\sim 50\%$ to the total VOCs over Darjeeling.

Carbonyl compounds over eastern Himalaya:

Study was also performed on another important gaseous carbonaceous compound called Carbonyl Compounds. This was also measured over Darjeeling. The average concentration of Carbonyl Compound was found to be $293.35 \pm 463.9 \mu\text{gm}^{-3}$. The maximum concentration of Carbonyl Compounds was found in autumn. Carbonyl was also found to be governed by the meteorological parameters, solar radiation. It helped carbonyl compounds to be destructed due to high solar radiation.

Overall, it was found that of the measured carbonaceous pollutants over Darjeeling, VOCs contributed by $\sim 56\%$, carbonyl compounds contributed by $\sim 43\%$ whereas particulate carbonaceous compounds, i.e. BC contributed by $\sim 1\%$. From the Himalayan perspective, such high loading of atmospheric carbonaceous pollutants draws serious attention not only for their acute health effect but also for climate related issues as they could significantly affect atmospheric energy balance, modulate cloud microphysical properties and hence precipitation, tropospheric ozone budget etc. The data of carbonaceous pollutants is of paramount interest and importance for various regional climate models over such geographically important region in India.

**Campaign study over Sundarban island:**

A field campaign was conducted over Kalas island, Sundarban for studying the effect of transport of gaseous and carbonaceous pollutants from Indo-Gangetic Plain regions to Bay of Bengal. It was observed that Black Carbon aerosols were transported significantly from IGP regions over Bay of Bengal. Black carbon particles were also found to be scavenged significantly by fog events which enhanced BC concentration to several folds.

Rain chemistry studies:

Rainwater samples have been chemically analyzed for several water soluble ionic species. The acidity was measured of the samples which showed high acidic rain over Darjeeling, moderately over Falta and highly alkaline over Kolkata. It was observed that the neutralizing alkaline species Ca^{2+} over Kolkata was maximum which neutralized the rainwater acidity. On the other hand, the concentrations of alkaline species were minimum over Darjeeling compared to anthropogenic acidic species. Positive Matrix Factorization model was used to apportion the sources of several chemical species scavenged by rain.

Falta Experimental Farm

In the current financial year, emphasis has been given for economic upliftment of Scheduled Tribe and Scheduled Caste beneficiaries under the "Scheduled Tribe-Specific Rural Biotechnology Programme" and DST/SEED project respectively. In the DST/SEED project four training programmes were conducted and 80 beneficiaries were trained on mushroom cultivation, vermicompost production, bee-keeping and sericulture. Out of 80 beneficiaries 40 were provided with set up of mushroom cultivation unit, vermicompost pit and bee-keeping boxes at their own land (any one set up for one beneficiary). Under the Scheduled Tribe-Specific Rural Biotechnology Programme Bose Institute is working for economic development of the tribal people in 5 districts of West Bengal namely, Purulia, Bankura, West Midnapore, Birbhum and South 24-Parganas (Sunderban area) in two modes i.e., direct mode through departmental machinery and NGO mode through some NGOs. Some onsite trainers were selected from the villages/NGOs; after a preliminary training at Falta Experimental Farm extensive training was given to them at the project sites while implementing each and every programmes. Twelve aspects have been selected for implementation such as rain water harvesting for drinking and irrigation purpose, orchard development, agriculture, sericulture, vermicompost production, bee-keeping, pig rearing, goat rearing, poultry bird (chicken & duck) rearing, and mushroom cultivation and food processing.

Some programme-wise photographs and brief descriptions are given below:

Rain water harvesting for drinking purpose:

Fig. 1a-1c: Rain water harvesting programme in Bhutadhi village of Purulia. Here concrete reservoirs (2,000 L capacity) were constructed for collecting rain water for drinking purpose. The scheduled tribe beneficiaries were constructing their own reservoirs under Bose Institute's guidance. Total 16 Nos. of tanks have been constructed so far in Bhutadhi village (13Nos) of Purulia and Chhachanpur village (3Nos) of Bankura.

Rain water harvesting for irrigation purpose:

Fig. 2: Rain water harvesting programme in Bhutadhi village of Purulia. Here polythene sheet layered small ponds (poly-pond) were constructed for collecting rain water for irrigation purpose. The scheduled tribe beneficiaries were preparing their own reservoirs under Bose Institute's guidance. Purulia district of West Bengal is a low rain fall area

and water holding capacity of soil is very low. Moreover evaporation loss due to high temperature in this region is also very high. The farmers in this region, suffers a lot for scarcity of irrigation water in the water bodies. We took initiative to develop small poly-ponds (size: 20'x20'x7', capacity: 40,000-50,000 L) at the end of the slope of one bigha land per farmer and the land we chose were fallow lands. The cost of preparing this type of pond is about Rs. 10,000/-. We want to show the beneficiaries that rain water whatever falls in a season could be collected in the poly-pond, stored totally and could be used for cultivation of at least one crop in one bigha land. After digging the poly-pond, stored totally and could be used for cultivation of at least one crop in one bigha land. To protect the pond with JCB, all the surfaces of pond was leveled with mud followed by black polythene sheet layering. To protect the polythene sheet from UV rays shed net was placed over the pond and for evaporation loss of water one more plastic was placed over the water surface. The pond was protected from domestic animals by fencing with plastic nets. A total of 7 nos. of poly-ponds have already been constructed in Bhutadhi village of Purulia and these ponds are now full of water and are used for fishery and irrigation purpose. In this region in spite of Govt. initiatives the toilet for all mission becomes ineffective because of unavailability of sufficient water for toilet use. If the poly-pond system and or concrete tank is tagged with the toilet for all mission it could be successful. In the next year we have a plan to tag poly-pond & cemented tank to some toilets to make the toilet programme successful in some remote villages of Purulia and West Medinipore.

Vermicompost:



Fig. 3: Different activities on vermicompost programme. The tribal beneficiaries were constructing their own vermicompost pits at Bhutadhi village, Block: Manbazar-2, Purulia (Fig. 3a & 3b). Tribal beneficiary along with resource persons and project staff were standing in front of the vermicompost pit at Chhachanpur village, Chhatna Block, Bankura (Fig. 3c). The Scheduled Caste Trainees in the vermicompost yard during their training under the DST-SEED project at Falta Experimental Farm (Fig. 3d).

Sericulture:

New initiative was taken to start community sericulture taking 15 bigha land comprising of mulberry plot and rearing facility one unit each at Bhutadhi village of Purulia and Chhachanpur village of Bankura. About 3,000 man days were created through this project in each of these villages.



Fig. 4: Sericulture activity at Bhutadhi village of Purulia & Chhachanpur village of Bankura. Tribal women were doing cultural activity at mulberry plot at Bhutadhi (Fig. 4a). Dr. K.C. Mandal, our resource person for sericulture was demonstrating mulberry cultivation to the beneficiaries at Chhachanpur (Fig. 4b). The beneficiaries were taking care about the silkworm larvae at Chhachanpur (Fig. 4c) & Bhutadhi (Fig. 4d). Bivoltine (Fig. 4e) and multivoltine cocoons (Fig. 4f) were ready for marketing at Chhachanpur village.

Pig rearing:



Fig. 5: Photographs of pig rearing programme. Twenty-one Sabar beneficiaries at Satyadaspur village of Pathar Pratima Block, Sunderban, South 24-Parganas were provided with two pigs per family. Two such beneficiaries with their pigs and new born piglets (Fig. 5a & 5b).

Orchard development:



Fig. 6: Different activities on orchard development. Orchard development was given one of the priority areas in the Scheduled Tribe development programme. Tribal beneficiaries were nurturing their plants in Chhachanpur village, Chhatna Block, Bankura (Fig. 6a & 6b). The tribal beneficiaries were taking the saplings for plantation in their land and watering the planted saplings (Fig. 6c & 6d) at Satyadaspur village, Pathar Pratima Block, Sunderban, South 24-Parganas.

Fishery:



Fig. 7: Different activities in fishery programme. a) Dr. A.K. Dutta, resource person in fishery programme was demonstrating fish breeding at night at Falta Experimental Farm during a training programme for scheduled tribe beneficiaries. b) Dr. Dutta was checking the growth of the fish after netting at Satyadaspur village, G-Plot, Pathar Pratima Block, Sunderban, South 24-Parganas. c) The tribal beneficiaries with the harvested fish at Satyadaspur village.

Agriculture:



Fig. 8: Some photographs of agriculture programme at Chhachanpur village of Bankura. Seeds and manures were distributed to the tribal beneficiaries at Chhachanpur village, Chhatna Block, Bankura (Fig. 8a & 8b). Some beneficiaries with their vegetable crops produced out of this programme (Fig. 8c & 8d).

Croilar chicken bird rearing:



Fig. 9: Photographs of croilar chicken bird rearing programme at Satyadaspur village of G-Plot, Pathar Pratima Block, Sunderban. Here seven sabar beneficiaries were given 24 birds each and out of seven beneficiaries four started rearing 50 birds after three months with their profit. a) The tribal beneficiaries were carrying baskets containing croilar chicken birds and sac containing chicken food for distribution. b) Prof. S.R. Sikdar, Coordinator Rural Biotechnology Programme was distributing chicken birds to the beneficiaries. c) Three months old croilar chickens of a beneficiary were ready for marketing.

NGO activity:



Fig. 10: Project activity at different NGO sites. a) Our project staff was demonstrating on bee-keeping at Murgabuni village, Ilambazar, Birbhum (operated by the NGO, Surul Suprity Society). b) A vegetable garden at Amlasole village

of West Midnapore (operated by Integrated River Basin Management Society). c) The onsite trainer in Purbasandalpur Adibasi para, Birbhum with his poultry birds operated by Sian Molla Danga Adibasi Milan Sangha. d) One beneficiary in front of his poultry at Murgabuni village, Ilambazar, Birbhum operated by the NGO, Surul Suprity Society. e) One beneficiary at Ghosaldanga village, Birbhum with his ducks operated by Ghosaldanga Adibasi Seva Sangha. f) One beneficiary at Subalpur village, Birbhum with a mushroom bed operated by Surul Suprity Society.

DST-SEED Project:



Fig. 11: Different activities of DST-SEED project (PI: Prof. S.R. Sikdar) for scheduled caste people for income generation through hands on training and facility development in beneficiaries own land on mushroom cultivation, vermicompost production, apiculture and sericulture. a) Group photo during the training programme at Falta Experimental Farm, b) & c) mushroom produced by the beneficiaries in their house at Dumurdaha village of Balagarh Block, Hooghly, d) & e) vermicompost production units were in operation in the beneficiaries own land at Krishnadaspur village of G-plot, Pathar Pratima Block, Sunderban, f) Women beneficiaries were handling the bee-keeping box during the training programme at Falta Experimental Farm.



J C Bose Centre

(Publication and Museum)

J C Bose Centre comprises the Museum dedicated to J.C. Bose and the Publication unit. The museum is a special attraction in the Main Campus. It nestles a permanent exhibition on the life, research contributions and works Acharya Jagadis Chandra Bose. Presently the Museum is a repository of some significant scientific instruments designed by J.C. Bose, commemorative items, 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 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. Further development of our museum is under progress.

Since its inception in 1980, the Publication Section has been entrusted with the responsibility 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. I 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.150.00; Acharya Jagadis Chandra Bose (Bengali) Rs.12.00; Akyakta (Bengali book written by Sir J.C. Bose) Rs.50.00; Acharya Jagadis Chandra Bose (Bengali Combined) Rs.325.00; Bose Institute-Myself & Ribosome Rs. 200.00; Academic Pride of West Bengal: A Compendium Rs. 250.00; 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.

Participation in Conferences / Symposia / Workshops & Invited Talks delivered at Various Organizations:

Ishani Chatterjee (J.C.Bose Centre) (i) presented paper entitled 'Museums for Regional Awareness on Indian Scientists' at the 3-day All India Museums Annual Conference held at State Museum, Guwahati (Assam) during 29.01.2015 to 31.01.2015 (ii) participated in the symposium on Biographical Museum and its relevance organized by Maulana Abul Kalam Azad Institute of Asian Studies at Maulana Azad Museum, Kolkata on September 17, 2014 (iii) visited J.C. Bose Museum of Darjeeling Campus during 21.05.2014 to 26.05.2014 and prepared a survey report for restoration and upgradation of the existing Museum. (iv) participated at the 18th National Science Exhibition at Amrabati Maidan, Sodepur during 3.09.2014 to 7.09.2014.

T K Maji, I Chatterjee (J.C. Bose Centre) participated at the National Exhibition-cum-Fair 2014 at Science City from 20.09.2014 to 26.09.2014.

Library

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 Jagadis Chandra Bose and a wing at the 'Centenary Building' was opened in 1983. In the year 2007 a small library was set-up in the Salt Lake Campus of the Institute. Library provides latest information to the BI faculty, researchers, staff members and students of Integrated M.Sc.-Ph.D. programme on Life Sciences and Physical Sciences. Library extends its physical Library facilities as well as online resources access to other Institutions / Universities / R&D organisations 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.

The library total collection of reading materials is 42,984 as on 31.03.2014 and subscribed to more than 5000+ online journals packages from more than 50 Publishers. Library also subscribed to online-only full-text journals / databases of different academic societies and national and international publishers. Library subscribed to e-books packages. All subscribed journals can be accessed from 1997 onwards. Library is also having very old rich print collection of important science journals.

Activities:

Collection Development:

Collection	Total as on 31 March 2015
Books	14580
Theses	529
Bound Volumes of Journals	28185

Other Collection

Sir J.C. Bose Collection
Reports, Newsletters, Annual Reports of other Institute(s), Publication of Bose Institute etc.
Online Journals subscribed
Online journals through National Knowledge Resource Consortia (NKRC)
Back Volume Journals (online)
Scientific Software(s)

Access Management of Resources

All Library resources can be accessed by Institute faculty / scholar from all campuses of Bose Institute. Library also provides off campus access to its resources to Institute faculty members.



Library uses open sources software KOHA for OPAC and D-Space for IDR. For access management library maintains five servers.

Resources

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

A. Journals Resources

Library subscribed to major publishers journals such as ASM, ACS, Life Sciences Reviews, Cell Press journals of Elsevier, Science Direct, Nature Journals, John Wiley & Sons, Inc, IOP, AIP, APS, Adenine Press, 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, Kluwer Academic Publishers Group (KAPG)/Springerlink, Landes Bioscience, Microbiology Research Foundations, National Academy of Sciences, Physical Society of Japan, Polish Academy of Sciences, Portland Press, Reed Business, 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. Databases

Library also subscribed to different databases such as :

- BIOBASE BIOLOGICAL Database-TRAN-AC/SE-O TRANSFAC®-Seat (Online);
- PROT-AC/SE-O PROTEOME™-Seat (Online);
- EXPL-AC/SE-O Explain™-Seat (Online);
- HGMD-AC/SE-O HGMD®-Seat (Online).
- Century of Science - Science Citation Index Expanded and ENDNOTE Web of ISI Web of Science, Thompson, USA.
- SCOPUS the largest abstract and citation database of research literature and quality web sources of Elsevier.
- SCIFINDER of ACS.

Science of Synthesis—The Electronic Version

C. Open Access Membership

(1) Biomed Central (BMC)

D. New Addition(s) in 2014-2015:

During the year 2014-2015 Library subscribed new Database:

- | | |
|-----------------------------------|------------|
| a) Origin Lab Pro | |
| b) Book(s) added in 2013-2014 | : 293 nos. |
| c) Thesis added | : 17 nos. |
| d) Bound Volumes of Journal added | : 194 nos. |

E. Available Back Volume Journals:

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

F. e-Books added from 2013-2014 :

E-Books

Oxford Scholarship Online Physics Titles

- OSO Con Framework Quantum Field
- OSO Conductor Insulat Qua Phas Trans
- OSO Luminesc Spectroscopy Of Semico
- OSO Many-Body Phy With Ul Cold Gases
- OSO Nicolas-Louis De La Cai Astr Geo
- OSO Niels Bohr & The Quantum Atom
- OSO Non-Equilibrium Ther & Stat Mech
- OSO Quant Theo Small To Large Scales
- OSO Stellar Magnetism 2e
- OSO Story Of Semiconductors

**G. Scientific Softwares Available:**

Sl. No.	Software(s)	Publishers
1.	Grammarly@edu writing support Suite	Kite India ?
2.	iThenticate: Plagiarism detection Software	iThenticate
3.	Genomatix software subscription: MatInspector and MatBase Individual Online Account 12 months license	Genomatix
4.	Pathway Studio Mammal Desktop	Elsevier
5.	Metamorph (Molecular Devices), Multiuser subscription.	Molecular Devices
6.	Gaussian09 for (Multiprocessor) Windows Version for 2 Users, Gauss VIEW 5 Windows Version for 2 users	Scube Scientific Software Pvt. Ltd.
7.	SPSS Software— (2 users)	IBM India Pvt.Ltd.
8.	Sigma Plot 12- Five user perpetual license-1 Set	Systat Software Incorporation
9.	Vector NTI static non-expiring academic license A13786 X 2	Invitrogen BioServices India Pvt. Ltd.

H. Resources through NKRC (<http://nkrc.niscair.res.in/indexpage.php>)

Library has joined with the National Knowledge Resource Consortia (NKRC) since 2008 which is joint consortia of CSIR and DST Institutes for accessing online resources. Through this consortia faculty members/scholars of this institute can access more than 5000+ online resources, SCIFINDER, ACS, Web of Science, Patent databases etc. Library could fulfill faculty / scholar demands for article resources from CSIR / DST Institutes subscribed journals. BI Library also provides article resources to all faculty/ scholars of DST / CSIR Institutes and also other institutes in India. Library is also member of FORSA Consortia.

Services and Management

Collection	Total Nos. as on 31 March 2014
Books Issued	185
Bound Volume Journal Issued	160
Loose Journal Issued	135
No. of Readers	4337
Internet Accessed (in hours)	11032
Photocopies	35020
Download of Articles (from Online Journals) (Approx.)	200000+

Services :

Reader's Service	The library is open to faculty member and scholars 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).
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 book through inter library book loan.
Institutional Membership	The library is member of various National and International organization(s) (i) Biomed Central (BMC), (ii) Public Library of Science (PLOS), (iii) International Federation of Library Associations and Institutions (IFLA), (iv) International Society of Tea Science (ISTS), (v) Indian Association Of Special Libraries And Information Centres (IASLIC), (vi) 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).
User Awareness Programme	Library conducts user orientation programmes time to time for the benefit of users and optimal utilization of subscribed resources. User orientation programme also includes "Reference management" for publications, citing references in thesis, using databases, citation report, h-index compilation, using different scientific software, using of anti-plagiarism software, grammar checking software etc.
Reprographic Service	The library provides reprography services to its users. Photocopy services are provided to all research workers of the Institute. A total 2,90,607 pages of photocopies were given to our faculty and outside users. Library also provides scanning services to its user.



Academic Programmes / Seminar Organised by BI Library

Bose Institute Library regularly organizing number of academic programmes for researchers of Bose Institute as well as nearby research institute(s) for promoting usage of Bose Institute Library subscribed resources as well as NKRC subscribed resources. These workshop(s) / training programme(s) also help scholars to lessen their research time. A good number of training programmes are organised for using databases, software etc. Library helps to all kind of research endeavor.

Further Academic Activities:

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

Bose Institute library hosted Internship Programme of "MLIS-5 year Integrated Course" of Department of Library and Information Science, University of Calcutta for three weeks (06th April – 30th April '2015) under guidance of Dr. Banhisikha Chaudhuri.

Publications:

1. Dr. (Ms.) Banhisikha Chaudhuri : Acharya-o-tar Jiban Sangram published in special issue on Jagadish Chandra Bose; Biggan Chinta. Published from Mirpur, Dhaka. Bangladesh on Nov 2014.

Workshop

The Workshop as well as the Workshop Superintendent 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, shopping, 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) are being manufactured on routine basis against the requisition of other famous institutions.
- 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 utilised as per requirement when internal transports are not affordable.
- v) Electrical Unit:- This section attends 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:-

- i) Replacement of the old electrical panels and switches at LT room of main Campus by a new panel board which caters the total power of different departments at Main Campus.
- ii) Monitoring & execution of all the equipments like HT breaker, Dry type transformer, main LT panel board, DG set, HVAC system, fire alarm system, Building Monitoring system, etc. related to the installation of new Animal House at Madhyamgram Experimental Farm.
- iii) 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.



Bose Institute Library (Centenary Campus)

LIST OF PERSONNEL

Administration

Dr. Sibaji Raha, Sr. Professor & Director

Shri Surajit Panigrahi, Registrar

Smt. Noreen Bhattacharjee, Deputy Registrar

Centenary Campus: Tapan Datta, Subir Sen, Ashis Chakraborty (Retd. on 13.12.2014), Sougata Banerjee, Sisir Chakraborty, Manick Ch. Das, Baladeb Goswami, Rina Roy, Amitabha Bhattacharjee, Dhrubajyoti Sen, Mantu Bhattacharjee, Achintya Mukherjee, Vineet Tandon, Supriya Das, Satya Swarup Behera, Ananya Malgope, Rubi Sarkar, Sudam Jana, Babli Marick, Rina Das, Somnath Das, Sanjoy Krishna Chaki, Debasis Koley, Angshuman Bhowmik, Atanu Deb, Biplab Malakar, Shaubhik Ghosh, Arpita Bose, Mahendra Nath Shee, Hemanta Kumar Sahoo, Goutam Behera, Gouranga Paramanik, Animesh Jana, Ratan Saha, Sumanta Ghosh, Satyabrata Chatterjee, Dipak Dutta (transferred to Library 06.3.2015), Chotelal Rangwa (Retd. on 31.7.2014), Kissun Turi, Khairul Basar Mallah, Kanai Hazra, Prafulla Bhunya, Kanak Baran Hazra, Duryodhan Nayak, Bablu Mandal, Sukanta Chakraborty, Subrato Banerjee, Ranjit Das, Sarada Devi, Sukumar Mandal, Bulaki Das (Retd. on 30.9.2014), Jagabandhu Nayak, Jagannath Das (transferred to Shyamnagar Experimental Farmon 23.2.2015).

Main Campus: Tarun Kumar Maji, Ishani Chatterjee, Chandra Kanta Sasmal, Madhusudhan Marick, Sanat Kr. Dhara, Kalicharan Turi, Munna Turi, Kodan Das, Rajbrat Ram, Rajkumari Balmiki, Tapas Chakraborty.

Acharya J.C. Bose Biotechnology Innovation Centre (Madhyamgram Experimental Farm)

Faculty: Dr. S. Raha (Director & Chairman), Dr. P. K. Saha (Scientist & Executive Chairman)

Staff Members: (Office): Mr. Amit Kumar Ghosh, (redeployed to MEF from 25.06.2014), Mr. Atanu Deb (redeployed to Administration from 25.06.2014), Sudipta Basu.

Staff Members: (Lab.): Mr. Asis Kumar Dalal, Dr. Saurav Bhattacharya, Dr. Subhendu Bandyopadhyay, Ms. Debopriya Chattopadhyay, Mr. Bapi Dey.

Staff Members: (Field): Mr. Pulak Kumar Roy, Mr. Raj Kishore Lenka (Retd. on 31.10.2014), Mr. Rabin Talukdar, Mr. Laxmi Kanta Pradhan, Sk. Inal Ali, Mr. Bhanu Kisku, Mr. Mahesh Dasgupta, Mr. Subhas Senapati.

Biochemistry Department

Faculty: Prof. B. Bhattacharyya (INSA Sr. Scientist), Prof. Pinakpani Chakrabarti (Sr. Professor & Chairman), Prof. Anuradha Lohia, (Sr. Professor on lien from 02.05.14), Prof. Rajagopal Chattopadhyaya (Professor) Prof. Pradeep Kumar Parrack (Professor) Dr. Subrata Sau (Professor), Dr. Srimonti Sarkar (Associate Professor), Dr. Ajit Bikram Datta (Assistant Professor & Wellcome Trust-DBT India Alliance Intermediate Fellow), Dr. Abhrajyoti Ghosh (DST Ramanujan Fellow).

Students/RA/Project Assistant: Dr. Tanaya Chatterjee (DST Women Scientist), Mr. Sandeeptan Sengupta, Mr. Amritanshu Chakraborty (upto 11.06.14), Ms. Aditi Ghosh (upto 31.12.14), Ms. Aritrika Pal (upto 31.01.15), Ms. Gopa Dhar, Mr. Somnath Datta, Ms. Sayani Sarkar, Mr. Aditya Prasad Behera, Mr. Sukhendu Mondal, Ms. Prerana Agarwal, Ms. Indrani Kar, Ms. Devlina Chakraborty, Mr. Anindya Biswas, Ms. Sayantani Chowdhury (upto 31.05.14), Mr. Shankari Prasad Datta, Mr. Soumitra Polley, Mr. Soumitra Polley, Ms. Nabanita Saha, Ms. Atrayee Ray, Ms. Shamila Sarwar, Ms. Ananya Jana, Mr. Supriyo Bera, Ms. Rwitie Mallik (upto 23.10.14), Mr. Pritam Naskar, Mr. Dibya Mukherjee (from 05.08.14), Mr. Ritam Datta (from 05.08.14 to 27.03.15), Mr. Mousam Roy (from 05.08.14), Ms. Chandrima Bhattacharyya (from 01.09.14), Mr. Debabrata Sinha (from 27.01.15), Mr. Shayantan Mukherji (from 21.01.15), Ms. Apurba Sarkar (from 12.06.14 to 08.12.14).

Staff Members: Mr. Ashim Kumar Banerjee (upto 31.01.2015), Mr. Subhash Chakraborty, Mr. Asim Kumar Poddar, Mrs. Debarati Kanjilal, Md. Asraf Ali Molla, Mr. Dulal Chandra Mondal, Ms. Ranubala Das, Mr. Atanu Pramanik, Mr. Tuhin Saha.

Bioinformatics Centre

Faculty: Dr. Pinakpani Chakrabarti, Scientist-In-Charge & Coordinator (DBT), Dr. Tapash Chandra Ghosh, Deputy Coordinator (DBT), Dr. Shubhra Ghosh Dastidar, Asstt. Professor, Dr. Zhumur Ghosh, Asstt. Professor, Dr. Sudipto Saha, Ramalingaswami Fellow.

Students /RA /Project Assistant : Soumita Poddar, Tina Begum, Sandip Chakraborty, Jyotirmoy Das, Kamalika Sen, Arup Panda, Deeya Saha, Atanu Maity, Arijita Sarkar, Sohini Chakraborty, Prerna Priya, Debarun Acharya, Debadrita Mukherjee, Ranjan Kr. Maji, Sarmistha Majumdar, Kakoli Biswas, Tonmoy Jana, Debashree Sarkar, Jesmita Dhar, Aritra Deb, Debarita Paul, Sibun Parida, Souparna Adhikary, Kalyan Reddy, Satyabrata Maity, Subarno Thakur, Rahul Dutta, Anwesha Dutta, Sumit Mukherjee Anushree Bhattacharya, Sukhen Das Mondal, Aritrika Pal.

Staff Members: Mr. Tushar Kanti Bhattacharya, Mrs. Sujata Roy, Sanjib Kr. Gupta, Mr. Jibananda Mondal.

Biophysics Department

Faculty: Dr. Siddhartha Roy, Professor, Dr. Gautam Basu, Professor, Dr. Anirban Bhunia, Assistant Professor, Dr. Subhrangsu Chatterjee, Ramanujan Fellow, Dr. Debjani Roy, Assistant Professor, Dr. Manju Roy, Visiting Scientist.



Students/RA/Project Assistant: Dr. Saumya Dasgupta, Ms. Sarbani Chattopadhyay, Mr. Bankim Mondal, Ms. Paulami Chatterjee, Mr. Anirban Ghosh, Mr. Jagannath Jana, Mr. Rajib Kumer Kar, Ms. Aritreyee Datta, Ms. Soma Mondal, Ms. Jyotsna Sahaji Bhat, Ms. Meghamukta Mukherjee, Dr. Shruti Sharma, Ms. Swapna Bera, Ms. Sudakshina Ganguly, Dr. Aparajita Pal, Mr. Anirban Roy, Ms. Ananya Dutta, Dr. Amrita Roy, Mr. Bhisma Narayan Ratha, Mr. M.E. Kalyan Reddy, Dr. Tulika Chakraborty, Ms. Sonali Ghosh.

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

Chemistry Department

Faculty : Dr. Joyoti Basu, Sr. Professor, Dr. Suman Kr. Banik, Asstt. Professor, Dr. K. P. Das, Sr. Professor, Dr. Pradip Das, Professor, Dr. Mmanikuntala Kundu, Sr. Professor & Chairperson, Dr. Jayanta Mukhopadhyay, Asstt. Professor, Dr. Soumen Roy, Asstt. Professor

Students/RA/Project Assistant : Srijon Kaushik Banerjee, Chandreyee Datta, Prasun Sarkar, Ayan Chatterjee, Soumyajyoti Banerjee, Manish Kumar, Sanjoy Kr. Sahoo, Rajdeep Kaur Grewal, Saptarshi Kr. Sinha, Indrani Paul, Arun Kr. Sharma, Arkajyoti Datta, Ayan Biswas, Amar Ch. Mahata

Staff Members: Pranab Dey, Tapas Ghosh, Dipak Ch. Konar, Rama Chatterjee, Sujata Roy, Gaurab Roy, Mrityunjoy Kundu, Subhas Ch. Paul, Asoke Kr. Maity, Sachchidanand Ram

Central Instrumentation Facility

Faculty: Dr. Sujoy K. Das Gupta (Professor & In Charge, Cent. Bldg.), Dr. T. P. Sinha (Professor & In Charge Main Campus).

Supporting Staff (Cent. Campus): Jaganmay Guin (retired on 30-11-2014), Jaideb Chattopadhyay (upto 31-08-2015), Ranjan Kumar Dutta, Smriti Ranjan Maji, Mrinal Das, Swaroop Biswas, Sheolee Ghosh Chakraborty, Amarendra Nath Biswas, Pallab Chakraborty, Alpana Bhattacharya.

Supporting Staff (Main Campus): Arup Kumar Sen (upto 30-11-2015), Samir Mukherjee, Prodip Karmakar (Retired on 28-02-2015), Tanima Modak Dhar, Debabrata Polley (Retired on 31-12-2014), Shankar Santra, Sarwasati Sarkar.

Division of Molecular Medicine

Faculty : Dr. Kaushik Biswas, Assistant Professor, Dr. Tanya Das, Professor, Dr. Kuladip Jana, Scientist-C, Dr. Atin Kumar Mandal, Assistant Professor, Dr. Nripendranath Mandal, Associate Professor, Dr. Subrata Majumdar, Professor, Dr. Anup Kumar Misra, Associate Professor, Dr. Mahadeb Pal, Associate Professor, Dr. Arun Kr. Ray, Emeritus Scientist, Dr. Manju Ray, Emeritus Scientist, Dr. Gaurisankar Sa, Professor, Dr. Parimal C. Sen, Senior Professor & Head, Dr. Parames Ch. Sil, Professor.

Students/RA/Project Assistant : Pinki Nandi, Swatilekha Ghosh, Argha Adhikari, Abhijit Sarkar, Parna Bhattacharya, Kirti Kajal, Argha Manna, Nikhil Baban Ghate, Supriya Chakraborty, Joyita Hazra, Joydeep Roy, Manjari Kundu, Dr. Anamika Bose, Anupam Adhikari, Bibhabasu Hazra, Jyotirmoy Ghosh, Joydeep Das, Saikat Majumdar, Shravanti Mukherjee, Gautam Guchhait, Abhishek Santra, Pabitra Bikas Pal, Sayantan Banerjee, Abhijit Sau, Poulami Khan, Monoranjan Ghosh, Kuntal Halder, Shibali Das, Barun Mahata, Tamashree Ghosh, Samik Chakraborty, Abir Kr. Panda, Amrita Bhattachajee, Sreeparna Chakraborty, Taniya Saha, Deblina Guha, Soumyadip Paul, Shahana Mitra, Kahkashan Rashid, Somanjana Khatua, Bidisha Paul Chowdhury, Dipankar Chaudhuri, Surav Dutta, Usri Chakraborty, Ajoy Mallik, Shilpi Saha, Dr. Minakshi Mazumdar, Dr. Santanu Kar Mahapatra, Dr. Amrita Dutta, Dr. Pushpak Bhattacharjee, Dr. Anindita Roy, Dr. Nivedita Roy, Dr. Aparajita Ghosh, Sankhadeep Pal, Krishnendu Sinha, Nihar Ranjan Biswal, Shabina Parveen Dr. Nivedita Roy, RA, Dr. Aparajita Ghosh, RA, Dr. Suman Bhandary, RA, Dr. Swatilekha Ghosh RA, Supriya Chakraborty, SRF, Arindam Basu, Kalyan Das, Joyita Hazra (SRF); Soumyadip Paul (SRF); Pooja Mukherjee (SRF); Asif Ali (SRF); Vinod Nelson (SRF), Suvranil Ghosh (JRF), Satyaki Chatterjee (JRF), Naibedya Dutta (Project assistant); Deepak Bharadwaj (Project assistant). Abhijit Sau (Thesis submitted and degree awarded from Calcutta University), Manas Jana, CSIR-SRF, Tamashree Ghosh, CSIR-SRF, Debashis Dhara, CSIR-SRF, Anshupriya Si, CSIR-JRF, Ishani Bhaumik, CSIR-JRF, Debashis Mazumder, Technical Asstt, Mr. Rhitajit Sarkar (SRF), Mr. Sourav Dutta (SRF), Ms. Usri Chakraborty (SRF), Mr. Nikhil Baban Ghate (SRF), Mr. Ajoy Mallik (SRF), Mr. Dipankar Chaudhuri (SRF), Mr. Sourav Panja (JRF), Mr. Debabrata Mondal (JRF), Dr. Abhishek Das (RA), Mrs. Tapasree Basu Mallik (JRF) and Mr. Pradip Kumar Mallick (Laboratory Attendant)

Staff Members: Pransanta Pal, Indrajit Ray, Sukumar Maitra, Barindra Nath Mandal, Prabal Kr. Gupta, Uttam Kumar Ghosh, Arindam Basu, Debasish Majumdar, Shanghamitra Das (Sahu), Sourav Samanta, Kalyan Das, Amartya Sen, Ranjit Das, Purnendu Manna, Shankar Prasad Bari, Kanan Singh, Sudhir Turi, Pradip Kr. Mallick (LA-MoES Project), Mr. Ranjit Kumar Das

Division of Plant Biology

Faculty : Dr. Sampa Das, Sr. Professor & Head, Dr. Swati Gupta Bhattacharya, Sr. Professor, Dr. Samir Ranjan Sikdar, Sr. Professor, Dr. Debabrata Basu, Professor, Dr. T.K Ghosh, Associate Professor, Dr. Gaurab Gangopadhyay, Associate Professor, Dr. Shubho Chowdhuri, Associate Professor, Dr. Pallob Kundu, Associate Professor, Dr. A.N. Lahiri Majumder, Sr. Professor, Raja Ramanna Fellow, DAE, Dr. Amita Pal, Sr. Professor, CSIR Emeritus Scientist, Dr. D.N Sengupta, Sr. Professor, Dr. Swati Sen-Mandi, ICMR Emeritus Medical Scientist, Dr. P.K Saha, Consultant Scientist, Dr. Anupama Ghosh, Inspire faculty.

Project Scientist : Dr. Sonali Sengupta (DBT Project: Staff Scientist), Dr. Swagata Ghosh (DST Women Scientist), Dr. Rajeswari Mukherjee (DBT RA) Dr. Srirupa Das and Dr. Mitali Chatterjee (DBT BIO-CARE Scientist).



Students/RA/Project Assistant : (Dr. Sumanti Gupta, Dr. Shubhendu Bandopadhyay, Dr. Sourav Bhattacharya, Dr. Sritama Mukherjee, Dr. Lekha Bandopadhyay, Dr. Amit Roy, Dr. Avishek Dey, Dr. Anirban Kundu, Mr. Pijush Mullick, Mr. Mrinmoy Majumder, Ms. Monia Chatterjee, Ms. Upala Saha, Mr. Ayan Das, Mr. Anirban Bhar, Mr. Prithwi Ghosh, Mr. Arunava Mondal, Ms. Senjuti Sen, Mr. Joydeep Chakraborty, Ms. Jayanti Joddar, Mr. Sourav Bose, Ms. Papri Basak, Ms. Anju Patel, Mr. Dipan Roy, Ms. Payel Bhattacharya, Ms. Sayani Dey, Mr. Amit Paul, Ms. Amrita Mukherjee Ganguly, Ms. Deepti Sarkar, Ms. Sefa Parveen, Ms. Poulami Sarkar, Ms. Payel Ganguly, Ms. Adrita Roy, Ms. Banani Mondal, Ms. Sanghamitra Adak, Mr. Sayantan Ghosh, Ms. Shruti Chattaraj, Mr. Rohit Das, Ms. Aishee Dey, Mr. Rahul Dutta, Dr. Himadri Shekhar Chakraborty, Dr. Basabdatta Das, Ms. Niti Yashvardini, Mrs Marufa Sultana, Mr. Bodhisattwa Saha, Mr. Vivek Arora, Ms. Debarati Dey, Mrs Sayantini Sihi, Ms. Sangita Roy, Mr. Arup Nayak, Dr. Subhobrata Ghosh, Ms. Ranjana Prasad, Ms. Nandini Ghosh, Ms. Kavita Ghosal, Mrs. Bipasha Roy, Mr. Gourab Sircar, Mr. Tathagata Nath, Mr. Anubhab Laha, Ms. Koyel Sengupta, Dr. Saurav Bhattacharya, Ms. Bijoya Karmakar, Mr. Ayan Sadhukhan.

Staff members : Mrs. Puspita Mukherjee, Mr. Subal Basak, Mr. Ashim Kumar Nath, Mr. Binoy Krishna Modak, Mr. Jayasish Ghosh, Mr. Arup Kumar Dey, Mr. Nadiram Kayal, Mr. Birendra Kumar Bari, Mr. Kisun Turi, Dr. Chaitali Roy, Mr. Chanchal Chakraborty, Mr. Jadab Kr. Ghosh, Mrs. Kaberi Ghosh, Mr. Bipul Kumar Nag, Mr. Siddhartha Roy, Mrs. Sarama Pradhan, Mrs. Moumita Mondal, Mr. Amitava Bhattacharya, Mr. Sanjib Das, Mr. Swarnava Das, Mr. Uttam Das, Mr. Surajit Maity, Mr. Sudipta Basu, Mr. Avhishek Mukherjee, Mr. Bapi Dey, Ms. Debopriya Chattopadhyay, Ms. Kakoli Mondal, Mr. Ranajit Ghorui, Mr. Nasiruddin Molla, Mr. Debraj Chattopadhyay, Ms. Nishita Rakshit, Mr. Asis Bera, Mr. Sanjoy Mondal, Mr. Dibakar Debnath, Mr. Binod Turi.

Environmental Science Section

Faculty: Dr. Sibaji Raha, Chairman and Director; Dr Abhijit Chatterjee, Assistant Professor and Dr Sanat Kumar Das, Ramanujan Fellow.

Staff Members: Dr Anandamay Adak, Mr Bhaskar Roy, Ms Debolina Seal, Mrs Ishani Chaudhury, Mr Saral Chandra Das

Students/RA/Project Assistant : Dr. Debajyoti Roy, Research Associate, Mr Chirantan Sarkar (SRF), Mr Arindam Roy (SRF)

Falta Experimental Farm

Faculty: Dr. S. R. Sikdar (Division of Plant Biology) Sr. Professor & Coordinator Rural Biotechnology Programme.

Staff Members: Shri Sobhan Roy Chowdhury (Senior Technical Assistant on contract), Shri Debarshi Porel and Shri Shuvankar Roy (both are Technicians on contract), Shri Amal Krishna Purkait, Shri Krishna Pada Biswas, Shri Santanu Haldar, Shri Sourav Mondal, Md. Sijarul Hoque

and Shri Sobal Kayal (all six are Master Trainers in the "Scheduled Tribe Specific Rural Biotechnology Programme"), Sk. Ansar Ali (Helper-G).

Microbiology Department

Faculty : Dr. Sujoy K. Dasgupta, Professor & Chairman, Dr. Tapan K. Dutta, Professor, Dr. Wriddhiman Ghosh, Associate Professor.

Students : Sri Prithwiraj Kirtania, Masrura Alam, Sm. Shreya Ghosh, Sri Soumik Basu, Sri Arindam Dutta, Sri Prasenjit Pyne, Sri Sourav Samaddar, Soumita Dutta, Sm. Soniya Chatterjee, Dr. Joydeep Chakraborty (terminated on 30/03/15), Sri Chayan Roy, Sm. Niketa Bhawinghka, Sm. Neha Gupta, Sm. Rimi Roy (upto 31/12/14), Shrestha Ghosh (from 01/08/13), Satamita Deb, Rameez M.J., Sabyasachi Bhattacharya (from 16/06/14), Apurba Sarkar (from 08/12/14), Subhrangshu Mandal (from 01/09/14).

Staff Members: Provat K. Chattopadhyay, Saifullah Gazi, Debashis Sarkar, Prabir Halder, Dilip Bhattacharyya, Ramesh Prasad, Robin Paul, Narayan Patali.

Physics Department

Faculty: Dr. Sibaji Raha, Sr. Professor, Director, Dr. Indrani Bose, Sr. Professor (CSIR Emeritus w.e.f. 01.09.2014), Dr. Dipankar Home, Sr. Professor, Dr. Barun Kumar Chatterjee, Sr. Professor & Chairman (w.e.f. 01.02.2014), Dr. Tripurari Prasad Sinha, Sr. Professor (w.e.f. 01.07.2014), Dr. Swapan Kumar Saha, Professor, Dr. Sanjay Kumar Ghosh, Professor, Dr. Partha Sarathi Joarder, Associate Professor, Dr. Somshubhro Bandyopadhyay, Asstt. Professor, Dr. Amitabha Mitra, Associate Professor, Dr. Dhruva Gupta, Asstt. Professor, Dr. Rajarshi Ray, Asstt. Professor, Dr. Supriya Das, Asstt. Professor, Dr. Achintya Singha, Asstt. Professor.

Students/RA/Project Assistant: Dr. Alo Dutta (SERB Young Scientist, upto 31.05.2014), Dr. Sumana Chakraborty (SERB Young Scientist), Dr. Rupa Sarkar (SERB Young Scientist, from 02.07.2014), Dr. Binita Ghosh (CSIR RA), Mr. Mohammed Younus, Mr. Sayan Biswas, Ms. Sudipa Upadhyay, Mr. Soumitra Maity, Mr. Subhasis Samanta, Mr. Kinkar Saha, Mr. Rama Prasad Adak, Mr. Sujoy Saha, Mr. Sadhan Chanda, Ms. Dipanwita Majumder, Mr. Mainak Pal, Mr. Anup Pradhan Sakhya (DST Inspire Fellow), Ms. Dyutima Das (resigned 03.06.2014), Mr. Saswata Haldar, Mr. Shib Shankar Singha (resigned 16.03.15), Mr. Saronath Halder, Mr. Prasenjit Deb, Mr. Rathijit Biswas, Mr. Pratapaditya Bej, Mr. Abhishek Banerjee, Mr. Rupamoy Bhattacharyya, Mr. Shyam Bihari Mehta, Mr. Avik Banerjee, Md. Sariful Sheikh (DST Inspire Fellow, joined 22.12.2014).

Staff Members: Mr. Sankar Prasad Singha, Mr. Shyamsundar Mallick, Dr. Subhasis Banerjee, Mr. Manas Datta, Mr. Subrata Das, Mrs. Rita Chakraborty, Mr. Sujit Basu, Mr. Kaushik Maiti, Mr. Bansi Dutta, Mr. Rajkumar Mourya, Mr. Amarnath Hela.

DRDO Project SMS: Scientist-"B": Ayona Chakraborty, Consultant (Administration): Arun K. Dasgupta.



IRHPA – ASTROPHYSICS: Dr. Ajay Kumar Singh (IRHPA II, Research Scientist-C), Dr. Sandhya Dey (Mandal) (IRHPA II, Research Scientist-C), Dr. Anindita Banerjee (SERB RA-II), Mr. Soumendra Singh (IRHPA 2, Research Scientist-C); Technical Assistants: Mrs. Sumana Singh, Mr. Bhaskar Roy, Mr. Bivek Gurung, Mr. Sabyasachi Majee, Ms. Debolina Seal.

Project Scientists/Technical Assistant: Dr. Partha Sarathy Ghosh, Professor (NASI Senior Scientist Fellow), Dr. Probir Roy, Professor (INSA Senior Scientist Fellow), Dr. Sidharth Kumar Prasad (Project ALICE II, RA-II), Mr. Sanjoy Mukherjee (Project ALICE II, Technical Assistant).

J. C. Bose Centre (Publication and Museum)

Staff Members : Tarun Kumar Maji, Ishani Chatterjee, Chandra Kanta Sasmal

Library

Dr. Arun Kumar Chakraborty (Librarian : on lien from 15/12/14), Dr. (Ms.) Banhisikha Chaudhuri (In-charge, Library : from 16/12/14), Ms. Ananya Raha, Ms. Sumita Dey (On lien), Ms. Gopa Dasgupta, Ms. Tanusri Bhattacharya, Mr. Gautam Mukherjee, Mr. Dipak Dutta, Mr. Mrityunjoy Jogsharma, Mr. Dinanath Das

Workshop

Mr. Raju Chandra Paul, Workshop Superintendent.

Main Campus: Mr. Basanta kr. Shit retired on 30/06/2014, Mr. Kisson Das retired on 30/11/2014, Mr Bholanath Saren, Mr Abdul Rahaman Molla, Mr Panchanan Santra, Mr Panchugopal Karak, Mr Sk. Md. Farruck, Mr W.D. Rozario, Mr Rajkumar Das, Mr Pranab Banerjee, Mr Brahmddeo Prasad, Mr Subrata Basak, Mr Sanjoy Santra, Mr Nageswar Das, Mr Fullchand Sardar , Mr Bidyut Mondal, Mr. Jyotimoy Sarkar (Assistant).

Centenary Campus: Mr. Sk. Md. Raffick retired on 31/05/2014. Mr. Ramprasad Ray (Consultant Electrical Engineer), Mr. Ashit Banerjee, Mr. Murari, Mohan Shee, Mr. Baidya Nath Murmu



Sir J.C. Bose, Patrick Geddes, Lady Abala Bose, P.C. Mahalanobis at Southern France (1927)

Statement of Accounts for the year 2014-2015

AUDITORS' REPORT

To the Members of the Council of the Bose Institute, Kolkata

- 1.0 We have audited the attached Balance Sheet as on 31st March, 2015 and the Income & Expenditure Account for the year ended as on date of BOSE INSTITUTE, 93/1, APC Road, Kolkata 700009. These financial statements are the responsibility of the Management of the Institute. Our responsibility is to express an opinion on these financial statements based on our audit.

We have conducted our audit in accordance with auditing standards generally accepted in India. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by, the management, as well as evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for our opinion.

- 2.0 On the basis of our audit as indicated in the preceding paragraph and subject to our audit observation as set out in Annexure I and together with the Principle Accounting Policies and Notes on Accounts of the Institute (as set out in Schedule 24) we report that :-

- i) we have obtained all the information and explanations, which to the best of our knowledge and belief were necessary for the purpose of our audit.
- ii) in our opinion, proper books of account as required, have been maintained so far as appears from our examination of those books
- iii) the Balance Sheet, Income & Expenditure Account and the Receipts & Payments Account dealt with by this report are in agreement with the books of account.



iv) in our opinion and to the best of our information and according to the explanations given to us, the said accounts, give a true and fair view in conformity with the accounting principles generally accepted in India :-

- a) in case of the Balance Sheet, of the state of affairs of the Institute as on 31st March, 2015 and
- b) in case of the Income & Expenditure Account, of the Deficit for the year ended on that date.
- c) In case of Receipts' & Payments Account of the cash transactions of the Institute for the year ended as on that date

For C. Ghosh & Co.
Chartered Accountants
(Registration No. 322547E)

Place : Kolkata

Date : 22nd September, 2015

Mahuya Ghosh
Partner
(Membership No : 058150)

AUDIT OBSERVATIONS

(Forming part of the
Audit Report)

Annexure I

1. Delays in deduction and payment of TDS noted, resulting in possible claims from the Income Tax department on account of defaults.

There are also certain old Statutory balances - Rs. 1.91 Lacs (Dr.) and Rs. 0.34 Lacs (Cr) which requires reconciliation:

2. Assets acquired from "Institute Development and Modernization Fund" amounting to Rs. 666.58 Lacs held under the head "Investment from Earmarked Funds" has not been capitalised.

Similarly, Work In Progress includes certain non moving items totaling to Rs. 22.75 Lacs (Dr) which requires thorough reconciliation to ascertain whether the assets have been already put into use but not as yet Capitalised.

Without a detailed Fixed Assets Register in place, the adequacy and correctness of valuation of the assets is difficult to ascertain.

Further, Impairment of assets if any has neither been identified nor provided for. The above observations may have an effect on the year's revenue and the Fixed Assets position of the Institute. (Refer AS 9, AS 10 and AS 28 issued by the ICAI)

3. Internal Audit has not been carried out in the Institute which in our opinion should be implemented considering the nature, complexity and size of the activity of the Institute.
4. The Institute has quite a number of staff on contracted employment, who are not being paid either Provident Fund or ESIC. Future liability on account of statutory requirements, if any has neither been determined nor provided which may have an effect on years revenue and Net Current Assets of the Institute.
5. Accounting for Retirement Benefits towards Gratuity and Leave Encashment for the employees has neither been ascertained nor provided for in the Financial Statements as per requirement of AS 15 issued by the ICAI. However Institute contends that since the entire fund for Retirement Benefits is received from DST, on the basis of Budgeted provision duly approved by the Finance Committee every year, such provision in this respect is not required.



6. Expenses are generally accounted for in the Financial Statements on cash basis which is not in accordance with the requirement of AS 9 issued by the ICAI.
7. There are pending cases against the Institute where future liability if any, is indeterminate in absence of any pre-assessment by the engaged lawyers. Valid contract with the Lawyers may be entered into as recommended by the Council of the Institute.
8. Without review of the Old outstanding balances of Rs. 57.02 Lacs (Dr) and Rs. 74.44 Lacs (Cr) included in Current Assets / Liabilities, possible impact on the years revenue and the Net Current Assets position as at the year end of the Institute is indeterminate at this stage.

BOSE INSTITUTE
KOLKATA

BALANCE SHEET AS AT 31ST MARCH, 2015

(Amount in ₹)

	Schedules	As At 2014-15	As At 2013-14
CORPUS/CAPITAL FUND AND LIABILITIES			
Corpus /Capital fund	1	1,23,85,39,435.85	81,69,95,653.56
Reserves and surplus	2		
Earmarked/Endowment funds	3	48,68,88,506.76	46,79,75,215.02
Secured loans and borrowings	4		
Unsecured loans and borrowings	5		
Deferred credit liabilities	6		
Current liabilities and provisions	7	52,18,47,449.54	73,90,29,500.00
Total		2,24,72,75,392.15	2,02,40,00,368.58
ASSETS			
Fixed Assets	8	87,53,84,440.22	77,37,07,881.40
Investments -from earmarked/endowment Funds	9	31,10,39,956.42	29,59,73,251.20
Investments-others	10	11,83,37,043.25	11,43,57,261.73
Current assets,loans,advances etc.	11	94,25,13,952.26	83,99,61,974.25
Miscellaneous expenditure (to the extent not written off or adjusted)			
Total		2,24,72,75,392.15	2,024,000,368.58
Significant accounting policies	24		
Contingent liabilities	25		

Place : Kolkata

Date : 22/09/2015

Signed in terms of our separate Report of even date.

Sd/-
(Samir Ranjan Sikdar)
Senior Professor &
Incharge-Registrar's Office

Sd/-
(Prof. Sibaji Raha)
Director

Sd/-
(Subir Sen)
Accounts Officer

For C. Ghosh & Co.
Chartered Accountants

Sd/-
(A. K. Biswas)
Audit & Finance Officer

Sd/-
(A. Mukherjee)
Accounts Officer

Sd/-
(Manik Chandra Das)
Accountant

Sd/-
(Shaubhik Ghosh)
UDC



BOSE INSTITUTE
INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31.03.2015

(Amount in ₹)

	Schedules	For the year ended 2014-15	For the year ended 2013-14
INCOME			
Income from Sales and Services	12	73,80,954.00	72,33,357.00
Grants/Subsidies	13	55,96,58,000.00	59,04,45,000.00
Fees/Subscriptions	14		
Income from Investments (Income on Invest, from earmarked /endowment Funds transferred to Funds)	15	2,96,46,611.54	2,70,42,576.98
Income from royalty, publication etc .	16		
Interest Earned	17		
Other Income	18	15,92,530.67	23,82,294.08
Increase/ (decrease) in stock of Finished goods and work-in-progress	19		
Total (A)		59,82,78,096.21	62,71,03,228.06
EXPENDITURE			
Establishment Expenses	20	38,27,97,022.90	39,67,36,224.00
Other Administrative Expenses	21	19,46,52,091.49	16,91,46,325.50
Expenditure on Grant, Subsidies etc.	22		
Interest	23		
Fund for capital Expenditure	23A	7,28,26,440.62	5,73,42,128.00
Depreciation (Net Total at the year end corresponding to Schedule 8)		5,94,38,582.00	6,12,44,992.00
Total (B)		70,97,14,137.01	68,44,69,669.50
Balance being excess of Income over Expenditure (A-B)		-11,14,36,040.80	-5,73,66,441.44
Transfer to Special Reserve (Specify each)			
Transfer to /from General Reserve			
Last Year Unspent Balance		-4,46,86,747.82	1,26,79,693.62
Balance being Surplus/(deficit) carried to corpus /capital fund		-15,61,22,788.62	-4,46,86,747.82
Significant accounting policies	24		
Contingent liabilities & Notes to Accounts	25		

Place : Kolkata

Date : 22/09/2015

Signed in terms of our separate Report of even date.

Sd/-
(Samir Ranjan Sikdar)
Senior Professor &
Incharge-Registrar's Office

Sd/-
(Prof. Sibaji Raha)
Director

Sd/-
(Subir Sen)
Accounts Officer

For C. Ghosh & Co.
Chartered Accountants

Sd/-
(A. K. Biswas)
Audit & Finance Officer

Sd/-
(A. Mukherjee)
Accounts Officer

Sd/-
(Manik Chandra Das)
Accountant

Sd/-
(Shaubhik Ghosh)
UDC

**SIGNIFICANT
ACCOUNTING
POLICIES & NOTES
ON ACCOUNTS**

Schedule : 24**1.0 Change in Accounting Policy:**

The Statement of Accounts has been drawn in the specified form applicable to Central Autonomous Bodies (NPOs) and Similar Institutions from the Financial Year 2013-14. To adopt the changes some account heads are clubbed or splitted and represented differently to suit the requirements of new format. The Balance Sheet has been drawn by consolidating Statement of Accounts of Council and the Governing Body with schedules thereon without incorporating the consolidated transactions in the Income and Expenditure Account. Further, the transactions of the Governing Body have not been incorporated in the books of Council. This principle of accounting has been consistently followed from year to year. In case of Governing Body, Pension Fund, Regional Sophisticated Instrumentation Centre 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 initiatives to prepare a comprehensive Fixed Asset Register with the help of an agency. The process is almost in the completion stage. This initiative will also cover the assets acquired in the year 1991-92 from "Institute Development and Modernisation Fund" (provided by Planning Commission). As the Fixed Asset Register will become ready after the finalisation of accounts for the financial year 2014-15, therefore the nomenclatures and order mentioned in Schedule 8 (old form schedule 4) is 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.

2.5 Valuation of assets

- The valuation of Fixed Assets has been made at cost less depreciation for the years 1990-91 till date.
- 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 2013-14 is in progress and will be included in the Fixed Asset Register.
- The identification of assets, impaired if any, as required in AS-28 issued by ICAI, has not been done.

3.0 Depreciation:

- Depreciation on Councils fixed assets has been incorporated in accumulated net balances as on 1990-91 and subsequent additions till 2013-14. The total depreciation upto 31st March 2013 has been deducted from the Capital fund of the Institute. But as per the requirements of new format depreciation for the year 2013-14 is charged to Income & Expenditure Account, and as per the requirement of new format depreciation for the year 2014-15 is charged to Income & Expenditure Account

- 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. Internet	- 60%

4.0 Revenue Recognition & Grant in Aid:

- During financial year 2014-15, 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.

- 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.

- Consumable Stores are charged to expenditure for purchases.

- 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.

- 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

- 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.

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

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

6.0 System of Fund Accounts

- 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.

- 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 but.

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.

**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 of ₹ 9,92,365.00 included under "Advance Council" is shown in the Balance Sheet under the head Advances (Schedule-II) which include a sum of ₹ 5,44,737.00 pending recovery/adjustment prior to 2012-13 .

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.

BOSE INSTITUTE**RECEIPT AND PAYMENT ACCOUNTS FOR THE YEAR ENDED 31.03.2015 (COUNCIL A/C)**

(Amount in ₹)

Receipts	Schedule no	Amount (₹)	Amount (₹)	Payments	Schedule no	Amount (₹)	Amount (₹)
Opening Balance				Current Liabilities			84,927,998.05
Bank Accounts	1	190,581,027.73		Other Liabilities	2	3,304,270.00	
Current Liabilities			190,581,027.73	Statutory Liabilities	3	72,913,855.05	
Other Liabilities	2	10,711,150.00		Sundry Creditors for			
Statutory Liabilities	3	71,931,249.40		Goods and Services	4	8,709,873.00	
Sundry Creditors for				Fixed Assets			156,953,903.47
Goods and Services	4	1,539,104.00	84,181,503.40	Building	6	758,611.00	
Fixed Assets				Other Assets	5	35,771,723.27	
Other Assets	5	991,720.00		Work in Progress	7	120,423,569.20	
Current Assets			991,720.00	Current Assets			313,233,324.38
Advance to GPF		2,200,000.00		Advance to GPF		2,200,000.00	
Loans & Advances (Asset)	9	47,097,948.00	49,297,948.00	Mobilisation Advance		260,000,000.00	
Branch / Divisions				Security Deposit (CESC LTD)			295,078.38
FAIR	8	544,876.04		Loans & Advances (Asset)	9	50,738,246.00	
Governing Body	8	98,360.00		Branch / Divisions			174,735.00
IRHPA (Prof. S. Raha)	8	38,091.00		Governing Body	8	34,971.00	
IRPHA (Prof A.Lohia)	8	19,886.00		Scheme/Project	8	139,764.00	
Scheme/Project	8	117,844.96		Indirect Incomes			7,709,139.00
Scheme/Project				Miscellaneous Received			
(Grant in Aid)	8	919,600,000.00	920,419,058.00	from Tripura University	10	28,234.00	
Indirect Incomes				TRAVEL GRANT	10	29,460.00	
MIF-2014	10	29,400.00		*st Specific Rural			
Miscellaneous Received		Other Income	10	Biotechnology Programme"10		7,495,773.00	
from Tripura University	10	57,600.00		Income From Services	10	5,672.00	
TRAVEL GRANT	10	75,000.00		Indirect Expenses			562,798,741.04
Grant in Aid	10	123,856.00		"Building Maintenance-			
Income From Services	10	1,585,204.00		Work in Progress"		458,794.00	
Interest Earned	10	9,382,417.05		ENTRY TAX		632,194.00	
Other Income	10	2,679,050.00	13,932,527.05	Establishment Expenses	11	385,620,009.00	
Indirect Expenses				Laboratory Expenses	12	80,924,437.70	
Establishment Expenses	11	1,303,344.00		Other Administrative			
Laboratory Expenses	12	1,005,327.00		Expenses	13	95,163,306.34	
Other Administrative				Earmarked Fund			100,000.00
Expenses	13	1,176,922.00		Council Fund		100,000.00	
			3,485,593.00	Closing Balance			136,991,536.24
Total			1,262,889,377.18	Bank Accounts	1	136,991,536.24	
				Total			1,262,889,377.18

Place : Kolkata
Date : 22/09/2015

Signed in terms of our separate Report of even date.

Sd/-
(A. Mukherjee)
Accounts Officer

Sd/-
(Kamal Sing)
Accountant (cash)

Sd/-
(Shaubhik Ghosh)
UDC

For C. Ghosh & Co.
Chartered Accountants

BOSE INSTITUTE
KOLKATA

Receipt and Payment accounts for the year ended 31.03.2015 (Projects)

Particulars	Sch. No.	Amount (₹)	Particulars	Sch. No.	Amount (₹)
OPENING BALANCE	1	578,080,206.66	PAYMENTS OF PROJECTS	2	206,319,812.46
RECEIPT OF PROJECTS	2	192,783,686.28	PAYMENTS OF IRHPA-S RAHA	4	
RECEIPT OF IRHPA-S RAHA	3		PAYMENTS OF IRHPA-A LOHIA	6	
RECEIPT OF IRHPA-A LOHIA	5		PAYMENTS OF FAIR (IFCC)	8	458,195,887.44
RECEIPT OF FAIR (IFCC)	7	521,726,149.42	CMS		-
CMS		33,000.00	CPF EMPLOYEE CONTRIBUTION		-
CPF EMPLOYEE CONTRIBUTION		62,656.00	CPF EMPLOYER CONTRIBUTION		-
CPF EMPLOYER CONTRIBUTION		62,656.00	CPFV		70,000.00
CPFV		70,000.00	I TAX (PARTY)		192,806.00
I TAX (PARTY)		303,381.00	I TAX (SALARY)		1,186,481.00
I TAX (SALARY)		1,186,481.00	LABOUR WELFARE CESS		-
LABOUR WELFARE CESS		7,551.00	LIABILITY (11-12)		-
LIABILITY (11-12)		-	LIABILITY FOR SECURITY GUARD		-
LIABILITY FOR SECURITY GUARD		464,726.00	LIABILITY (2012-2013)		-
LIABILITY (2012-2013)		-	LIABILITY (2013-14)		410,647.00
LIABILITY (2013-14)		-	LIABILITY (2014-15)		1,353,839.00
LIABILITY (2014-15)		1,353,839.00	OVERHEAD		11,552,774.00
OVERHEAD		11,552,774.00	PAYABLE TO STAFF		250.00
PAYABLE TO STAFF		894,134.00	P TAX		59,440.00
P TAX		59,440.00	SALES TAX		-
SALES TAX		22,652.00	SECURITY DEPOSIT		-
SECURITY DEPOSIT		75,506.00	STALE CHEQUE		679,773.00
STALE CHEQUE		822,251.00	MISC INCOME		-
MISC INCOME		-	PICKUP SERVICE		8,500.00
PICKUP SERVICE		8,500.00	BANK CHARGES		7,931.62
			RECEIVABLE FROM SCHOLARS		-
RECEIVABLE FROM SCHOLARS		6,750.00	5,000.00		
RECEIVABLE FROM SECURITY STAFF		-	ADVANCES		400,000.00
ADVANCES		400,000.00	GRANT-IN-AID RECEIVABLE		960,637.00
BANK CHARGES		7,931.62	INTEREST ON UNSPENT BALANCE		4,399,952.00
INTEREST ON UNSPENT BALANCE		4,399,952.00	Inter Unit Account		
Inter Unit Account			BOSE INSTITUTE (COUNCIL)		930,448,140.83
BOSE INSTITUTE (COUNCIL)		858,555,303.13	IRHPA DR A LOHIA		-
IRHPA DR A LOHIA		-	IRHPA PROF.SIBAJI RAHA		
IRHPA PROF.SIBAJI RAHA			FAIR (IFCC)		220,339,423.00
FAIR (IFCC)		139,658,040.96	INTEREST PAID		26,671,204.49
INTEREST RECEIVED		26,671,204.49	Closing Balance	1	477,440,111.72
		2,339,273,771.56			2,339,273,771.56

Place : Kolkata
Date : 22/09/2015

Signed in terms of our separate Report of even date.

Sd/-
(A. Mukherjee)
Accounts OfficerSd/-
(Kamal Sing)
Accountant (cash)Sd/-
(Debdas Nandy)
OSFor C. Ghosh & Co.
Chartered AccountantsAUDITORS' REPORT
GOVERNING BODY

1.0 We have audited the attached Balance Sheet as on 31st March, 2015 and the Income & Expenditure Account for the year ended as on date of **BOSE INSTITUTE (Governing Body)**, 93/1, APC Road, Kolkata 700009. These financial statements are the responsibility of the Management of the Institute. Our responsibility is to express an opinion on these financial statements based on our audit.

We have conducted our audit in accordance with auditing standards generally accepted in India. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by, the management, as well as evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for our opinion.

2.0 On the basis of our audit as indicated in the preceding paragraph and subject to our audit observation as set out in Annexure I of the Governing Body we report that :-

- we have obtained all the information and explanations, which to the best of our knowledge and belief were necessary for the purpose of our audit.
- in our opinion, proper books of account as required, have been maintained so far as appears from our examination of those books
- the Balance Sheet and the Income & Expenditure Account dealt with by this report are in agreement with the books of account.
- in our opinion and to the best of our information and according to the explanations given to us, the said accounts, give a true and fair view in conformity with the accounting principles generally accepted in India :-



- i) in case of the Balance Sheet, of the state of affairs of the Governing Body as on 31st March, 2015 and
- ii) in case of the Income & Expenditure Account, of the Surplus for the year ended on that date.

For C. Ghosh & Co.
Chartered Accountants
(Registration No. 322547E)

Place : Kolkata

Date : 22nd September, 2015

Mahuya Ghosh
Partner
(Membership No : 058150)

AUDIT OBSERVATIONS

(Forming part of the Audit Report)

Annexure I

1. Fixed Assets Register has not been compiled for the Fund. Further, impairment of assets if any has neither been identified nor provided for. This will have an effect on year's revenue and the Fixed Assets of the Institute. (Refer AS 28 issued by the ICAI)
 2. There are certain non moving balances which needs thorough reconciliation: Old non moving balances held under Current Assets and Liabilities other than "Payable to Council"
- Cash Closing Certificate was neither made available to us nor the same could be physically verified by us.
- Investment in 7.5% Preference shares of CESC, were also not produced to us for verification.
- In absence of review of the liability/assets, the impact on the years revenue and the Net Current Assets position as at the year end of the Governing Body is indeterminate at this stage.

**BOSE INSTITUTE (GOVERNING BODY)**

93/1, ACHARYA PRAFULLA CHANDRA ROAD, KOLKATA - 700009

BALANCE SHEET AS AT 31ST MARCH 2015

	Schedule No.	As on 31/03/2015 (₹)	As on 31/03/2014 (₹)
FUNDS & LIABILITIES			
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	1	30,22,629.96	30,32,629.96
DEPOSITS & OTHER LIABILITIES	2	11,68,210.66	12,31,550.66
TOTAL		81,08,442.38	81,81,782.38
PROPERTIES & ASSETS			
FIXED ASSETS			
AS PER LAST ACCOUNT	3	23,74,712.85	23,74,712.85
INVESTMENTS	4	52,59,661.67	48,26,492.67
RECEIVABLE & DEPOSITS	5	32,795.00	32,795.00
AS PER LAST ACCOUNT	6	10,47,505.84	11,25,373.37
CASH & BANK BALANCES			
INCOME & EXPENDITURE A/C			
EXCESS OF EXPENDITURE OVER INCOME		(6,06,232.98)	(1,77,591.51)
TOTAL		81,08,442.38	81,81,782.38

INCOME & EXPENDITURE STATEMENT FOR THE YEAR ENDED 31ST MARCH 2015

Particulars	2014-15 (₹)	2013-14 (₹)
INCOME		
INTEREST ON TERM DEPOSIT	4,33,169.00	4,02,320.00
INTEREST ON SAVINGS BANK	21,110.47	20,004.00
TOTAL	4,54,279.47	4,22,324.00
EXPENDITURE		
SALARY & WAGES	21,600.00	21,600.00
ACCOUNTING CHARGES	-	-
AUDIT FEES	3,420.00	3,371.00
BANK CHARGES	618.00	652.00
EXCESS OF INCOME OVER EXPENDITURE FOR THE YEAR	4,28,641.47	3,96,701.00
TOTAL	4,54,279.47	4,22,324.00
INCOME BROUGHT DOWN AND ADJUSTED WITH LAST YEAR	4,28,641.47	3,96,701.00
BALANCE BROUGHT DOWN FROM LAST A/C (DEBIT)	(1,77,591.51)	2,19,109.49
BALANCE TAKEN TO BALANCE SHEET (DEBIT)	(6,06,232.98)	(1,77,591.51)

Place : Kolkata
Date : 22/09/2015Sd/-
(Samir Ranjan Sikdar)
Senior Professor &
Incharge-Registrar's OfficeSd/-
(Prof. Sibaji Raha)
DirectorSd/-
(A. Mukherjee)
Accounts OfficerSigned in terms of our separate Report of even date.
For C. Ghosh & Co.
Chartered AccountantsSd/-
(Kamal Sing)
Accountant (Cash)Sd/-
(Debdas Nandy)
OS**AUDITORS' REPORT**

1.0 We have audited the attached Balance Sheet of Bose Institute, Indo - FAIR Coordination Centre of P 1/12, CIT Scheme VIIM, Kolkata 700 054 as on 31st March, 2015 and the Income & Expenditure Account for the year ended as on date. These financial statements are the responsibility of the Management. Our responsibility is to express an opinion on these financial statements based on our audit.

We have conducted our audit in accordance with auditing standards generally accepted in India. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by the management, as well as evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for our opinion.

2.0 On the basis of our audit as indicated in the preceding paragraph and together with the Notes on Accounts of the Centre we report that :-

- we have obtained all the information and explanations, which to the best of our knowledge and belief were necessary for the purpose of our audit.
- in our opinion, proper books of account as required, have been maintained so far as appears from our examination of those books
- the Balance Sheet, Statement of Expenses and Receipts & Payments Account dealt with by this report are in agreement with the books of account.



iv) in our opinion and to the best of our information and according to the explanations given to us, the said accounts, give a true and fair view in conformity with the accounting principles generally accepted in India :-

- a) in case of the Balance Sheet, of the state of affairs of the Centre as on 31.1 March, 2015 and
- b) in case of the Statement of Expenses for the year ended on that date.
- c) In case of Receipts & Payments Account of the cash transaction of the Centre for the year ended as on that date

For C. Ghosh & Co.
Chartered Accountants
(Registration No. 322547E)

Place : Kolkata

Date : 22nd September, 2015

Mahuya Ghosh
Partner
(Membership No : 058150)

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 will be 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 in April 2006.

A joint declaration was signed on 7.2.2007 by the Minister for Science & Technology and Earth Sciences, Govt. of India and the Federal Minister for Education & Research, Federal Republic of Germany concerning the participation in construction and operation of the international facility for Anti-proton and Ion research. A joint statement was issued by the Chancellor of Republic of Germany and Prime Minister of India on 30.10.2007 in this regard. On 4.10.2010, the international agreement on the construction of FAIR was signed by nine countries namely Germany, Finland, France, India, Poland, Romania, Russia, Slovenia and Sweden. 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 Indian 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 as before, without changing in format for Central Autonomous Institutes.

2. Department of Science and Technology (DST) under the Ministry of Science and Technology, Govt of India vide Memo No. SR/MF/PS-01/2011 dtd 04/03/2011 mentioned under Clause 11 that a "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 decisions.

BOSE INSTITUTE (IFCC)
KOLKATA

BALANCE SHEET AS AT 31ST MARCH 2015

March 2014 (₹)	March 2015 (₹)	March 2014 (₹)	As on 31st March 2015 (₹)
307,122.00	Fund for Creation of Asset 3,07,122.00	54,732.00	Shares in FAIR GmbH 54,732.00
		252,390.00	Office Equipment 2,52,390.00
(21,626,410.47)	Unspent Grant Grant from Department of Science and Technology (Schedule-1) 3,37,61,341.51	30,000.00	Advance to Dr. R K Bhandari
101,577,992.00	Grant from Department of Atomic Energy (Schedule-2) 2,28,71,564.00		
18,019,373.00	Interest Earned (Schedule-3) 2,46,94,325.00		Bank Balances
5,618.00	Audit Fees Payable 5,618.00	518,565.53	S.B. A/c - Union Bank of India 2,70,794.51
	Payable to Bose Institute 7,480.00	17,291,501.00	Fixed Deposits 8,10,69,534.00
		80,136,506.00	Receivable from Bose Institute
98,283,694.53	8,16,47,450.51	98,283,694.53	8,16,47,450.51

STATEMENT OF EXPENDITURE FOR THE YEAR ENDED 31ST MARCH 2015

For the year ended 31st March 2014 (₹)	Particulars	For the year ended 31st March 2015 (₹)
-	Advertisement Expenses	7,130.00
-	Ad-hoc Bonus	3,454.00
5,618.00	Audit Fees	5,618.00
438.85	Bank Charges	1,045.73
5,825.00	Contingency Expenses	42,124.64
64,216.00	Honorarium Expenses	99,354.00
4,57,553.00	Meeting Expenses - IFCC	2,87,532.00
-	Overhead Charges	4,50,000.00
180,000.00	Conveyance Expenses	45,000.00
13,20,000.00	Salary	13,73,365.00
6,07,013.00	Student Support	1,67,574.00
17,617.00	Telephone Expenses	8,714.65
19,54,235.00	Travelling Expenses	27,20,308.00
1,133,225.00	Workshop	-
57,45,740.85		52,11,220.02

Place : Kolkata
Date : 19th September, 2015Signed in terms of our separate
Report of even date.For C Ghosh & Co.
Chartered AccountantsSd/-
(Accountant)
Bose InstituteSd/-
(Accounts Officer)
Bose InstituteSd/-
(Accounts & Administrative Officer)
Bose Institute IFCCSd/-
(Director)
Bose InstituteBOSE INSTITUTE (IFCC)
KOLKATA

Receipt and Payment Accounts for the year ended 31.03.2015 (FAIR)

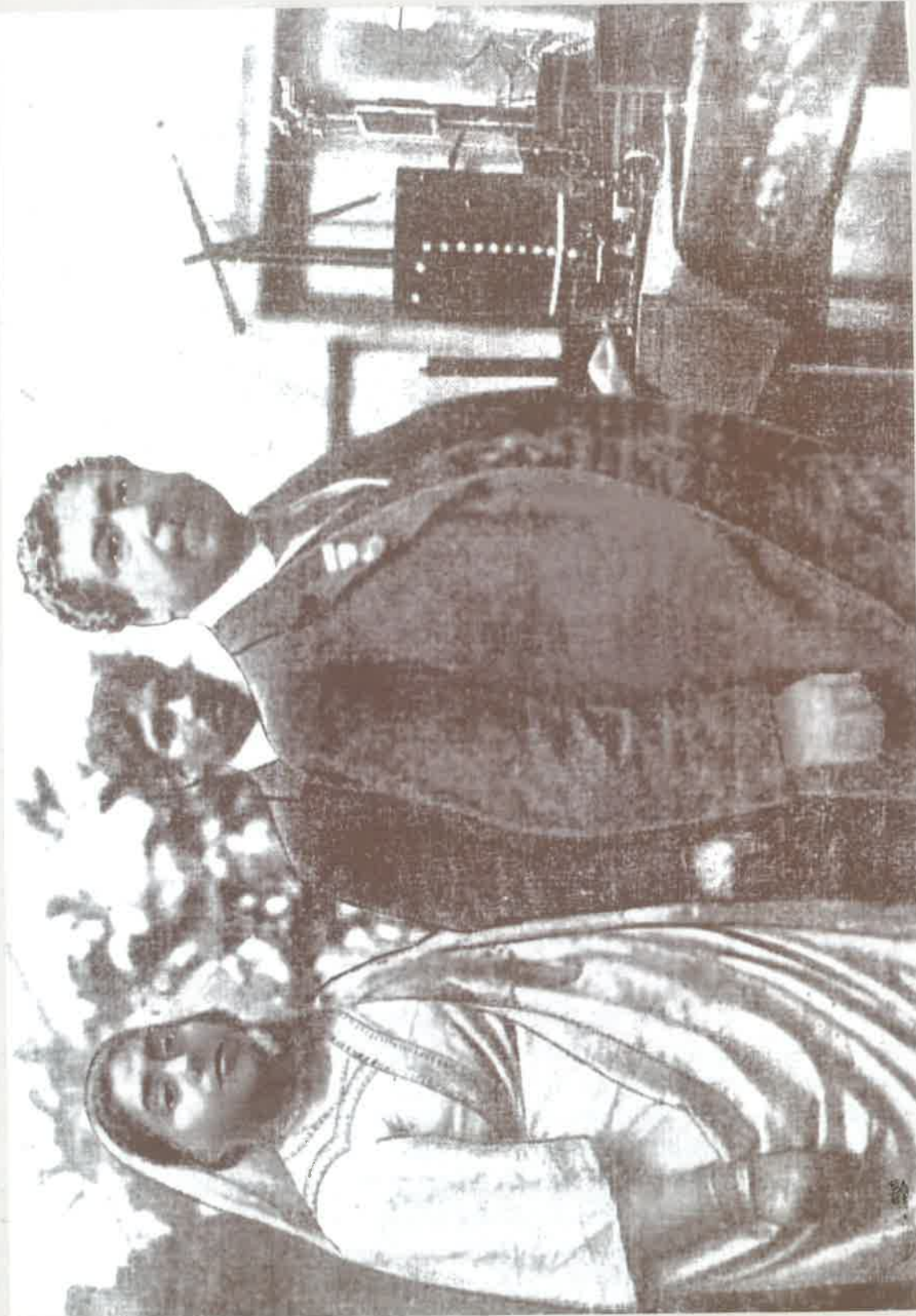
Particulars (₹)	Particulars (₹)
Opening Balance	
S.B A/c Union Bank of India	518,565.53
Fixed Deposits	17,291,501.00
GRANT FROM D.A.E.	-
GRANT FROM D.S.T	139,305,400.00
GRANT FROM D.S.T (IFCC Exp.)	-
Interest on SB A/c	264,416.00
Interest on FD (Term Deposits)	6,410,536.00
Advance	1,751,161.00
Honorarium Expenses	-
Liability for Audit Fees	5,618.00
Meeting Expenses - IFCC	90.00
Profession Tax	7,480.00
TDS (Party: ₹ 3076.00 + Salary: ₹ 126972.00)	130,048.00
Sundry Creditors	
(CSIR-CMERI & IBIS Hotel, Pune)	3,998,287.58
Travelling Expenses	1,183,909.00
	Advance 1,721,161.00
	Honorarium Expenses 99,354.00
	Liability for Audit Fees 5,618.00
	Meeting Expenses - IFCC 287,622.00
	Profession Tax 7,480.00
	TDS (Party: ₹ 3076.00 + Salary: ₹ 126972.00) 130,048.00
	Sundry Creditors
	(CSIR-CMERI & IBIS Hotel, Pune) 3,998,287.58
	Travelling Expenses 3,904,217.00
	Audit Fees 5,618.00
	Ad-hoc Bonus 3,454.00
	Advertisement Expenses 7,130.00
	Bank Charges 1,045.73
	Contingency Expenses 42,124.64
	Overhead Charges 450,000.00
	Conveyance 45,000.00
	Salary 1,373,365.00
	Student Support 167,574.00
	Telephone Expenses 8,714.65
	Office Equipment -
	FAIR Remittance (4th Cash Contribution) 152,709,534.00
	Vaccum Chamber (In-Kind) 190,058.00
	Beam Stopper (In-Kind) 3,910,000.00
	Detector [FAIR Experiment] (In-kind) 603,264.00
Inter Unit Account	Inter Unit Account
Bose Institute (Council)	7,480.00
Scheme/Project	220,089,423.00
	Bose Institute (Council) 544,876.04
	Scheme/Project 139,408,040.96
	Closing Balance
	S.B A/c Union Bank of India 270,794.51
	Fixed Deposits 81,069,534.00
	390,963,915.11
	390,963,915.11

Place : Kolkata
Date : 19th September, 2015Signed in terms of our separate
Report of even date.For C Ghosh & Co.
Chartered AccountantsSd/-
(Accountant)
Bose InstituteSd/-
(Accounts Officer)
Bose InstituteSd/-
(Accounts & Administrative Officer)
Bose Institute IFCCSd/-
(Director)
Bose Institute

Compliance Report of Bose Institute on the Audit Observations for the Financial Year 2014-15

Sl. No	Audit Observation	Replies
1.	Delays in deduction and payment of TDS noted, resulting in possible claims from the Income Tax department on account of defaults. There are also certain old Statutory balances - Rs. 1.91 Lacs (Dr.) and Rs. 0.34 Lacs (Cr) which requires reconciliation.	Delay in payment of TDS happened in very few cases, but all-out effort is given for deduction and deposition of TDS within due date. Reconciliation of old Statutory balances are under process.
2.	Assets acquired from "Institute Development and Modernization Fund" amounting to Rs. 666.58 Lacs held under the head "Investment from Earmarked Funds" has not been capitalised. Similarly, Work In Progress includes certain non moving items totaling to Rs. 22.75 Lacs (Dr) which requires thorough reconciliation to ascertain whether the assets have been already put into use but not as yet Capitalised. Without a detailed Fixed Assets Register in place, the adequacy and correctness of valuation of the assets is difficult to ascertain. Further, Impairment of assets if any has neither been identified nor provided for. The above observations may have an effect on the year's revenue and the Fixed Assets position of the Institute. (Refer AS 9, AS 10 and AS 28 issued by the ICAI)	Draft Fixed Asset register of Bose Institute is prepared and verification process is in progress. With the finalization of Fixed Asset register, asset acquired under "Institute Development and Modernization Fund" will be capitalized. Adequacy and correctness of valuation of the assets will be ascertained. Since the accounting of Bose Institute is done in Historical Cost basis, therefore impairment of assets is not considered for.

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| <p>3. Internal Audit has not been carried out in the Institute which in our opinion should be implemented considering the nature, complexity and size of the activity of the Institute.</p> <p>4. The Institute has quite a number of staff on contracted employment, who are not being paid either Provident Fund or ESIC. Future liability on account of statutory requirements, if any has neither been determined nor provided which may have an effect on years revenue and Net Current Assets of the Institute</p> <p>5. Accounting for Retirement Benefits towards Gratuity and Leave Encashment for the employees has neither been ascertained nor provided for in the Financial Statements as per requirement of AS 15 issued by the ICAI. However Institute contends that since the entire fund for Retirement Benefits is received from DST, no such provision in this respect is required.</p> <p>6. Expenses are generally accounted for in the Financial Statements on cash basis which is not in accordance with the requirement of AS 9 issued by the ICAI.</p> <p>7. There are pending cases against the Institute where future liability if any, is indeterminate in absence of adequate details. Valid contract with the Lawyers may be entered into as recommended by the Council of the Institute.</p> <p>8. Without review of the Old outstanding balances of Rs. 57.02 Lacs (Dr) and Rs. 74.44 Lacs (Cr) included in Current Assets / Liabilities, possible impact on the years revenue and the Net Current Assets position as at the year end of the Institute is indeterminate at this stage.</p> | <p>The cadre restructuring process of Bose Institute is under process, in which it is proposed to strengthen the Internal Audit department.</p> <p>Medical facility is extended to the staff on contractual employment as per approval of Council of Bose Institute. Decision may be taken for extension of EPF to contractual employees.</p> <p>Pension and retirement benefit funds are received from the DST on the basis of budgeted provisions duly approved by the Finance Committee every year and also duly ratified by the council of Bose Institute, hence such provision is not followed.</p> <p>Since all expenses are matched with the receipt of Grant-in-aid from Department of Science and Technology against budget prepared and approved in advance for a specific financial year, therefore expenses are charged on cash basis only except a few accrued expenses.</p> <p>There is no future liability evidenced from the report of lawyer given for the financial year 2014-15.</p> <p>Reconciliation of the Old outstanding balances of Current Assets / Liabilities will be done before finalization of annual accounts of 2015-16.</p> |
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Acharya J.C. Bose with Lady Abala Bose and his Assistant Dr. Sen beside the apparatus Bose invented for recording the sensitiveness of plants to electricity (1914)

On going project during 2014-15

Sl. No.	Name of the Project	Duration	Guide	Opening Balance as on 01.04.14	Grant Received during 2014-15	Other Receipts during 2014-15	Expenditure during the year 2014-15	Debit / Credit Balance as on 31.03.15	
1	DBT - "Setting up of National Facility on Interactive Graphics Computer System for Biomolecular Modeling, molecular dynamics & structures"	extended upto 31.03.2017	Pror Pinakpani Chakrabarti, B.I.C	381	607729.42	588005.00	8047.00	725790	477,991.42
2	DBT - "Centre of Excellence (COE) at Bose Institute"	upto 31.03.2017	Prof. P. Chakrabarti, B.I.C.	775(A)(B)	4,130,075.76	2,205,242.00	125,447.00	3,813,180.00	2,647,584.76
3	DST - "Award of J.C.Bose Fellowship to Prof. Pinakpani Chakrabarti"	03.05.2007 to 02.05.2012 extended upto 02.05.2017	Prof. Pinakpani Chakrabarti, Biochemistry	795	(387,029.38)	1,800,000.00	1,247,245.26	165,725.36	
4	RCI - "Studies on Microwave Scattering (SMS)(DRDO)"	Extended upto 27.11.2014	Prof. Sibaji Raha, Physics	803	4,644,820.15	-	4,260,950.00	383,870.15	
5	ICMR - "Centre of Plant DNA Finger- printing and diagnostics for North East and Eastern India"	Extended upto 31.08.2014	Prof. Swati Sen Mandi, DPB	805	573,822.95	-	531,754.42	42,068.53	
6	CCRH- "Role of homeopathic medicines -study"	from 09.07.2008 extended upto 30.06.2014	Prof. Tanya Das & Prof. G. Sa, DMMI	827	233,786.00	-	237,070.73	(3,284.73)	
7	DBT - "Regulation of microRNA transcription and biogenesis by fungal-stress in tomato"	01.06.2010 to 31.05.2013 extended upto 31.05.2014	Dr. Pallob Kundu, DPB	918	191,984.14	755,000.00	8,253.00	841,984.90	113,252.24
8	DAE - "Raja Ramanna Fellow"	Extended upto 01.12.2014	Prof. B. Bhattacharyya, Biochemistry	928	406,967.00	80,000.00	490,639.00	(3,672.00)	
9A	DBT - "Generation of Salt tolerant rice Plants : A translational approach"	06.10.2010 to 05.10.2015	Prof. A. N. Lahiri Majumdar, DPB	929	(5,131.66)	2,783,835.00	27,398.00	3,112,210.00	(306,108.66)
9B	DBT - "Generation of Salt tolerant rice Plants : A translational approach"	06.10.2010 to 05.10.2015	Prof. D. N. Sengupta, Division of Plant Biology	929	(87,671.00)	1,063,000.00	11,693.00	1,047,496.00	(60,474.00)
9C	DBT - "Generation of Salt tolerant rice Plants : A translational approach"	06.10.2010 to 05.10.2015	Dr. Shubho Chaudhry, Division of Plant Biology	929	(66,482.66)	891,848.00	10,762.00	925,552.00	(89,424.66)



10	DST - "Stress-induced regulation of extracytoplasmic sigma factors in mycobacteria"	07.12.2010 to 06.12.2013 extended upto 20.11.2014	Prof. Manikuntala Kundu, Chemistry	932	497,028.86	-	491,469.06	5,559.80
11	DBT - "Purification and characterization of bioactive natural antioxidant immunomodulator and anticancer products from <i>Dioscorea alata</i> L., of North Eastern region of India"	17.02.2011 to 16.02.2014 extended upto 17.08.2014	Prof. N. Mandal, DMM	953	14,122.24	-	13,372.00	750.24
12	DAE - "Raja Ramanna Fellow" extended upto 28.02.2016	18.04.2011 to 17.04.2014	Prof. A. N. Lahiri Majumdar, DPB	957	267.00	629,733.00	626,661.00	3,339.00
13	CSIR - "Studies on the protective of antioxidant protein molecule purified from the herb, <i>Phyllanthus niruri</i> : Signal transduction mechanism in organ pathophysiology"	Extended upto 30.09.2014	Prof. P. C. Sili, DMM	966	1,597.00	273,200.00	270,400.00	4,397.00
14	ICAR(NFBSFARA)-"Development of pod borer resistant transgenic pigeonpea and chickpea"	01.01.2011 to 31.12.2013 extended upto 31.12.2016	Prof. Sampa Das, DPB	971	(284,908.45)	2,267,326.00	417,882.45	2,095,094.90
15	CSIR - "Understanding the molecular mechanism of the energy homeostasis in normal and malignant cells: the role and inter-relationship of creatine kinase and AMP-activated protein kinase"	13.05.2011 to 31.05.2014 extended upto 30.04.2015	Prof. Manju Roy, DMM	972	119,876.00	606,841.00	677,751.00	48,966.00
16	CSIR- "Isolation of the conditional lethal mutants of mycobacteriophage L1 repressor possessing high operator binding affinities and development of an expression vector for my mycobacterial systems"	01.06.2011 to 31.05.2014	Prof. Subrata Sau, Biochemistry	974	83,547.30	33,333.00	97,134.00	19,746.30
17	Welcome Trust & DBT India Alliance - "Award of Intermediate Fellowship to Dr. Ajit Bikram Dutta" - 	01.08.2011 to 31.07.2016	Dr. Ajit Bikram Dutta, Biochemistry	978	(1,094,205.19)	3,557,595.00	3,558,395.55	(1,095,005.74)

18	CSIR - "Function of molecular chaperone Hsp70 in quality control of protein kinase"	30.06.2011 to 30.06.2014 extended upto 31.07.2014	Dr. Atin Kr. Mandal, DMM	987	(1,197.39)	133,334.00	132,129.00	7.61
19	CSIR - "Molecular mechanisms of tumor progression : Role of tumor derived products in mediating tumor cell growth, motility and metastasis"	01.07.2011 to 30.06.2014 extended upto 31.07.2015	Dr. Kaushik Biswas, DMM	988	264,180.14	136,000.00	376,225.00	23,955.14
20	DBT - "Identification of the host cell factors responsible for survival and death of leishmania"	27.09.2011 to 26.09.2016	Prof. Subrata Majumdar, DMM	992	28,043.00	-	-	28,043.00
21	Indo-Korean - "Mycobacterium tuberculosis infection : understanding the role of microRNAs in regulating the immune response of macrophages"	23.08.2011 to 22.08.2014	Prof. Joyoti Basu, Chemistry	993	289,612.38	-	25,756.00	218,608.38
22	DBT - "Role of protein complexes and protein protein interaction network in eukaryotic protein evolution"	26.12.2011 to 25.12.2014	Prof. Tapash Ch. Ghosh, BIC	1003	(76,242.00)	714,600.00	384,667.00	253,691.00
23	CSIR - "Structural study of de novo designed novel antifreeze peptide s from leucospondium antacticum antifreeze protein-1 (AFP-1)"	23.02.2012 to 28.02.2015	Dr. Anirban Bhunia, Biophysics	1005	(42,891.78)	393,774.00	352,368.86	(1,486.64)
24	CSIR - "Role of microRNAs in the immune response to mycobacterial infection"	01.07.2011 to 30.06.2014	Prof. Joyoti Basu, Chemistry	1006	60,529.02	36,414.00	96,905.00	38.02
25	CSIR - "Understanding the origin(s), evolution and interaction(s) of different molecular mechanisms of chemotrophic sulfur oxidation : Elucidating the metabolic strageisges of early life"	01.01.2012 to 31.12.2014	Dr. Wriddhiman Ghosh, Microbiology	1007	(173,473.64)	569,483.00	395,905.00	104.36



26	CSIR - "Theoretical and experimental analyses of bacterial GxRS-RNA Glx_GatCAB Co-evolution and the molecular basis of their interaction"	01.02.2012 to 31.01.2015	Prof. Gautam Basu, Biophysics	1008	(96,891.18)	346,280.00	188,921.00	60,467.82
27	CSIR - "Synthesis of oligosaccharides corresponding to shigella dysenteriae for the preparation of glycoconjugates to treat shigelosis"	01.04.2012 to 31.03.2015	DR. Anup Kr. Misra, DMM	1009	20,958.67	350,000.00	371,507.67	(549.00)
28	DBT - "Exploration of lichens from Barak Valley of Southern Assam and Arunachal Pradesh (North East India) and isolation phytochemicals and bioprospecting of some selected lichens species"	23.04.2012 to 22.04.2015	Dr. Nipendranath Mandal, DMM	1031	(133,286.88)	478,000.00	493,925.00	(149,211.88)
29	DST - SERC Fast Track Scheme - "Molecular signaling involved in pathophysiological action of common air pollutant 'benzo(a)pyrene' in tyesticular DNA damage and apoptosis in connection to male infertility : possible protection by natural aryl hydrocarbon receptor antagonists"	01.04.2012 to 31.03.2015	Dr. Kuladip Jana, DMM	1032	18,366.00	500,000.00	354,220.00	164,146.00
30	DBT - "Sys TB : A network program for resolving the intracellular dynamics of host pathogen interaction in TB infection"	09.01.2012 to 08.01.2017	Prof. Joyoti Basu, Chemistry	1033	507,944.43	2,616,225.00	57,909.00	2,612,671.00
31	DST - "Synthesis of oligosaccharide antigens of the Enterohemorrhagic Escherichia coli (EHEC) strains for the preparation of glycoconjugates" ...	01.09.2011 to 31.08.2014	Dr. Anup Kr. Misra, DMM	1036	18,778.00	100,000.00	9,852.00	128,564.00
								66.00

32	SERB(DST)-IRHPA-II - "Study of cosmic ray interactions and cosmic ray aerosol cloud connection in the context of the regional climate change"	01.08.2012 to 31.07.2017	Prof. Sibaji Raha, Physics	1042	77,044,593.29		36,157,400.02	40,887,193.27
33	DBT - "Mechanistic insight into the role of conformational modulations in driving BCI2's apoptotic network : Structural dynamics to therapeutic design"	21.02.2012 to 20.02.2015	Dr. Subhra Ghosh Dasitdar, BIC	1049	479,556.13	100,000.00	10,952.00	553,346.00
								37,162.13
34	DBT - "Role of DNA dependent protein kinase in transcription control in human cells"	25.06.2012 to 24.06.2015	Dr. Mahadeb Pal, DMM	1050	94,331.81	841,474.00	16,208.00	779,551.00
								172,462.81
35	DBT - "Identification and characterization of 19S proteasomal component of the early diverging eukaryote Giardia lamblia"	29.08.2012 to 28.08.2015	Dr. Srimonti Sarkar, Biochemistry	1051	(132,580.62)	1,278,773.00	5,526.00	885,351.00
								266,367.38
36	DST - "Targeted alteration of MAPK family members ERK and p38MAPK/JNK to channelize oncogenic Ras-induced proliferative-signaling into apoptotic signaling"	28.05.2012 to 27.05.2015	Prof. Gauri Sankar Sa, DMM	1054	1,847,373.99	300,000.00	1,814,022.18	333,351.81
37	CSIR - "Functional characterization of the lipid-binding FYVE protein from Giardia lamblia"	01.01.2012 to 31.12.2015	Dr. Srimonti Sarkar, Biochemistry	1067	332,879.81	390,200.00	650,413.00	72,666.81
38	CSIR - "Mechanistic insights into dendritic cell maturation and its role in Leishmania donovani infection : Emphasis on dendritic cell-based anti-leishmanial therapy"	01.01.2013 to 31.12.2015	Prof. Subrata Majumdar DMM	1068	18,873.00	390,200.00	390,192.00	18,881.00
39	DBT - "The role of two component systems and cell division proteins in mycobacterial physiology"	29.09.2012 to 28.09.2015	Prof. Manikuntala Kundu, Chemistry	1076	(70,446.18)	1,547,000.00	10,600.00	1,675,869.88
								(188,716.06)



40	DBT - "Understanding causes of codon usage bias in organisms"	06.12.2013 to 05.12.2014	Prof. Tapash C. Ghosh, BIC	1079	124,243.00	311,000.00	329,365.00	105,878.00
41	DAE - "Remodeling the cellular calcium homeostasis by ethyl-4-(3-nitro)-phenyl-g-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (Nifetipimine) : a mechanistic approach towards cancer regression and immune rejuvenation"	01.04.2013 to 31.03.2016	Prof. P. C. Sen, DMM	1080	31,239.46	849,903.00	11,576.00	807,392.03
42	SERB(DST) - "Quantum entanglement & distributed quantum information processing"	21.01.2013 to 20.01.2016	Dr. Somshubro Bandyopadhyay, Physics	1082	(179,949.00)	1,000,000.00	878,044.00	(57,993.00)
43	CSIR - "Understanding molecular mechanisms of MYMIV-resistance in Vigna mungo through genomic approach"	01.03.2013 to 28.02.2014	Prof. Amita Pal, CSIR Emeritus Scientist, DPB	1083	290,484.00	586,200.00	554,231.00	322,453.00
44	SERB(DST) FAST TRACK Scheme - "Comprehensive Gromicrobiology of two high temperature hydrothermal systems of India: Paradigms of primitive metabolisms and biogeochemical evolution, prospects of of biotechnological resource"	07.08.2012 to 06.08.2015	Dr. Wridhiman Ghosh, Microbiology	1089	2,127.23	400,000.00	404,662.00	(2,534.77)
45	SERB(DST) FAST TRACK Scheme - "Design, Synthesis and mechanistic insights of novel antimicrobial peptides (AMP) using high resolution NMR spectroscopy: Role of outer membrane permeability and DNA-binding"	14.01.2013 to 13.01.2016	Dr. Anirban Bhunia, Biophysics	1090	(508.52)	-	-	(508.52)
46	DBT - "Host phosphatases and kinases participating in CD40-induced anti-leishmanial vs. pro-leishmanial pathways"	26.03.2013 to 25.03.2016	Prof. Subrata Majumdar, DMM	1095	193,524.00	819,676.00	10,007.00	921,709.00

47	IITM(MoES) - "Study on biosphere-atmosphere exchange of carbon dioxide, water vapor and energy in a tropical high altitude forest canopy at Eastern Himalaya"	15.06.2012 to 14.06.2015	Dr. Abhijit Chatterjee, ESS	1097	2,101,469.00	-	1,872,842.00	228,627.00
48	DAE - "Production and molecular characterization somatic hybrid mushroom strains between Agaricus bisporus + Pleurotus florida and Agaricus bisporus + Calocybe indica"	11.09.2013 to 10.09.2016	Prof. S. R. Sikdar, DPB	1099	348,706.00	619,659.00	14,511.00	809,209.00
49	DBT - "Micro-Regulatory Networks in Leukemia Stem cells (RHYI)"	07.02.2013 to 06.02.2016	Dr. Zhumur Ghosh, BIC	1105	459,583.00	617,000.00	15,193.00	961,216.31
50	DBT - "Biophysical and structural aspects of oncogenic G-Quartets bound to drugs : screening, high resolution NMR and low resolution spectroscopy (RGYI)"	13.08.2013 to 12.08.2016	Dr. Subhansu Chatterjee, Biophysics	1107	248,288.00	-	4,482.00	256,050.00
51	DAE - "Exploration of promoters of biotechnological importance from metagenomic DNA"	24.06.2013 to 23.06.2016	Dr. Tapan Kr. Dutta, Microbiology	1110	164,457.00	497,424.00	11,695.00	620,133.00
52	DAE - "Studies on the binding mechanism of a global virulence regulator SarA of staphylococcus aureus"	01.11.2013 to 31.10.2016	Dr. Subrata Sau, Biochemistry	1111	340,476.61	285,588.00	2,667.00	559,201.21
53	DST - "Targeted delivery of nanoconjugated methylglyoxal to cancer cells and understanding the bioenergetic difference between normal and malignant cells at the molecular level"	26.09.2013 to 25.09.2016	Prof. Manju Ray, Biophysics	1112	1,307,739.00	900,000.00	35,744.00	1,498,170.49
54	DBT - "In vitro study of input-output robustness of MprAB signaling pathway in Mycobacterium tuberculosis"	24.06.2013 to 23.06.2016	Dr. Suman Kr. Banik, Chemistry	1113	189,191.65	-	-	172,664.00



55	SERB(DST) - "Molecular mechanisms of HSF1 mediated chromatin remodelling during transcriptional inductions of human hsp 70 by stressors"	29.07.2013 to 28.07.2016	Dr. Mahadeb Pal, DMM	1114	1,010,195.90	500,000.00	1,435,814.19	74,381.71
56	DBT - "Characterization and design of inhibitors of Mycobacterium tuberculosis transcription"	14.10.2013 to 13.10.2016	Dr. Jayanta Mukhopadhyay, Chemistry	1115	3,298,336.20	-	56,874.00	2,908,350.33
57	SERB(DST) - "Mapping the molecular mechanisms of resistance to apoptosis switch over of non small cell lung carcinoma by curcumin : an approach towards chemo sensitization"	01.12.2013 to 30.11.2016	Prof. Tanya Das, DMM	1116	217,375.77	700,000.00	778,113.00	139,262.77
58	MOES - "Pre-seismic geochemical monitoring continuation"	01.06.2013	Prof. Bikash Sinha	1118	(471,788.00)	-	-	(471,788.00)
59	CSIR - "Diagnosis of mould allergy among inhabitants of urban and rural peoples of the gangetic plains of West Bengal through aerobiological and immunochemical studies"	01.12.2013 to 30.11.2016	Prof. Swati Gupta Bhattacharya, DPB	1123	132,119.00	332,450.00	448,618.00	15,951.00
60	CSIR - "Investigating the role of ARID/HMG4 (Atlg4880) protein in transcription regulation of cold stress responsive genes"	01.10.2013 to 30.09.2016	Dr. Shubho Chaudhuri, DPB	1124	695,399.00	500,000.00	1,188,856.59	6,542.41
61	DBT - "Studies on the mould spore diversity as environmental allergen in outdoor and indoor environments of urban and rural areas of Agartala, Tripura"	29.01.2014 to 28.01.2017	Prof. Swati Gupta Bhattacharya, Department of Plant Biology	1125	461,892.00	-	8,960.00	447,989.00
62	DBT - "Studies on the efficacy of flavonoid and non-flavonoid polyphenols against chronic inflammation induced disease pathogenesis"	03.03.2014	Dr. Kaushik Biswas, DMM	1127	1,269,000.00	-	31,318.00	1,157,664.28

63	DST - "Training of four different income generation schemes to the Schedule Caste people and setting up individual scheme in the beneficiaries own land for their financial upliftment"	05.02.2014 to 04.02.2015	Prof. Samir Ranjan Sikdar, DPB	1128	1,047,630.00	-	661,720.00	385,910.00
64	DBT - "Setting up of a state-of-the-art 600 MHz FT-NMR with cryoprobe facility at Bose Institute"		Prof. Gautam Basu, Biophysics	1135	89,526,464.00	-	3,576,977.00	6,213,715.67
65	DBT - "Carbon monoxide conversion using native hydrogenogenic micro-organisms for sulphate rich wastewater treatment"	31.03.2014 to 30.03.2015	Prof. Tapan Kumar Dutta, Microbiology	1138	-	662,000.00	8,191.00	639,438.00
66	SERB - "Functional Analysis of the DNA polymerase lambda gene and the protein from Indica Rice Cultivars"	08.07.2014 to 07.7.2017	Prof. D. N. Sengupta, DPB	1139	-	1,535,200.00	-	741,238.00
67	DBT - "Binning stochastic phenotypic states of cancer cell population in different color box"	02.06.2014 to 01.06.2017	Prof. Tanya Das, DIMM	1150	-	4,310,800.00	125,615.00	1,083,124.75
68	DST - "ALICE - A Large Ion Collider Experiment (ALICE) upgrade, operation and utilization"	10.07.2014 to 31.12.2019	Prof. Sibaji Raha, Physics	1154	-	10,700,000.00	-	1,207,168.00
69	CSIR - "Phenotypic heterogeneity in cell populations: A search for physical principles"	01.09.2014 to 31.08.2017	Prof. Indrani Bose, CSIR Emeritus Scientist, Physics	1163	-	440,000.00	-	121,810.00
70	CSIR - "Understanding the evolutionary origin and mechanism of action of a putative primase-polymerase encoded by the mycobacterial plasmid pAL5000"	01.10.2014 to 30.09.2017	Prof. Sujoy K. Das Gupta, Microbiology	1165	-	932,000.00	-	788,850.00
71	SERB - "Investigating the genome wide changes in Histone H3K27 acetylation and gene expression in rice during cold stress"	01.09.2014 to 31.08.2017	Dr. Shubho Chaudhuri, DPB	1168	-	2,750,000.00	-	2,206,326.20



72	CSIR - "Exploring membrane-associated NAC-transcription factors (NAC MTFs) in tomato to apprehend membrane mediated signaling during pathogenesis"	01.10.2014 to 30.09.2017	Dr. Pallob Kundu, DPB	1171	382,000.00	248,067.00	133,933.00
73	DBT - "Understanding the role of tumor derived glycosphingolipids in carcinogenesis: An in vivo approach"	12.11.2014 to 11.11.2017	Dr. Kaushik Biswas, DMM	1172	2,081,000.00	872,321.00	1,232,574.00
74	DBT - "Raf1 quality control and development of pathophysiological conditions"	01.11.2014 to 31.10.2017	Dr. Atin Kr. Mandal, DMM	1173	3,139,000.00	48,446.00	849,748.00
75	DAE - "The role of the secreted antigenRv0009 of Mycobacterium tuberculosis in modulating signaling in macrophages"	24.10.2014 to 23.10.2017	Prof. Joyoti Basu, Chemistry	1174	989,275.00	13,319.00	766,075.00
76	CSIR - "Investigation of the archaeal diversity and activity in Sundarbans mangrove sediment, India"	01.01.2015 to 31.12.2017	Dr. Abhrajyoti Ghosh, Biochemistry	1177	791,000.00	124,455.00	666,545.00
77	DBT - "Identification and characterization of micro RNAs (miRNAs) in Penaeus monodon"	24.03.2015 to 23.03.2018	Prof. Nipendranath Mandal, DMM	1180	1,785,800.00	50,000.00	1,735,800.00
78	ICMR - "Systematic discovery of biomarkers of asthma caused by common environmental allergens using human plasma proteomics, cytokine profiling and network biology - a system approach to drug discovery"	01.03.2015 to 28.02.2018	Prof. Swati Gupta Bhattacharya, DBP	1184	-	-	-
79	DBT - "TLR2-dependent engagement of the host cell kinases and phosphatases that dictate disease progression or resolution"	30.1.2015 to 29.01.2017	Prof. Subrata Majumdar, DMM	1192	-	-	-

The 130th Birthday of Prof. Debendra Mohan Bose was celebrated on 26th November 2014 at the Main Campus Lecture Hall of the Institute. Prof. A.K. Barua of Indian Institute of Engineering, Science & Technology, Shibpur, presided over the function. On this occasion, the **D. M. Bose Memorial Lecture** on the topic **A brief history of the Standard time : the energy and non-energy consequences of adjusting the Indian Standard Time** was delivered by **Prof. D. P. Sengupta**, Visiting Professor, National Institute of Advanced Studies, Bangalore, where he proposed shifting IST by half an hour to GMT +6 hours, and discussed the consequences of such an action.

