



ANNUAL REPORT
OF
BOSE INSTITUTE
FOR
2013-2014

Bose Institute

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Kolkata -700 009

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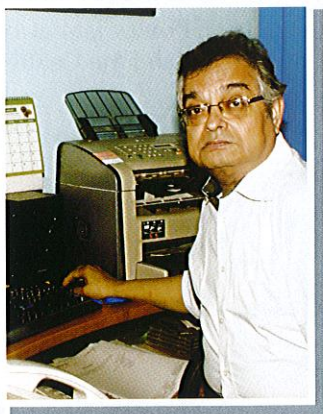
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From the Director's Desk



I am very happy to present the Annual Report of Bose Institute for the year April 1, 2013 till March 31, 2014. 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 readers for their continued support and encouragement, so that we can continue to do our part in bringing about 'the greater India yet to be'.


Sibaji Raha
Director,
Bose Institute

Laying of Foundation Stone for the Tagore Centre for Natural Sciences and Philosophy at Bose Institute

Foundation Stone for the Tagore Centre for Natural Sciences and Philosophy (TCNSP) was laid at Bose Institute on June 19, 2013. The institute is a collaborative effort between Bose Institute and the Centre for Natural Sciences and Philosophy, headed by Prof. Bikash Sinha.



His Excellency **M. K. Narayanan**, Governor of West Bengal, at the Foundation Stone laying session for TCNSP on June 19, 2013 (from left: **Prof. Sibaji Raha**, Director, Bose Institute, **M. K. Narayanan**, Governor of West Bengal, **Soumitra Chatterjee**, Film actor and poet, **Prof. Bikash Sinha**, **Prof. Sushanta Dattagupta**, Vice-chancellor, Visva-Bharati and **Dr. T. Ramasami**, Secretary, Ministry of Science and Technology, Govt. of India).



BOSE INSTITUTE

Established: 30th November, 1917

Introduction

Bose Institute was founded by Acharya Sir Jagadis Chandra Bose in 1917 for the advancement of science and dissemination of knowledge. The Institute has served the nation for the past 97 years through its pursuit of advancement of knowledge in science and technology and by developing highly competent and able scientific manpower for the country. The Institute has on its staff highly qualified and experienced scientists devoted to original and path breaking research in the fields of Plant Sciences, Structural Biology, Molecular Biology, Biomedical Sciences, Biotechnology, Quantum Mechanics, Astrophysics and Condensed Matter Physics. Bose Institute started with three original departments, Botany, Chemistry and Physics. With time more departments were added the Animal Physiology Section (1930), Department of Microbiology (1942), Department of Biochemistry (1974), the Plant Tissue Culture Section (1976, subsequently renamed Plant Molecular & Cellular Genetics Section in 1989), Department of Biophysics (1985), the Environmental Science Section (1992) and the Immunotechnology Section (1992). Very recently, a division of Molecular Medicine has been established, absorbing the sections of Animal Physiology and



Immunotechnology, along with the induction of a few scientists from the Departments of Chemistry and Microbiology. In addition, the institute hosts support and service centres like the Central Instruments Facility (CIF), the Distributed Information Centre (DIC), Library, Workshop, J.C. Bose Centre (comprising the Museum and the Publication sections). The wide-ranging and comprehensive base of available scientific infrastructure at Bose Institute also comprises the Acharya J.C. Bose High Altitude Research Centre at Darjeeling and the experimental field stations at Falta, Madhyamgram and Shyamnagar. Recent augmentations include the establishment of a National Facility on Proteomics and Genomics, a National Facility on Astroparticle Physics and Space Sciences, a Centre of Excellence in Bioinformatics, a Rural Biotechnology Training Centre at Falta and the J.C. Bose Biotechnology Innovation Centre based at the Madhyamgram campus. The facilities available in the institute for scientific enquiry and its applications also cater regularly to the scientists from several universities and research centres in the country. Special efforts have been undertaken to upgrade and modernize the library of Bose Institute during the recent years.

The eminence of Bose Institute scientific research spanning a wide range of disciplines is evident from the large number of research publications in the most competitive peer reviewed international and national journals, the recognition received by the scientists in the form of S.S. Bhatnagar Prize, INSA young scientist award, fellowship of the National Science Academies, fellowship of the Third World Academy of Science, Nehru Fellowship, K.S. Krishnan Fellowship, 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

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

Plant scientists of Bose Institute are working on different fundamental topics of plant biology, especially on understanding of various biotic and abiotic stress-induced patho-physiological changes in plant and crop yield related problems. To address these issues, for the last several years, proteomic and transcriptomics approaches have been taken. Using Next Generation Sequencing (NGS) and other molecular techniques attempts are being made to bioprospect novel genes/proteins/regulatory elements. Recent initiatives have also been undertaken to understand epigenetic, transcriptional and post-transcriptional modifications and small RNA regulators of key genes and upstream elements. The effective exploitation of these novel genes and regulatory elements are being continued to improve the plant performance in the field; and to combat biotic and abiotic stresses of crop plants.

II. Structural Studies and Biophysical Problems :

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.

III. Computational Biology :

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.

IV. Molecular Medicine :

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.

V. Basic and Applied Microbiology :

Genomic approaches have been taken to study the basic biology of microbes leading to useful insights into the mechanisms of their growth, proliferation and cell-cycle regulation. Molecular mechanisms underlying the processes by which some of these microbes cause infectious diseases are being elucidated. Identification of microorganisms with a potential for bioremediation is also under study.

VI. Systems Biology :

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 signalling networks in host cells. Mathematical modelling has been employed to understand stress responses in mammalian cells and in bacterial pathogens.

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

The Department of Physics contributes both to fundamental knowledge as well as applications relevant to industry and society in general. The Department's current research activities are in the areas of 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, Nuclear and High Energy Physics, Astroparticle Physics and Cosmology, Physics Relativistic Heavy Ion Collisions. Recently, intense activities have also been initiated in Millimeter Wave and Microwaves as well as atmospheric sciences.

In other experimental stations attempts are being put forward to translate the knowledge acquired at plant molecular biological laboratories to the field.

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. Prof. Debi Chakravarti
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]
4. Shri Swami Atmapriyananda] Two eminent and active scientists in the area of research pursued in B.I. nominated by the Governing Body. They may not necessarily be members of the Governing Body.
5. Prof. MRS Rao]
6. Prof. JP Khurana] Two eminent and active Scientists to be nominated by the DST
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.

Institutional Projects for the 12th five-year Plan (2012-2017)

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

Dr. Sampa Das (Coordinator), Dr. D. N. Sengupta, 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

II. Structural Studies and Biophysical Problems :

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

III. Computational Biology :

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.

IV. Molecular Medicine :

Dr. P. C. Sen (Coordinator), Dr. P. C. Sil, 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.

V. Basic and Applied Microbiology :

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

VI. Systems Biology :

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

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

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. Somsubhro 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.



Scientific Reports

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

Proteolytic cleavage of MAPK4 is associated with susceptibility to *Alternaria brassicicola* in *Brassica juncea* : Dr. Srirupa Das and Dr. Debabrata Basu

Profiling of MAPK3 and MAPK4, the key signaling component of plant-pathogen interaction have been carried out by immunoblotting in susceptible *B. juncea* and resistant *S. alba* upon challenge with the necrotrophic pathogen *A. brassicicola*. In susceptible *B. juncea* decline in both MAPK3 and MAPK4 proteins with drastic decline of MAPK4 compared to slight increase in MAPK3 and unchanged MAPK4 protein level in *S. alba* on interaction with *A. brassicicola* indicate a unique mode of pathogen induced signaling in plant. This modulation of MAPK3 and MAPK4 in the susceptible *B. juncea* compared to the resistant *S. alba* was correlated with the 26S proteasome-mediated degradation in susceptible plants by using MG132. Moreover, it was observed that inhibition of MAPK4 signalling by applying MAPK4 specific inhibitor, broke the resistance of *S. alba* against *A. brassicicola* which indicated a MAPK4 signalling/activation dependent induction of the resistance response. This preferential degradation of MAPK4 implies a possible surge in the salicylic acid (SA) dependent signalling responses in *B. juncea* upon infection, as MAPK4 is well known for acting as molecular switch between SA and JA (jasmonic acid) response and favors necrotrophic mode of resistance.

Functional analysis of anther specific expression of β - 1, 3- glucanase gene upstream sequence of *Sesamum indicum* : Dr. Debabrata Basu in collaboration with Dr. Samir R. Sikdar and Dr. Sampa Das

The superior oil quality and important agronomic characters of *Sesamum indicum* make this plant a potential crop for human consumption. Therefore, with an aim to improve of the crop yield through hybrid vigor, isolation and identification of anther specific genes was carried out by cDNA subtraction. Numbers of transcripts were identified and validated, which showed anthers specific expression at the transcript level. Among these, one very promising β - 1, 3- glucanase gene, which is known for various functions in plants including pollen development in anther has been isolated. *In vivo* functional assay of the upstream sequence of this gene demonstrated, tapetal cell layer specific expression in the anther of transgenic tobacco plants as evident by expression of the *GUS* gene. The expression of the gene was found to be corresponding to the stage prior to the release of the microspores from the tetrads. During abiotic and biotic stresses and upon treatment with ABA, induction of the promoter in the

vegetative parts of transgenic plant indicated multi-various function of the gene.

Epigenetic regulations during plants response to different environmental or developmental stimuli : Dr. Shubho Chaudhuri

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

The highly complex structure of chromatin imparts resistance to several nuclear processes including transcription. Nucleosome is the site for the dynamic modifications which occur to generate 'open' or 'closed' chromatin configuration inside the cell. Several covalent modifications of the N-terminal tails of histones together generate a "histone code" which promotes accessibility and binding of nuclear factors to their cognate binding site during any nuclear processes. For a highly regulated phenomenon like transcription, alterations in the chromatin structure of a locus, is presumed to be tightly regulated. The Dehydration responsive element binding (DREBs) proteins are the major transcription factors that regulate stress responsive gene expression in plants. The spatiotemporal expression of DREB homologs is controlled by different abiotic stress signal such as cold, high salt or drought. Among the five DREB homologs in rice, expression of OsDREB1A and OsDREB1B was induced by cold stress, whereas OsDREB2A was induced by drought and high-salt stresses. There was a significant change in the nucleosome arrangement in the vicinity of *cis* elements and TATA box at the core promoter of OsDREB1b locus in response to cold stress. ChIP assays show hyper-acetylation of histone H3K9 throughout the locus whereas region specific increase was observed in H3K4me3, H3K14ac and H3K27ac. Moreover, enrichment of RNA PolII occupancy at the promoter region was also observed during transcription activation. Interestingly, cold induced enhancement of *OsDREB1b* transcription as well as histone H3 acetylation diminishes when stressed plants are returned to normal temperature. These findings indicate that transcriptional activation of the DREB1b gene in the presence of cold stress involves active changes in the epigenetic landscape of the locus and is mediated by alteration in the H3 acetylation promoting active repositioning of nucleosomes at the DREB1b loci.

OsBZ8 encodes b-ZIP transcription factor which is rapidly induced by salt stress. Nucleosome mapping of the promoter and upstream region of OsBZ8 gene of *Oryza sativa* L. cv. IR-64 shows three nucleosomes in this region. The nucleosome occupancy indicates that the nucleosome at the core promoter region of OsBZ8 has loosely positioned nucleosome which is flanked by two well positioned nucleosomes. ChIP analysis indicates that there is an enrichment of Histone H3 acetylation and methylation of H3K4 residue at the promoter and upstream region of OsBZ8 locus during salt induce transcription. These changes in histone modifications facilitate rearrangement of nucleosome at the promoter and upstream region of OsBZ8 gene resulting in the increase in RNA PolII and TATA box binding protein occupancy during transcription on sate of OsBZ8 gene. A thorough analysis of epigenetic language of

these stress induced genes can decipher the mechanism of transcription regulation of these genes in salt sensitive and tolerant lines of rice plant.

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

Plants have a novel class of HMG protein known as ARID/HMG. These proteins are characterized by the presence of two DNA binding domain: AT-rich interaction domain (ARID) and HMG box in a single polypeptide. Biochemical analysis has shown that ARID/HMG have lower binding affinity for linear DNA compared to canonical HMGs. However the individual domains of ARID/HMG can bind DNA with higher affinity compared to full length ARID/HMG. These proteins can change the topology of DNA backbone by either bending the small DNA fragments to form DNA mini circle or by inducing supercoiling in the relaxed plasmids. Although the exact role of ARID/HMG proteins is not known but it can be hypothesized that the presence of two DNA-binding motifs in ARID/HMG proteins can regulate transcription by either modulating chromatin accessibility or by acting as transcription activators.

In order to understand the function of ARID/HMG protein in vivo, yeast two hybrid assay was performed to identify the interacting partners of ARID/HMG proteins. Initial screening has identified two nuclear proteins which interact with ARID/HMG proteins: a) AT5G47610: encodes protein which belongs to RING / U box superfamily; b) At3G23300: encodes S adenosyl methyltransferase. Present investigation is focused on to understand how these interacting partners modulate the function of ARID/HMG inside the cell. At1g04880 which is member of ARID/HMG family has been shown to be induced by cold stress. Investigation is going to at present understand how At1g04880 proteins modulate the transcription of cold stress responsive genes in plants.

Identification and Expression of insect/pathogen resistant gene(s)/ protein(s) with special emphasis on understanding plant's defense response to biotic stress : Dr. Sampa Das

Antibiotic resistance marker gene free aphid resistant ASAL (mannose binding *Allium sativum* leaf agglutinin) transgenic mustard plants were established which are found to be environment friendly as well as biologically safe insect resistant plant types (Bala et al/ 2013).

A site directed mutagenesis derived monomeric mASAL protein was generated which is exhibiting significant anti fungal property against a range of plant invading fungal pathogens. Rice transgenics are being developed with chimeric mASAL gene construct which is showing sheath blight resistance in rice. An extensive biochemical and immunochemical analyses of mASAL was done following the guide lines framed by FAO and WHO that demonstrated no toxic or allergenic features of mASAL in model mammals (Ghosh et al 2013)

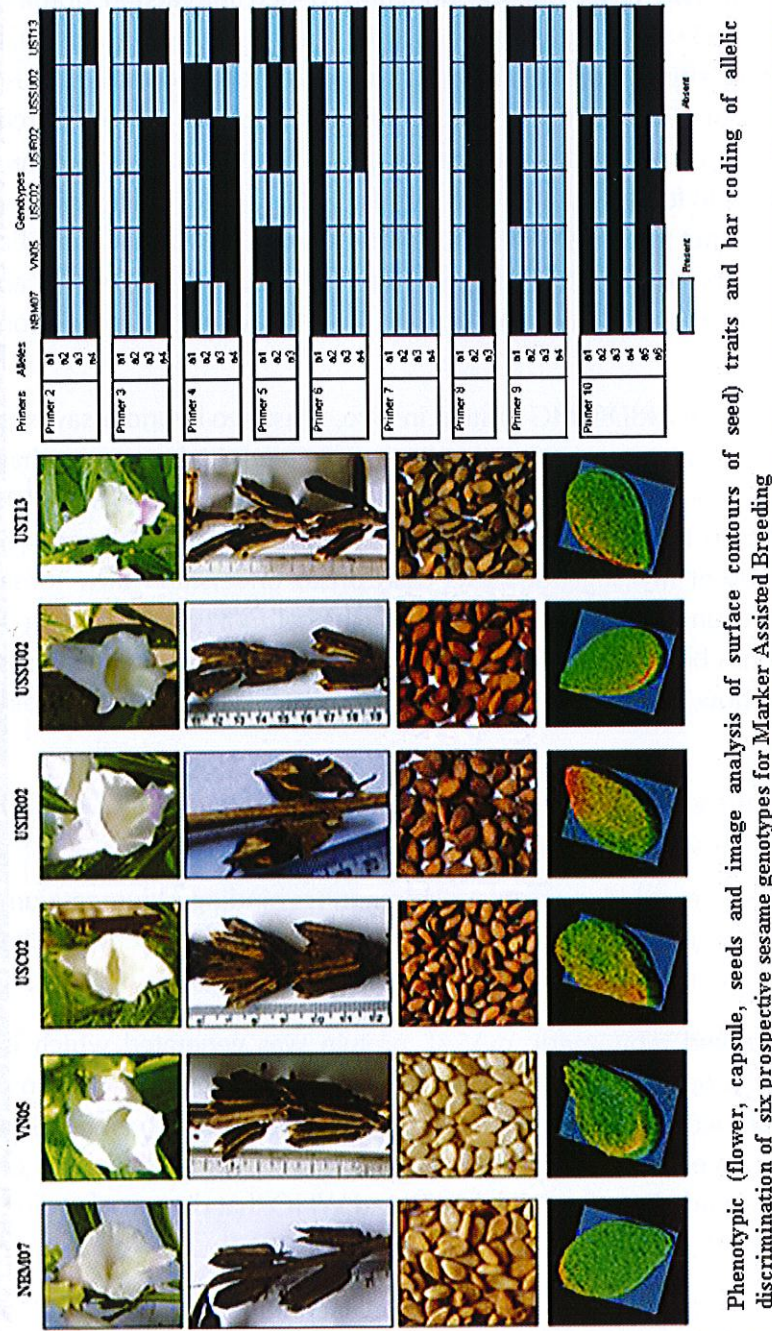
Functional Genomic, proteomic, NGS based transcriptomic techniques were adopted to

analyse differentially expressed transcripts and proteins in resistant/ susceptible chickpea plant types. Thus, a number of differentially expressed transcripts /proteins induced in chickpea by challenging with fungal pathogen- *Fusarium oxysporum* were obtained which are now being analysed (Gupta et al 2013a and 2013b) for further molecular analyses.

The key residues of Cry 1 Ac toxin involved in binding to the previously identified HaALP,

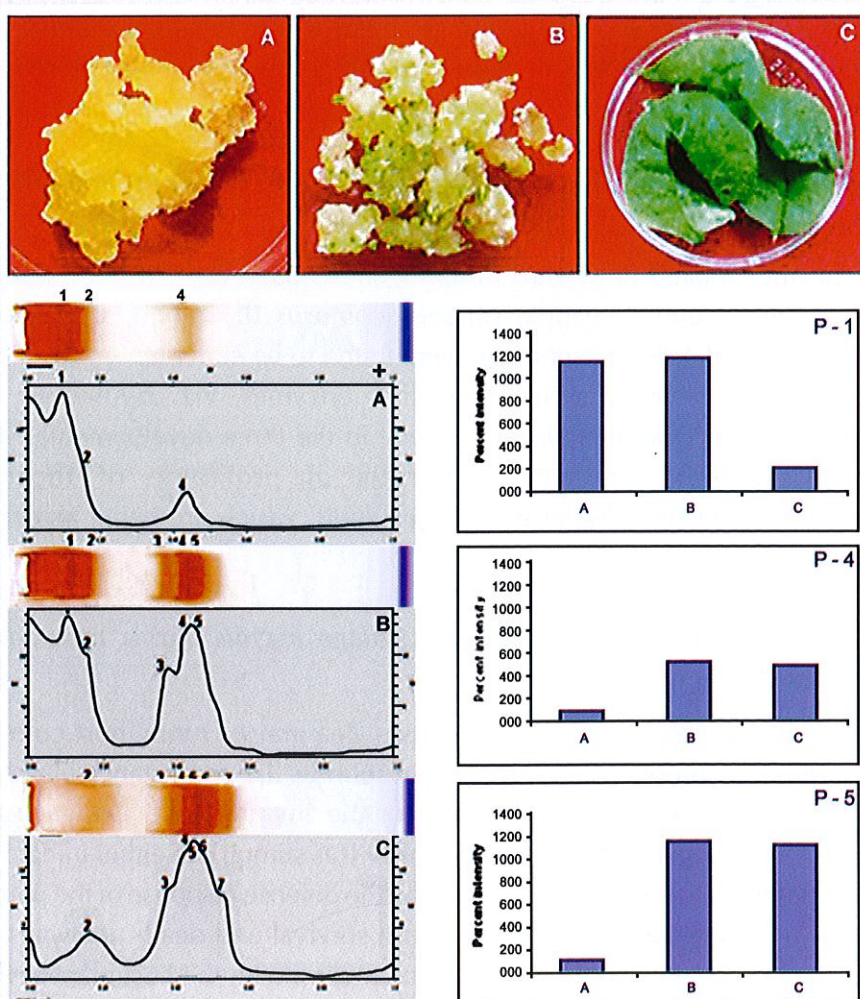
receptor proteins of *Helicoverpa armigera* were mutated. The real time binding analyses of the receptor with native as well as mutated toxins were carried out. Through *in silico* analyses the toxin-receptor complex interplay was validated that identified the residues playing important role in this particular interaction in real time manner and also resolved the detail dynamics of the binding. Significant correlation was observed between the structural studies and experimental kinetic values for different mutants in terms of their receptor binding as well as insecticidal potentiality. The study conducted in collaboration with **Shubhro Ghosh Dastidar, Bioinformatics** (Sengupta et al 2013).

Improvement of cultivated sesame through Marker Assisted Breeding



: Dr. Gaurab Gangopadhyay

Five exotic sesame accessions (*Sesamum indicum* L.) were selected by combined phenomic and genomic approaches as prospective male parents to introgress certain desirable traits as lighter testa colour, synchrony in capsule maturation and non-shattering habit of mature capsules for improvement of one selected Indian accession. One SCAR (Sequence Characterized Amplified region) marker, specific to the female parent (Indian) and certain SSR (Simple/Short Sequence repeats) allelic polymorphism between female and five prospective exotic male parents are reported, which will be helpful for marker assisted breeding of sesame. Simultaneously an F_2 population derived from an inter-specific hybridization programme between cultivated and wild (*S. mulayanum* Nair) sesame is presently being screened with SSR markers to understand the association between phenotypic traits and molecular markers.



Differential expression of iso-peroxidase enzyme during *in vitro* morphogenesis in Tobacco (*Nicotiana tabacum* L.)

SSR markers for assessing the hybrid nature of high yielding Mulberry varieties :**Dr. Gaurab Gangopadhyay**

The challenge in Mulberry breeding is deciphering suitable markers, and to link those with important agronomic traits so that those can be helpful for early screening of promising recombinants in Marker Assisted Selection / Breeding (MAS/MAB) programme. The present work reports use of *Morus* specific SSRs to check the hybrid nature of high yielding Mulberry varieties in the backdrop of their respective parents. These genotypes maintained in the repository of Central Sericulture Research and Training Institute (CSR&TI) at Berhampore, WB, India are unique since they constitute of parents and hybrids of two consecutively successful hybridization programmes, wherein the hybrid of the first crossing programme was further crossed with an open pollinated selection of a landrace to develop even superior Mulberry genotype, which is awaiting release as specific accession. Furthermore, the segregation patterns of the SSR markers are also being screened in the mapping population with the ultimate objective of identification of association between agro morphological traits with molecular markers.

Understanding molecular factors behind *in vitro* plant morphogenesis :**Dr. Gaurab Gangopadhyay**

Isoforms of enzymes related to *in vitro* morphogenesis have been worked out in Tobacco (*Nicotiana tabacum* L) and Pineapple (*Ananus comosus* (L.) Merr.). Certain isoforms of Peroxidase, Esterase and Acid Phosphatase, were found to be either up- or down regulated in the course of dedifferentiation, while two other enzymes, viz. α -Amylase and Malate Dehydrogenase showed little alteration in activity in the three developmental stages under study. Two-dimensional gel electrophoresis of proteome of those different developmental stages has resulted in few unique spots, which are being analyzed through MALDI-TOF.

Survival strategies of the corn smut fungus *Ustilago maydis* during host colonization :**Dr. Anupama Ghosh**

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 are currently trying to evaluate the effect of metacaspase activity on both host invasion by the pathogen and also in its pathogenic development.

Understanding the role of endoplasmic reticulum chaperones in the pathogenicity of the corn smut fungus *Ustilago maydis* : Dr. Anupama Ghosh

During host colonization *Ustilago maydis* secretes a huge repertoire of proteins into the apoplastic regions. These are the effector proteins that aid in establishment of infection by the pathogen by overcoming the plant defense responses. The mechanism of secretion of these effector proteins follow mostly the endoplasmic reticulum (ER) mediated conventional route. Upon plant infection the expression of these effector proteins get induced to several folds. This induced expression of effector proteins therefore exerts a huge pressure on the protein folding system of endoplasmic reticulum that comprises of different chaperones, to assist proper folding of the secreted proteins. In this project we are engaged in dissecting the function of this group of endoplasmic reticulum chaperones in the pathogenicity of the fungus. We have started with a HSP70 homologue (Um00904) that possesses an ER retention signal and therefore we assume it to be an ER resident. Currently we are in the process of generating and testing an Um00904 deletion strain of *U. maydis* for its virulence towards host plant *Zea mays*.

Deciphering the secreted effectorome of rice sheath blight fungus *Rhizoctonia solani* : Dr. Anupama Ghosh, in collaboration with Dr. Sampa Das, Division of Plant Biology, Bose Institute

Phytopathogenic fungi and oomycete genome code for a huge repertoire of small secreted proteins. These proteins often referred to as effector proteins exhibit different localisation within an infected tissue. Some of the secreted effectors remain within the apoplast and are referred to as apoplastic effectors while others end up inside host cells and are referred to as cytoplasmic effectors. In the past few decades a large number of studies have been carried out that aimed towards cataloguing the effector repertoire of different pathogens. Most of these studies adopted a sequencing based approach followed by application of an *in silico* effector identification pipeline. Some of the most important criteria included in these pipelines are presence of a signal peptide, small size, presence of different effector motifs and differential expression during infection when compared to growth in axenic culture. One of the major drawbacks of this approach is its inability to identify those secreted effector molecules that lack a conventional signal sequence and not secreted via classical secretory pathways. An alternative approach using reverse genetic tool could be a solution to this problem. In this

project we are trying to identify the effector repertoire of a very devastating phytopathogen *Rhizoctonia solani* that causes sheath blight of rice using a proteomics based approach. The total proteome of the apoplastic fluid isolated from either *R. solani* infected rice plants or mock infected rice plants has been planned to be analysed.

Genetic Diversity Analysis of Rice Landraces of West Bengal : Dr. T. K. Ghose

- In relation to bacterial leaf blight resistance we are now working on the inherent genetic diversity of four copper transporter genes (COPT genes), Xa13 gene and its promoter.
- We are also trying to identify homologues of the rice bacterial leaf blight resistance genes Xa1, Xa5, Xa13, Xa21, Xa26 and Xa27 in other *Xanthomonas* host plants.
- A genetic diversity analysis of aroma genes of prominent aromatic and basmati landraces are also in process.

Correlating the various alleles of the BLB resistant genes with disease phenotype : Dr. T. K. Ghose

- Inoculation studies were done to disease phenotype a set of rice landraces.
- Genetic diversity of that set of rice landraces were done with linked SSR markers.
- Correlation of the alleles obtained from the PCR profiles with the disease phenotype is in progress.

Studies on airborne allergenic pollen grains and spores: Biochemical, clinical and molecular approach : Dr. Swati Gupta-Bhattacharya

Immunoproteomic analysis to identify IgE reactive proteins has been performed on three predominant airborne pollen grains viz. *Helianthus*, *Lantana camara*, *Cocos* and *Peltophorum* and a mold *Curvularia*. Pectate lyase from *Helianthus*, ATP synthase beta subunit from *Lantana*, Vicilin from *Cocos* and Aspartyl protease from *Curvularia* has been identified as major allergens. The major 21 kD subunit of coconut pollen allergen has been purified by native form by FPLC. Two major allergens aspartic protease and cyclophilin from *Rhizopus oryzae* have been cloned and expressed in *E. coli*. These recombinant allergens are now being tested for their potential of allergenicity. Another focus of this lab is on molecular typing of pathogenic and allergenic *Aspergilli* group. OPA-1, OPA-2, OPA-3, OPA-4, OPA-5, OPA-6, OPA-7, OPA-8 and OPA-9 primers have been found to work for genotyping of *A. fumigatus*. Other species are under trial. A new DBT and CSIR funded projects on environmental monitoring of mould has been started from different indoor environments like school, college, library, bank, hospital area and outdoor environments in Kolkata and suburbs. Biomonitoring has also been done to study the changes in mycofloral composition in a locality affected by acid rain.

Understanding the mechanisms of transcriptional and post-transcriptional regulation of gene expression during biotic stress response in tomato plant : Dr. Pallob Kundu

Two disease models in tomato have been studied. a) *Alternaria* fungus, necrotrophic pathogen causing blight; b) Tomato leaf curl New Delhi virus, a biotrophic pathogen causing leaf curl disease. Following works are carried out using these plant and pathogen interaction models.

Analysis of role of small RNAs in blight disease development : Known and novel miRNAs differentially expressed during *Alternaria*-infection in tomato plant has been identified by NGS analysis. Expression of some of these significantly regulated miRNAs has been validated using alternative techniques. Analyses of the targets of these differentially expressed miRNAs have indicated the key genes/pathways are regulated during infection.

***Alternaria*-stress responsive tomato transcriptomics :** Alteration in tomato-transcriptome during infection also being investigated. In combination of transcriptome and small RNA transcriptome data, key regulatory molecules have been marked.

Analysis of signalling mechanism that leads to the regulation of miR-genes under biotic and environmental cues : Spatio-temporal regulation of miR gene promoter is being investigated *in vitro* analysis and in transgenic plant. Role of biotic stress related cis-elements are analyzed.

Studies on molecular signalling associated with disease symptom manifestation : We have found that leaf curl virus infection causes de-regulation of certain leaf developmental genes. Role of these genes in symptom manifestation and cause of their de-regulation is investigated. For blight symptom development studies, miRNAs that target genes related to programmed cell death are being analyzed.

Understanding the membrane mediated signalling during disease initiation : Initial focus was on membrane bound transcription factors (MTFs) in transmission or effecting of stress signals. In genome wide analysis all NAC transcription factors in tomato have been identified and from these NAC MTFs have been marked for characterization. Some of these NAC MTFs are also found to be stress responsive and further biochemical analyses to characterize these MTFs and their role in stress signalling are in progress.

Generation of Salt Tolerant rice through metabolic engineering : A translational approach : Dr. A.N.Lahiri Majumder

Attempts are being made to generate salt-tolerant rice varieties through engineering of pathways known to exhibit abiotic stress-tolerance by introgression of genes earlier identified in the laboratory from wild resources. The exploration of one such pathways indicates that inositol itself and many of its derivatives can impart abiotic stress tolerance (against salinity, dehydration, chilling or oxidative stress) to plants when overexpressed. A salt tolerant Inositol synthase gene from *Porteresia coarctata* (*PcINO1*) has been overexpressed along with Inositol

Methyl Transferase 1 (*PcIMT1*) from *Porteresia coarctata*, to obtain gain-of function rice transgenics. These transgenics produce higher amount of inositol and pinitol and therefore provide an elevated tolerance towards salinity. Another salt tolerant gene Fructose-1,6-bis phosphatase from *Porteresia* has also been introgressed in rice and T3 generation transgenics are obtained with heightened photosynthesis under salt stress. Both the pathways engineered into high-yield rice varieties are expected to give high salt tolerance. The role of inositol derivatives as signaling molecules is also emerging and a novel regulation mechanism of Raffinose Family Oligosaccharide accumulation through galactinol synthase (*ColS*) in rice has been revealed.

**Overlap between Salt and Mechanical stress response: evaluating plant smartness :
Dr. Sonali Sengupta**

To understand the cross-talk among non-canonical abiotic stresses, model plants were explored for genes sensing touch, vibration and salinity. In touch-sensitive *Mimosa pudica*, 10 proteins were found important for sensing touch; whereas in a differential phenomic-genomic screen of rice plants, 6500 candidate genes and 500 pathways showed up. The phenomic study showed that different plants take a different course of time to delineate the stress coping strategy, and may not be stereotyped. Statistical correlations indicate that a function of plant smartness (not unlike intelligence quotient) can be outlined as a useful screen of adaptability of genotypes towards abiotic stress.

**Dynamic transcriptomic responsiveness of *Vigna mungo* against MYMIV-infection :
Dr. Amita Pal**

To explore the dynamic immune transcriptomic response of *V. mungo* against Mungbean Yellow Mosaic India Virus (MYMIV) infection, RNA-seq approach was adapted. Annotation of the transcripts against the soybean, *Medicago* and cowpea genomic databases revealed a total of 101,877 transcripts. Differentially expressed transcripts were primarily involved in stress response, signalling pathways, metabolic processes, cellular transport and various other molecular functions and biological processes. Expression of 61,676 transcripts are common to both, while 1,147 and 41,616 are exclusive in the control and MYMIV-infected samples, respectively. Further analyses of these differentially expressed transcripts are underway to reveal insights into the MYMIV-resistance mechanism in *V. mungo*.

**Proteomic analysis of cotyledonary explants during shoot organogenesis in *Vigna radiata* :
Dr. Amita Pal**

Comparative protein profiles of two cotyledon types, Cot and Cot E, were analysed prior to and during early time points of shoot morphogenic induction to understand the unique differential regeneration response in these two explant types which was reported earlier. These

explants were grown separately *in vitro* on shoot induction medium (SIM) containing Gamborg's B5 basal nutrient salts supplemented with 15 μ M N₆-benzyladenine. Proteomes from Cot and Cot E explants during early events of shoot differentiation were isolated and characterized using 2D-gel electrophoresis followed by MALDI-TOF-TOF spectrometry. A total of 112 differentially identified proteins were classified according to their putative biological functions. Prompt acquisition of competence in Cot E for direct shoot morphogenesis was probably owing to fast phytohormone signalling. Abundance of proteins in Cot E indicated stimulation of several metabolic and associated pathways than Cot explants. Enhanced accumulation of folding-assisted proteins involved in organogenesis mediated cellular reprogramming in Cot E explants contributed further in rapid and efficient regeneration responsiveness.

Analysis of gene pool with reference to seeds : Dr. Prabir Kumar Saha

Experiments were carried out with twenty five Indian sesame accessions (23 *Sesamum indicum* L. and two *S. mulayanum* Nair. Family: Pedaliaceae) having potential economical importance. Preliminary categorized seeds using macro and micro morphological characters were subjected to mineral distribution pattern on their testa. SEM studies revealed different patterns of architecture and ornamentation in the testa as well as hilar region of the seeds. Combining seed morphological and mineral assessment data with hierarchical cluster analysis dendrogram was obtained. Those data collectively demonstrated huge phenotypic diversity among the accessions. These findings can be used as valuable phenotypic markers for the preliminary assessment of gene pool of the selected Indian sesame genotypes.

Resource survey analysis of gene pool with reference to seeds : Dr. Prabir Kumar Saha

Seeds of *Morinda citrifolia* L., a medicinally important plant were collected from different locations and phenotypically characterized. Investigation on germination pattern of the seeds revealed that diversity exists among same seed lot. The seeds do not germinate due to hard testa and temperature dependent. Scarification of freshly harvested seeds showed 100% germination.

Regulation of Gene Expression in Rice during seed dormancy, in response to dehydration and salt tolerance : Dr. Dibyendu Narayan Sengupta

In our last report we have reported that red light illumination (1hr per day for 4 days) or sun drying for 4days (4hrs each day), remove dormancy of the freshly harvested seeds of Nonabokra and Pokkali, otherwise their seeds are Dormant. This year we have detected the transcripts for PHYA, PHYB, PHYC, CRY1, and CRY2 genes by RT-PCR of the red light illuminated rice seeds. The role of red light in the dry seeds and also the expression of ABA-8-hydroxylase genes are now going on to see the expression of gene for ABA for degradation. In addition we are going to measure the ABA level in those seeds.

To obtain full length cDNA for DNA Pol λ from indica rice, our efforts did not show any full length RT-PCR products. Since the extreme 5' end of the ORF for DNA Pol lambda in indica rice differs from japonica rice, we have amplified the 5'-end of the ORF by using a newly synthesized primer 150bp from the beginning of ORF, using genomic DNAs from Nonabokra and IR-29 for rice (indica) cultivars.

In addition our effort to get full length cDNAs for 14-3-3 genes also gave amplification of their cDNAs. Since 14-3-3 proteins are involved in the regulation of a few important protein like nitrate reductase, sucrose phosphate synthase and EmBP1 (bZIP factor involved in ABA inducible gene expression) reported from wheat, we are very much interested to see its interaction with OsBZ8 in rice (a bZIP class of factor for ABA inducible gene expression). The upstream promoter of DREBP2 gene has been amplified and we obtained difference in the expression in salt sensitive, salt tolerant and dehydration tolerant rice cultivars. In transgenic rice project, the detection of Hpt gene (Hygromycin resistance) and the SAMdc cDNA in tissue culture raised IR-64 plants were positive by genomic PCR and now we are trying for good southern blot analysis, using both Hpt and SAMdC cDNA as probe. In addition we have started *Agrobacterium* mediated transformation of IR 64 with OsBZ8 cDNA.

Molecular Documentation and Bioprospecting of gene related to Medicinal Potential in Plants of Eastern and North Eastern India : Dr. Swati Sen-Mandi

***Rumex nepalensis* L. :**

Rumex nepalensis is an important medicinal plant used in North East India. This plant is reported to possess numerous medicinal properties like purgative, antifungal, antibacterial, antihistaminic, anticholinergic, antibradykinin and antiprostaglandin activities. Two Trait Related AFLP markers for total antioxidant potential have been developed in this species for use in identifying superior genotypes of *Rumex nepalensis* from the wild.

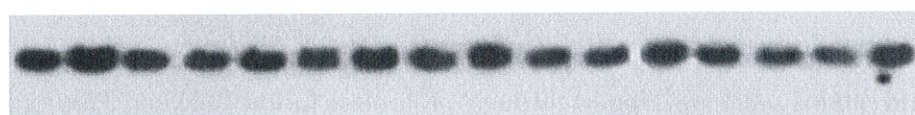
***Zingiber officinale* Roscoe.:**

Zingiber officinale, medicinally the most important species within Zingiber genus, contains 6-gingerol as the active principle which has immense medicinal importance and is used in various herbal drug formulations. Our study demonstrates that variation in content of 6-gingerol in ecotypic variants (collected from a wide range of locations that included high and low altitude regions) of *Zingiber officinale* is due to variation in one amino acid (Asparagine³³⁶ to Serine³³⁶) at the catalytic triad of the Chalcone Synthase enzyme, the rate limiting enzyme of 6-gingerol producing pathway. Since asparagine at position 336 of CHs is a component of the catalytic triad that is, responsible for substrate binding and subsequent product formation leading to synthesis of 6-gingerol, this variation in 6-gingerol content in ecotypic variants of *Zingiber officinale* suggests weak enzyme-substrate association as the mechanism for low 6-gingerol production in the ecotypic variants collected largely from low altitude areas.

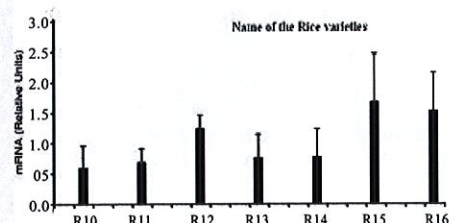
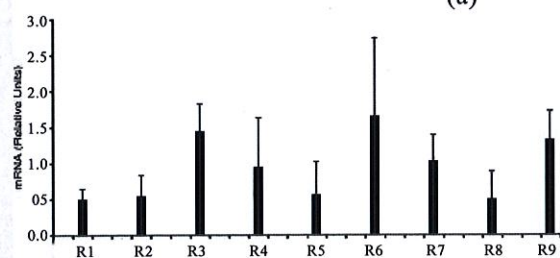
***Oryza sativa* L.:**

Rice (*Oryza sativa* L.) varieties exhibiting high / low seed vigour-viability were used to explore genetic controls associated with varietal difference in seed vigour and viability traits. Our gene expression study demonstrated that low seed vigour in rice varieties is due to low expression of ACCase gene brought about by its promoter methylation. Since promoter methylation is transferable through breeding lines this study opens up an opportunity for introgressing high seed vigour-viability trait into otherwise desirable varieties.

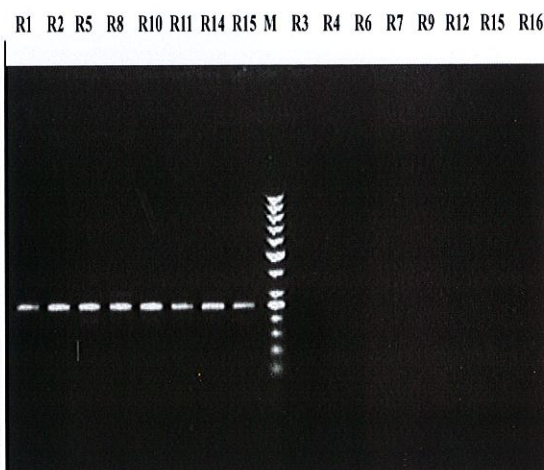
R1 R2 R3 R4 R5 R6 R7 R8 R9 R10 R11 R12 R13 R14 R15 R16



(a)



(b)



(c)

- (a) Southern Blot analysis showing single copy of ACCase gene in all the studied *Oryza sativa* varieties irrespective of their vigour-viability status.
- (b) ACCase Gene expression study in *Oryza sativa* varieties showing high ACCase gene expression in high vigour-viable varieties (R3, R4, R6, R7, R9, R12, R15, R16) and low gene expression in low vigour-viable varieties (R1, R2, R5, R8, R10, R11, R14, R15).
- (c) ACCase promoter methylation study showing a 250 bp band in low vigour-viable varieties (R1, R2, R5, R8, R10, R11, R14, R15) and complete absence of this band in high vigour-viable varieties (R3, R4, R6, R7, R9, R12, R15, R16), M-50bp ladder.

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

Sequencing and cloning of the candidate defence response gene identified as differentially regulated on aphid challenge in wild crucifer : *Dr. Samir R. Sikdar*

To identify candidate defence response and/or resistance gene(s) against mustard aphid *Lipaphis erysimi* from the aphid resistant wild crucifer *Rorippa indica*, cDNA AFLP and real time RT PCR analysis of aphid challenged *R. indica* transcriptome resulted in the identification of several candidate genes. Sequencing and cloning of full length coding region of one such induced resistance R genes from *Rorippa indica*, the plant defensin has been done.

New strain development through mushroom biotechnology : *Dr. S.R. Sikdar*

Two somatic hybrid strains were developed through protoplast fusion between *Pleurotus florida* + *Agaricus bisporus*. Further molecular characterization is in progress.



FACS

II. Structural Studies and Biophysical Problems

Domain-domain interactions of *E. coli* GluRS : *Dr. Gautam Basu*

Further experiments and detailed coevolutionary analyses on a series of *E. coli* GluRS mutants were performed to identify domain-domain communication. A revised manuscript is being written describing our results.

Crystal structure of *E. coli* GluRS : *Dr. Gautam Basu, in collaboration with Dr. Ajitbikram Datta*

A manuscript describing preliminary diffraction data on an engineered *E. coli* GluRS obtained was submitted describing the preliminary crystallographic data. Structural refinement is in progress for generating the crystal structure.

Understanding the role of Zn-binding domain in bacterial GluRS : *Dr. Gautam Basu*

Bacterial GluRS contain a Zn-binding domain at its N-terminal catalytic domain. Several mutants of *E. coli* GluRS were designed, expressed and studied to understand the role of the Zn-binding domain in bacterial GluRS.

Design, Synthesis and High Resolution Structure Determination of Biomolecules Using Nuclear Magnetic Resonance (NMR) Spectroscopy : *Dr. Anirban Bhunia*

(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.

Structural studies on proteins from *Vibrio cholera* : Dr. P. Chakrabarti

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. Protein L-isoaspartyl-O-methyltransferase (PIMT) is a highly conserved enzyme involved in the repair of isoaspartyl residues formed due to isomerization of normal aspartyl residues. As *V. cholerae* passes through stomach (acidic) and colonizes small intestine (slightly alkaline) the residues may undergo isomerization at a higher rate, and PIMT may have a crucial role in cell survivability of the organism. The protein was over-expressed, purified, and its interaction with cofactors and effect of osmolytes on unfolding studied. Its enzyme activity determined and compared to those from other organisms. Crystals have been grown for the protein and the structure solved.

Protein-nanoparticle interaction : Dr. P. Chakrabarti

For application in drug delivery and as nano-medicines, one needs to understand the nature of the interaction of nanoparticles with well-characterized proteins. In collaboration with Dr. SP Singh of NPL, Delhi we have synthesized ZnO nanoparticles (NPs) and modified the surface using polyethyleneimine (PEI). The effect of binding of ZnO nanoparticle on the structure and stability of α -lactalbumin has been studied. The PEI-functionalized NP (which was found to be more soluble) was found to be effective in killing antibiotic resistant *Helicobacter pylori* and the molecular basis of inactivation has been elucidated. This work was done in collaboration with Dr. Rukhsana Chowdhury of IICB.

Design, synthesis of Novel Aptamers, Peptides, Small molecules selectively bind Telomeric and oncogenic G quadruplexes : Dr. Subhrangsu Chatterjee

(a) 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.

Understanding misfolding and aggregation of proteins and peptides by high resolution NMR : Dr. Subhrangsu Chatterjee

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.

Understanding the DNA structures with mutations : Dr. Subhrangsu Chatterjee

Mutations in the genome are responsible for several fatal genetic disorders. The default DNA repair mechanism restores the malfunction of the gene caused by mutation to maintain functional regularity and sequential integrity of the cell. We investigate the mutated DNA structures to unravel its function in biological processes.

Unfolding and pH- dependent studies of a lectin from the Rhizomes of Turmeric (*Curcuma longa* Lectin) : Dr. Rajagopal Chattopadhyaya

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. Size exclusion chromatography and dynamic light scattering show it to be a dimer at pH 7, but it converts to a monomer near pH 2. Circular dichroism spectra and fluorescence emission maxima are virtually indistinguishable from pH 7 to 2, indicating secondary and tertiary structures remain the same in dimer and monomer within experimental error. The tryptophan environment, as probed by acrylamide quenching data, yielded very similar data at pH 2 and pH 7, implying very similar folding for monomer and dimer. Differential scanning calorimetry shows a transition at 77.3°C for dimer and at 54.0°C for monomer. Thermal unfolding and chemical unfolding induced by guanidinium chloride for dimer are both reversible and can be described by two-state models. The temperatures and the denaturant concentrations at which one-half of the protein molecules are unfolded, are protein concentration-dependent for dimer but protein concentration-independent for monomer. The free energy of unfolding at 298 K was found to be 5.23 Kcal/mol and 14.90 Kcal/mol for the monomer and dimer respectively. The value of change in excess heat capacity upon protein denaturation (ΔC_p) is 3.42 Kcal/mol/K for dimer. The small ΔC_p for unfolding of CLA reflects a buried hydrophobic core in the folded dimeric protein. These unfolding experiments, temperature dependent circular dichroism and dynamic light scattering for the dimer at pH 7 indicate its higher stability than for the monomer at pH 2. This difference in stability of dimeric and monomeric forms highlights the contribution of inter-subunit interactions in the former. In the presence of Me- α -mannopyranoside, both transitions shifted to higher temperatures, suggesting that the ligand binds preferentially to the native conformation of CLA.

Influence of Plant Extracts on Fenton-reaction mediated DNA damage : Dr. Rajagopal Chattopadhyaya

Transition metals like iron, the most abundant one in our body, can react with H_2O_2 to produce hydroxyl radical ($\text{OH}^\cdot$) via the Fenton reaction as follows : $\text{Fe}^{2+} + \text{H}_2\text{O}_2 + \text{H}^+ \rightarrow \text{Fe}^{3+} + \text{OH}^\cdot + \text{H}_2\text{O}$. The $\text{OH}^\cdot$ 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. Some of the plant extracts (*Terminalia chebula*, *Terminalia belerica*, and *Emblica officinalis*) have been shown to be selectively cytotoxic to murine tumor cells, inducing apoptosis in those cells. Recent research has also shown that some of the plants (*Terminalia chebula*, *Terminalia belerica*, *Emblica officinalis*, *Acacia catechu*, *Hemidesmus indicus*) also have anti-cancer effect. Fenton reaction mediated DNA damage is enhanced by the extracts from *Terminalia chebula*, *Terminalia belerica*, *Emblica 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.

Interactions of silver nanoparticles with proteins : Dr. K. P. Das

Silver nanoparticles (AgNP) are finding increasing applications as potential candidates for antimicrobial agents and controlled drug release systems. For rational design of functional nano-biomaterials, biocompatibility must be achieved. This requires detailed study of the biomolecular interaction with the nanoparticles. Using the SPR signal of AgNP, we studied the concentration dependent interaction of a number of proteins with AgNP. Apart from the typical "dip and rise" profile with increasing concentration of proteins, the SPR signal sharply decreased linearly in the range 1-10 $\mu\text{g/ml}$ of a number of proteins. This property can be utilized to develop a protein sensor in such low concentration range. From the general nature of the interaction of proteins with AgNP irrespective of protein structure and its dependence on PI values of proteins led us to conclude that both hydrophobic and electrostatic interaction was responsible for the AgNP-protein interaction.

Control of protein fibrillation with small molecules : Dr. K. P. Das in collaboration with Dr. S. Chatterjee and Dr. A. Bhunia, Biophysics, BI

Further to our work reported last year, we tried to identify the probable binding site of NK9 with insulin by STD NMR and cluster analysis. Our result indicated that the residues I2, V3, V5, L7 and V8 of the NK9 interacted closely with insulin suggesting a dominance of hydrophobic interactions. From molecular docking study the residues PheB1, ValB2, GlnB3, LeuB6, HisB10 and LeuB17 of insulin were found to be interacting with the peptide NK9. Very few residues of insulin A-chain namely, LeuA13, TyrA14, and GluA17 were found to be involved in interaction. NK9 was found to have very little hemolytic activity. Cytotoxicity of NK9 peptide on HT1080 cell line showed less than 5% activity. NK9 is thus a non-toxic agent that can have future applications for therapeutic uses.

Structural and functional studies of α -crystallin : Dr. K. P. Das in collaboration with Dr. R. Banerjee, CU

We undertook a fluorescence based multi probe approach to explore the changes in various levels of organization of α -crystallin in different urea concentrations. Our study reveals a compact structural intermediate at 0.6M urea with exposed hydrophobic patches on surface. At 2.8M urea the tertiary interactions largely collapsed with partial collapse of secondary and quaternary structure. At present the surface salvation of the protein at different urea concentration is being probed by picoseconds time resolved spectroscopy. The subunit exchange rate of the protein is also being studied to compare the activation energy for the subunit exchange process.

DNA damage and repair in plants : Dr. Sujit Roy, CSIR Pool scientist and Dr. K. P. Das in collaboration with Dr. D. N. Sengupta, DPB, BI)

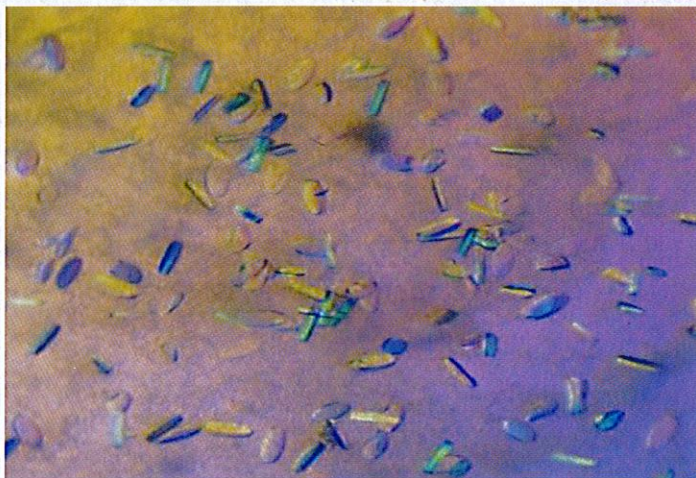
DNA polymerase λ is the sole member of family X DNA polymerase in plants and plays a crucial role in repair of double strand breaks, induced by genotoxic agents like high salinity and DNA cross-linking agent, via the Non Homologous End Joining pathway in *Arabidopsis*. Studies at the molecular genetics and phenotypic levels have demonstrated direct involvement of this protein in the repair of double strand breaks in plant genome. It has been shown that loss of function mutants of Plo λ displayed increased sensitivity to high salinity and DNA cross-linking agent. It was also shown that overexpression of Plo λ enhances DNA repair efficiency. Pol λ plays a significant role in providing resistance to a wide variety of environmental stresses and genotoxic agents in the context of the maintenance of genomic stability.

Molecular basis of specificity ubiquitination machinery in eukaryotes : *Dr. Ajit Bikram Datta*

A wide variety of cellular processes, that include cell cycle regulation, transcription, DNA repair, proteostasis etc., are regulated via ubiquitination, a post-translational modification involving covalent conjugation of ubiquitin to substrate proteins. A series of three sequential enzymatic steps involving the ubiquitin activating enzyme (E1), a conjugating enzyme (E2) and an 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 E2 (about 30) and E3 enzymes (> 600) that in a combinatorial manner dictates the proper substrate selection as well as the modification topology. This specificity of E3-E2 interaction as well as the substrate selectivity is not well understood.

We have engaged in understanding the mechanistic details of E2 activity as well the molecular basis of E3-E2 selectivity. In this regard, we have identified few candidate E2s

and E3s and have successfully purified quite a few of them for biochemical and structural analyses. Using such biochemical analysis we have recently identified a self-regulatory mechanism that regulates a class of E2s (manuscript under preparation). We have also been able to obtain crystals for few E3 ligases alone or in complex with various cofactors including E2, E2~Ub and also substrates. However, most of these crystals were not amenable to diffraction studies and thus requiring further optimizations.



Crystals of an Ubiquitin E3 ligase



Crystals of an E3 ligase complex

**Crystal structure of the Lambda repressor in complex with O_{r2} operator :
*Dr. Ajit Bikram Datta in collaboration with Prof. Siddhartha Roy, Indian Institute of Chemical Biology, Kolkata***

The CI repressor protein of bacteriophage lambda acts as key regulator to maintain the lysogenic state of the phage in *Escherichia coli* through its interaction with promoter regions pR and pL. Recent studies carried out in the laboratory of Prof. Siddhartha Roy indicated that interaction of ci protein with the pL and pR regions are not structurally equivalent rather there exists considerable differences between these complexes. While structures of ci and its complex with pL have already been reported, structure of ci bound to pR is not yet known. We have recently been successful to obtain crystals of the CI repressor protein in drops containing a small double stranded DNA encompassing the pR promoter region. These crystals however diffracted poorly in the present home source and efforts are underway to improve their diffraction.

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

We have also recently initiated structural studies on a plant receptor like kinase (RLK) that play a role in plant-microbe interaction leading to symbiosis. This kinase has been extensively characterized both biochemically and functionally in the laboratory of Prof. Dasgupta. We have been successful in obtaining diffracting crystals for two mutant versions of the protein and are in the process of determining their crystal structure.

Optimization of recombinant *Mycobacterium tuberculosis* RNA polymerase expression and purification : *Dr. Jayanta Mukhopadhyay*

Mycobacterium tuberculosis, the human pathogen that causes tuberculosis, warrants enormous attention due to the emergence of multi drug resistant and extremely drug resistant strains. RNA polymerase (RNAP), the key enzyme in gene regulation, is an attractive target for anti-TB drugs. Understanding the structure-function relationship of *M. tuberculosis* RNAP and the mechanism of gene regulation by RNAP in conjunction with different σ factors and transcriptional regulators would provide significant information for anti-tuberculosis drug development targeting RNAP. Studies with *M. tuberculosis* RNAP remains tedious because of the extremely slow-growing nature of the bacteria and requirement of special laboratory facility. Here, we have developed and optimized recombinant methods to prepare *M. tuberculosis* RNAP core and RNAP holo enzymes assembled in vivo in *Escherichia coli*. These methods yield high amounts of transcriptionally active enzymes, free of *E. coli* RNAP contamination. The recombinant *M. tuberculosis* RNAP is used to develop a highly sensitive

fluorescence based in vitro transcription assay that could be easily adopted in a high-throughput format to screen RNAP inhibitors. Thus, these recombinant methods would be useful to set a platform for *M. tuberculosis* RNAP targeted anti TB drug development, to analyze the structure/function of *M. tuberculosis* RNAP and to analyze the interactions among promoter DNA, RNAP, σ factors, and transcription regulators of *M. tuberculosis* in vitro, avoiding the hazard of handling of pathogenic *M. tuberculosis* bacteria.

A recombinant reporter assay of Mycobacterium tuberculosis : Dr. Jayanta Mukhopadhyay

Taking advantage of *M. tuberculosis* RNA polymerase assembly in *E. coli*, we have further developed anmCherry reporter assay that has enabled us to monitor the interaction of *M. tuberculosis* RNA polymerase with its promoter in vivo. The assays involve three-plasmid expression system in *E. coli*, wherein, the two plasmids will be responsible for *M. tuberculosis* RNAP production and the third plasmid harbour the mCherry reporter gene expression cassette under the control of either a sigma factor or a transcriptional regulator dependent promoter. This reporter assay has been validated for the principal sigma factor sigmaA, for an alternative sigma factor, sigmaE and for a transcriptional regulator, CRP from *M. Tuberculosis*. Thus, this novel recombinant reporter assay would render a new and efficient avenue to monitor the interactions among *M. tuberculosis* RNAP, σ factors, transcription factors and their cognate promoters in vivo without the hazard of handling *M. tuberculosis*, a pathogenic, slow growing bacteria, and nullifying the need of generation of specific gene knockout *M. tuberculosis* strain for the study.

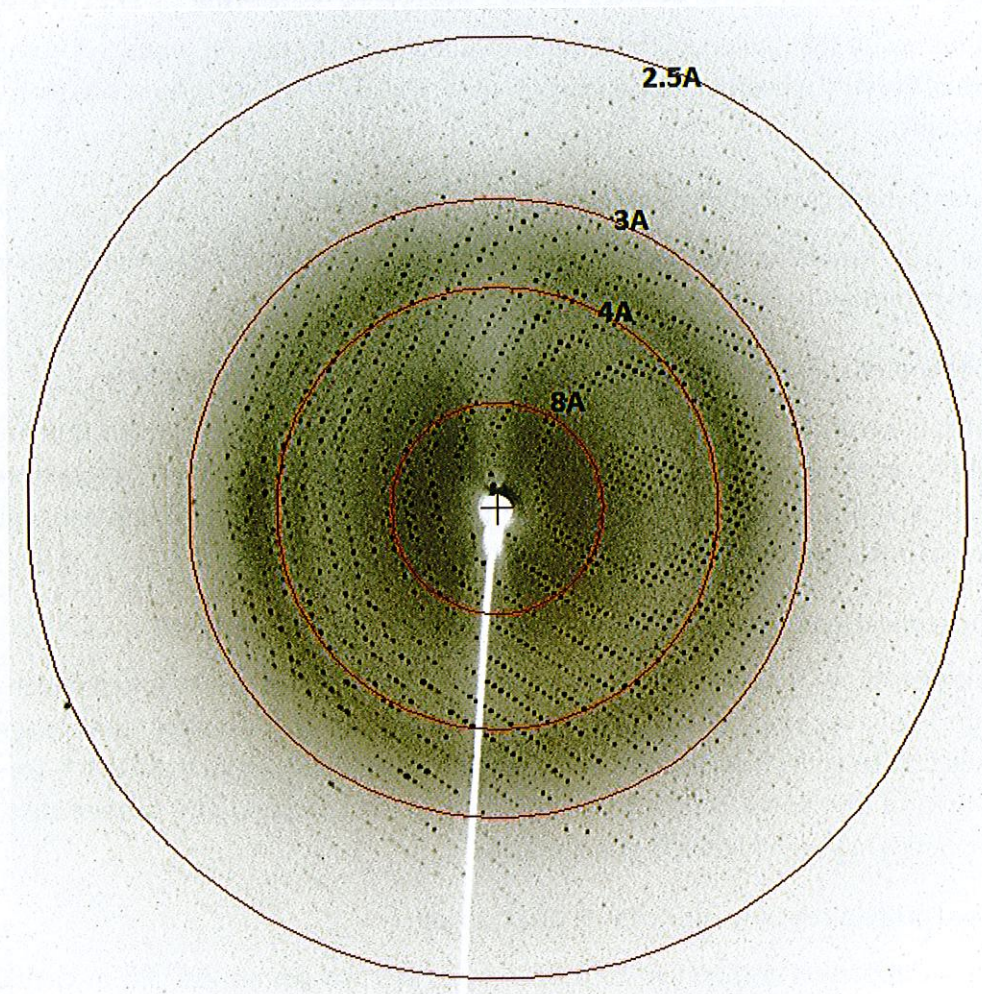
Structural Studies on the C1 protein of Bacteriophage P22 : Dr. P. Parrack

The C1 protein of the temperate phage P22 of *Salmonella typhimurium* is a transcriptional activator that is involved in the lytic versus lysogenic decision making switch of P22. C1 binds to a unique sequence TTGCN₆TTGC/T in -35 regions of promoter, the same motif that is recognized by the transcription activator protein CII of phage lambda.

Although λ CII and P22 C1 share strong similarities in their functions, a striking difference in P22 is that a single base pair mutation in the -35 region (which overlaps with the 5' end of the C1 coding gene) changes the P_{RE}-35 target as well as the amino terminal region of C1, creating P_{RE}^{osi} and C1_{osi} respectively. Although C1_{osi} activates the P_{RE}^{osi} promoter, it fails to activate the wild-type promoter P_{RE}. Because of its functional and structural similarity with the P22 C1 protein, λ CII has served as the basis for informed speculation on the function of P22 C1. However, if one assumes a three-dimensional structure for P22 C1 to be very similar to that of λ CII, the osi mutation results cannot be explained.

In view of these unsolved questions we sought to solve the three dimensional structure of P22 C1. We have crystallized the wild type C1 protein in complex with the promoter P_{RE} to learn about the molecular basis of interaction of the protein with its promoter. The crystals of the complex diffract to $2.2 \text{ \AA}$ using our in house Cu-K α source under cryogenic (100 K) conditions and belong to the space group $P2_1$, with unit-cell parameters $a = 87.7$, $b = 93.9$, $c = 111.7 \text{ \AA}$, $\beta = 95^\circ$. Solution of this structure using molecular replacement is in progress.

X-ray diffraction pattern for the P22 C1- DNA (P_{RE}) complex



III. Computational Biology

Electrostatic interactions in protein-protein complexes : Dr. Gautam Basu

Additional work was performed extending our ongoing work on electrostatic control of subunit orientations in protein-protein complexes. The revised work is being written as a manuscript for communication.

Prediction of aminoacylation rates of mutant tRNA from crystal structure of the wild type tRNA-aminoacyl-tRNA synthetase crystal structures : Dr. Gautam Basu

Our earlier result that aminoacylation rates of mutant tRNAs can be predicted from crystal structure of the wild type tRNA-aminoacyl-tRNA synthetase crystal structures was extended to more systems.

Molecular Dynamics simulations of tRNA : Dr. Gautam Basu

Work on MD simulations on tRNA^{Gln} and its mutants are continuing to understand how dynamics controls function.

Sequence analysis of tRNA^{Glx} from bacterial whole genomes : Dr. Gautam Basu

Bioinformatics work to determine the origin of tRNA^{Gln} isoacceptors in bacteria is in progress. In addition, extensive comparison between bacterial tRNA^{Gln} and tRNA^{Glu} sequences have yielded meaningful functional insights. Our ongoing work on the evolutionary origin of GluRS2 was published in BMC Evolutionary Biology.

Physicochemical features of protein-protein interfaces : Dr. P. Chakrabarti

To delineate features that characterize protein-protein interactions is a long-standing theme in our group. We have compared a large number of proteins both in the unbound and bound form and found that on going from the former to the latter state there is an increase in the accessible surface area of atoms that constitute the interface in the complex. The paper published in *Protein Science* has been highlighted in the issue.

Analysis of protein conformation : Dr. P. Chakrabarti

Water is an important component of protein structure; sometimes they fill in cavities and stabilize local structural motifs. We have analyzed π -turns, which are wider than other turns (β - or α -), and because of these can accommodate solvent molecule in the interior. Sometimes the solvents can be replaced by the hydroxyl group of a residue occurring in the turn. The conformation of such water and side-chain embedded π -turns has been elucidated.

Comparison of three dimensional structures of enteric pilins : **Dr. Rajagopal Chattopadhyaya**

The three dimensional structures of four type IVb pilin globular domains in *Vibrio cholerae*, *Salmonella enteric* serovar Typhi, enteropathogenic *Escherichia coli* (EPEC) and enterotoxigenic *Escherichia coli* (ETEC) reported earlier are compared. A new sequence alignment of TcpA (1oqv), CofA (3s0t), BfpA (1zwt) and PilS (1q5f). By superimposing in stereo, it is seen that three of the four pilins possess five super imposable β -strands, four nearly super imposable α -helices and a disulphide bond, while the bundle-forming pilin (BfpA) domain of EPEC does not superpose well, exhibiting a different strand topology, quite different locations for its four helices and several hydrophobic cores instead of a larger one. As a result, it lacks the extensive side chain-side chain interactions of $\alpha 1$ with almost parallel, three central β -strands observed in all other type IV pilins. Further, it cannot form the $\alpha 2$ - $\alpha 4$ lateral interactions between consecutive subunits within the left-handed three-start helices forming the fiber. We opine this NMR structure 1zwt may not be biologically relevant. Our alternative model for BfpA possesses secondary structures almost identical to those in the experimental study but is based on the *V. cholerae* pilin crystal structure. Structural differences within the type IVb pilins are also discussed.

Bioinformatic analyses of bacterial ring-hydroxylating oxygenases : **Dr. Tapan K. Dutta**

Using different maximum-likelihood models of adaptive evolution, signatures of natural selective pressure, operating across the naphthalene family of dioxygenases, were examined. A lineage- and branch-site specific combined analysis revealed that purifying selection pressure dominated the evolutionary history of the enzyme family. Specifically, episodic positive Darwinian selection pressure, affecting only a few sites in a subset of lineages, was found to be responsible for the evolution of nitroarene dioxygenases (NArDO) from naphthalene dioxygenase (NDO). Site-specific analysis confirmed the absence of diversifying selection pressure at any particular site. Different sets of positively selected residues, obtained from branch-site specific analysis, were detected for the evolution of each NArDO. They were mainly located around the active site, the catalytic pocket and their adjacent regions, when mapped onto the 3D structure of the α -subunit of NDO. The analysis enriches the current understanding of adaptive evolution and also broadens the scope for rational alteration of substrate specificity of enzyme by directed evolution.

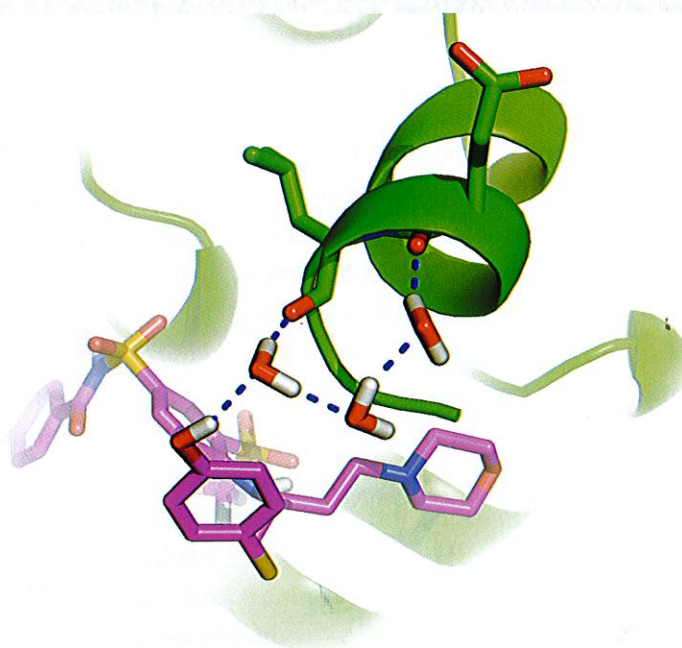
A manually curated database, RHObase (available at <http://bicresources.jcbose.ac.in/ssaha4/Rhobase/>), has recently been designed which provides comprehensive information on all biochemically characterized bacterial ring-hydroxylating oxygenases (RHOs). Apart from query search based on organism, oxygenase, substrate or protein structure, the database also provides analysis tools to perform blast search for prediction of putative substrate(s) for a query oxygenase and its phylogenetic affiliation. Furthermore, there is an integrated

cheminformatics tool to search for structurally similar compound(s) in the database vis-a-vis RHO(s) capable of transforming those compound(s). Thus, the resources in RHObase and multiple search/display options therein are intended to provide oxygenase-related requisite information to researchers, especially working in the field of environmental microbiology and biocatalysis to attain difficult chemistry of biotechnological importance.

Insight into Structural dynamics of biomolecules, leading to drug design :
Dr. Shubhra Ghosh Dastidar

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. For example, investigating the mechanism of conformational transitions of Bcl2 family of proteins that control the apoptosis has been a primary objective. This family of proteins is an example of a potential drug target having a relatively flat, flexible and non-groovy binding pocket, which is appropriate to frustrate a drug designer; which makes it an interesting system to study. 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 interactions between the Bcl-xl and some of its promising inhibitors underscoring the role of 'bridging-water' to stabilize the association.



Evolutionary Bioinformatics : *Dr. Tapash C Ghosh*

The main theme of our research goal is to identify and understand the different evolutionary forces by analyzing the genomic and functional data of various organisms. We conduct systematic analyses on genomic data of both prokaryotic and eukaryotic genomes, by applying multidisciplinary approach.

Regulatory RNA and stem cell biology : Dr. Zhumur Ghosh

Aim 1: Finding out the epigenetic regulators of cancer stem cells

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 has 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. To fulfill this work we did the following:

- (A) We annotated human and mouse lncRNAs and piRNAs based on their genomic context and have developed two databases based on such analysis [piRNAQuest (paper accepted at BMC Genomics and lncRBase (paper accepted in PLOSONE)].
- (B) We are checking how their genomic localization influences their functionality.
- (C) For setting up the experiments, we are collecting bone marrow samples from Acute Myeloid Leukemia patients to isolate leukemia stem cells from it.
- (D) We shall thereafter check the lncRNA and piRNA profile in this group of cells and which of them are potential biomarkers for the disease.

Aim 2: 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) [published at 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.

MicroRNA network in Parkinson's Disease : Dr. Debjani Roy

Parkinson's disease (PD) is the second most prevailing neurodegenerative disorder in the world. In order to explore the detailed role of PD related microRNAs (miRs) and its regulation by Transcription Factor (TF) we have studied TF-miR-mRNA regulatory network as well as miR co-expression network in PD. 23 novel unreported miRs were identified. These 23 novel hub miRs can be considered as potential disease markers and therapeutic targets for PD.

Protein-protein interaction networks of Parkinson's Disease : Dr. Debjani Roy

Microarray based gene expression data and protein-protein interaction (PPI) databases were combined to construct the PPI networks of differentially expressed genes in Parkinson's

disease (PD). Nodes with High Connectivity and High Betweenness-Low Connectivity (bottlenecks) were identified to be the most significant nodes of the networks. Three and four-cliques were identified in the PPI networks as core functional modules consisting of tightly knitted sub-networks. Hitherto unreported 37 PD disease markers were identified based on their topological significance in the networks. These network biomarkers may provide as potential therapeutic targets for PD applications development.

Drug-Target Network to study drug repositioning for Parkinson's disease : Dr. Debjani Roy

New computational approaches are required for the identification of new uses of existing drugs or drug repositioning which shorten the time to obtain drug approval by a huge factor. We developed a bidirectional (Top-down & Bottom-up) drug repositioning method for this purpose. In order to find best repositioning candidates for PD, the proposed method took into account of topologically significant nodes in both PD-specific drug-target networks as well as in protein-protein interaction network. Our study provides the opportunity to identify drugs known to work in other diseases to treat PD as well.

Modeling and structure-based virtual screening of a new tubercular maltosyl transferase, GlgE : Dr. Debjani Roy in collaboration with Dr. Sanghamitra Bandyopadhyay, Indian Statistical Institute, Kolkata

Recently maltosyl transferase of *Mycobacterium tuberculosis* (mtb GlgE) belonging to α -amylase family has been identified as a potential drug target. In this study we have modeled its 3D homo-dimeric structure using its homologue in *Streptomyces coelicolor* (stp GlgE) as the template. It has three binding cavities, one primary (pbs) and two secondary (sbs1 and sbs2), with one unique insert appearing within sbs2. Virtual screening with known substrates and substrate analogues of α -amylase family proteins indicated better binding of natural substrate maltose to sbs1 than pbs. This reveals for the first time the unique 3D structure of mtb GlgE and provides insights into its active sites and substrate binding affinities.

Pharmacophore- based virtual screening, docking and MD simulation studies on maltosyl transferase of *Mycobacterium tuberculosis* : Dr. Debjani Roy in collaboration with Dr. Sanghamitra Bandyopadhyay, Indian Statistical Institute, Kolkata

Pharmacophore-based virtual screening with subsequent docking and molecular dynamics simulations (MD) have been done in order to identify potential inhibitors of homology modeled 3D structure of maltosyl transferase of *Mycobacterium tuberculosis* (mtb GlgE). 23 molecules with better binding affinity than its natural substrate maltose have been identified. Top four ligand-protein complexes have been subjected to MD simulations. Analyses of trajectories of these complexes reflect the stable protein-ligand binding. Results reported in our study may provide insight into anti-tuberculosis therapeutic development research.

**Systematic discovery of novel motifs mediating protein protein interaction :
*Dr. Sudipto Saha***

A computational framework has been developed for identification of novel motifs from oncoproteins (MYC, MDM2, APC) that mediate multiple protein interactions. A database of linear motifs mediating protein-protein interactions has been developed.

Discovery of Asthma biomarkers using systems approach : *Dr. Sudipto Saha in collaboration with Dr. Swati Gupta Bhattacharya*

High throughput asthma biomarker studies including genomics and proteomics were integrated for identification of novel biomarkers. Database of Asthma and Allergy Biomarkers (DAAB) has been developed.



HPLC

IV. Molecular Medicine

Molecular mechanisms of tumor progression : Role of tumor derived products in mediating tumor cell growth, motility and metastasis : Dr. Kaushik Biswas

In order to establish the functional role of tumor derived gangliosides particularly GM2, siRNA knockdown strategy was utilized in GM2 over expressing cell lines SK-RC-26B, CCF52 and A549. Data shows that siRNA mediated silencing of GM2/GD2 synthase gene expression and consequent GM2 expression resulted in a significantly reduced level of migration in CCF52 (~ 40%) and in A549 (~ 50%) knockdown cell lines vs wild type. Data also indicates similar reduction in migration in the kidney cancer cell line, SK-RC-26B in response to siRNA mediated knockdown. We have also over-expressed GM2 in a cell line (SK-RC-45) minimally expressing GM2. According to RT-PCR and immunofluorescence data, the kidney cancer cell line (SK-RC-45) has moderate expression of GM2. Accordingly, β -1,4-GALNT gene have been successfully cloned in a mammalian expression vector pEF1/V5-HisA. In this regards, the full length coding sequence for the β -1,4-GALNT gene (NIH Accession Number NM_00148.3) have been amplified, cloned in pEF1/V5-HisA and transfected in SK-RC-45 cell line under G418 selection pressure. GM2 over-expressing SK-RC-45 cells showed increase in tumor cell migration by almost 50% compared to cells transfected with empty vector, thereby confirming the pro-migratory role of GM2 and higher order gangliosides. Further, addition of exogenous GM2 on SK-RC-45 cells resulted in a significantly increased migration (over 60%) of the tumor cells compared to non-treated cells, thereby confirming the direct role of ganglioside GM2 in tumor cell migration *in vitro*. DNA microarray analysis performed with RNA isolated from both wild type and GM2/GD2 synthase siRNA transfected CCF52 cells showed altered expression of several genes associated with cellular migration. Among the 50,000+ genes and ESTs analyzed, 1400 genes were found to be differentially regulated in CCF52 knockdown cells. Enrichment analysis highlighted genes involved in integrin signaling. Preliminary real time PCR validation and western blot analysis confirmed the integrin mediated signaling pathway to play an important role in GM2 mediated tumor cell migration. Further studies are underway to map the various signaling events and thereby elucidate the mechanism through which complex gangliosides promote tumor cell migration, motility and invasiveness.

Understanding the role of tumor derived glycosphingolipids in carcinogenesis : An *in vivo* approach : Dr. Kaushik Biswas

With an aim to translate the *in vitro* findings in an *in vivo* setting, mouse tumor cell line Renca-v (a GM2 over-expressing variant of the mouse kidney cancer cell line Renca) was selected for generation of a stable and permanent GM2/GD2 synthase knockout Renca line, which can be used in a syngeneic mouse tumor model. Using precise and targeted genome engineering tools

and rigorous clonal selection procedures, a stable GM2/GD2 synthase knockout cell line has been successfully generated (Renca-v^{GM2syn^{-/-}}), which is completely devoid of GM2 expression as evidenced by immunofluorescent microscopy. Immunofluorescent microscopic observation of the clones show complete depletion of ganglioside GM2 levels in 4 clones. Clonally selected complete GM2 synthase knockout (Renca-v^{GM2syn^{-/-}}) cells show significantly less clonogenicity and low anchorage-independent growth in soft agar assay, although there is no significant change in proliferative capacity and morphology as compared to the Renca-v wild type cells. These *in vitro* data suggest that GM2 may be involved in cellular transformation and neoplastic growth. Further, precise genome editing at GM2 synthase locus will help us to understand the function of GM2 synthase genes and complex gangliosides in tumorigenicity *in vivo* using syngeneic Balb/c mouse tumor models.

Studying the epigenetic regulation of ganglioside synthase genes in cancer : Dr. Kaushik Biswas

Although aberrant expression of gangliosides have been reported in various tumors previously, very few studies were performed to find out how these genes are regulated at the transcriptional level. Till date no direct evidence exists on the epigenetic regulation of ganglioside synthase genes in cancer. We have initiated a study to define the epigenetic role in regulating ganglioside synthase gene activity focusing primarily on two key ganglioside synthases – β -1,4-GalNAcT (β -1,4-N-acetylgalactosaminyltransferase or GM2/GD2 synthase) and ST-II (sialyl transferase/GD3 synthase), since these two enzymes regulate the biosynthesis of higher order gangliosides. Preliminary experiments suggest a plausible epigenetic role in the regulation of GM2/GD2 synthase gene in at least two cancer cell lines, SK-RC-26B and CCF52, compared to a normal kidney epithelial cell line, NKE. The study will also involve identification of the components involved in such an epigenetic regulation and elucidate the underlying mechanism through which ganglioside synthase genes are epigenetically controlled in cancer.

Studies on the efficacy of flavonoid and non-flavonoid polyphenols against chronic inflammation induced disease pathogenesis : Dr. Kaushik Biswas in collaboration with Dr. Rupak Mukhopadhyay, Asst. Prof., Tezpur University

This project has only been recently sanctioned by DBT under its Twinning Programme in collaboration with Dr. Rupak Mukhopadhyay, Assistant Professor of Tezpur University. The major aim of the project is to screen and identify potential compounds from natural sources, that by virtue of being anti-inflammatory may have anti-cancer potential, since chronic inflammation have been widely reported to be associated with carcinogenesis.

Contribution of cancer stem cells in initiation and maintenance of human triple negative breast carcinoma-induced angiogenesis : *Dr. Tanya Das*

Triple-negative breast cancer (TNBC) is characterized by most aggressive and therapy resistant invasive type of cancer that lacks the expression of estrogen and progesterone receptor (ER/PR) and HER2 (ERBB2) genes. TNBC has an increased likelihood of distant recurrence and death compared to women with other types of breast cancer and it possesses almost no molecular targets for therapeutic option in this horizon. Our effort towards better understanding the relevant targets that are associated with TNBC pathogenesis and therapeutic resistance to meet the urgent unmet medical need, identified cancer stem cells (CSCs) as the 'master regulators' of TNBC-induced angiogenesis that plays a central role in ensuring tumor growth and metastasis. Our exploration revealed that besides hypoxia enriching highly resistant CSCs, hypoxic niche and CSCs co-exist in the tumor mass of TNBC patients. CSCs secrete high levels of the pro-angiogenic factor VEGF under hypoxic condition, to regulate TNBC-induced angiogenesis in three ways: (i) by directly inviting endothelial cell migration and network formation; (ii) by optimizing the angiogenic potential of non-stem cancer cells (NSCCs); and (iii) by maintaining the angiogenic signal through de-differentiation of NSCCs to CSCs. Cumulatively, our findings establish the role of CSCs both in initiation and maintenance of TNBC-induced angiogenic process. These findings highlight the therapeutic significance of targeting CSCs to restrain TNBC-driven angiogenesis from the root.

A mechanistic approach to inhibit metastasis by targeting cancer stem cells : *Dr. Tanya Das*

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 in various cancers including breast cancer and has been shown to target CSCs. Here, we aimed at evaluating the effects of curcumin on breast CSC (bCSC) migration and studying the underlying mechanisms. We report that curcumin abrogates migration of bCSCs by restoration of E-cadherin expression, which is inherently down-regulated in these cells as compared to the rest of the tumor population. A search for the underlying mechanism revealed that in bCSCs, nuclear translocation of β -catenin (i) decreases E-cadherin/ β -catenin complex formation and membrane retention of β -catenin, and (ii) up-regulates the expression of its EMT-promoting target genes including Slug, thereby down-regulating E-cadherin transcription to subsequently promote EMT and migration of these breast cancer stem cells. In contrast, curcumin inhibits β -catenin nuclear translocation thus impeding trans-activation of Slug. As a consequence, E-cadherin expression is up-regulated thereby increasing E-cadherin/ β -catenin complex formation and cytosolic retention of more β -catenin to finally suppress EMT and migration of bCSCs. Cumulatively, our findings disclose that curcumin inhibits bCSC migration by amplifying E-cadherin/ β -catenin negative feedback loop.

An approach to restore the 'missing' p53-SMAR1 positive feed-back loop to induce apoptosis in HPV18-infected cervical adenocarcinoma : *Dr. Tanya Das*

Development of cervical cancer, which is the second most common cause of cancer death in women worldwide, is highly associated with infection by high risk human papilloma viruses (HPV). HPV oncoprotein E6, contributing effectively in anti-apoptosis network, represents one of the most promising therapeutic targets for the treatment of HPV-positive tumors and dysplasias since its repression may result in reactivation of tumor suppressor pathways in cancer cells. In this regard, matrix attachment region (MAR) binding proteins have been implicated in the transcriptional regulation of host as well as viral genes but their precise role in HPV-infected cervical cancer remains unclear. Here we show that HPV18 promoter contains consensus MAR element in the LCR and E6 sequences where SMAR1 binds and reinforces HPV18 E6 transcriptional silencing. In fact, curcumin-induced up-regulation of SMAR1 ensures recruitment of SMAR1-HDAC1 repressor complex at the LCR and E6 MAR sequences thereby decreasing histone acetylation at K9 and K18 leading to re-orientation of the chromatin. As a consequence, c-Fos binding at the putative AP1 sites on E6 promoter is inhibited. E6 depletion interrupts degradation of E6-mediated p53 and lysine acetyl transferase, Tip60. Tip60, in turn acetylates p53, thereby restoring p53-mediated transactivation of pro-apoptotic genes to ensure apoptosis. This hitherto unexplained function of SMAR1 signifies the potential of this unique scaffold matrix-associated region-binding protein as a critical regulator of E6-mediated anti-apoptotic network in HPV18-infected cervical adenocarcinoma. These results also justify the candidature of curcumin for the treatment of HPV18-infected cervical carcinoma.

Stabilization of Quadruplex Structures of c-Myc Oncogene in Breast Cancer Cells : *Dr. Banabihari Giri*

- a. c-Myc oncogene is highly over expressed in the cancer cell and many studies has been done to inhibit the expression of c-Myc oncogene in breast cancer cell. None of the studies is successful yet to control the overexpression of c-Myc. However, complete understanding of how to regulate c-Myc overexpression that leads to the progression disease is lacking. Thus, to better understand the regulation of the c-Myc oncogene in breast cancer, it is our thought that we can determine the relative contributions of guanine rich sequences which form quadruplex (G4) structures in the promoter region of c-Myc oncogene during replication and/or transcription in presence of potassium. Moreover, various helicase including G4 Resolvase 1 (G4R1) unwinds G4 quadruplex structures invitro. Neither G4R1 nor KCl has been studied before in the context of stabilization of c-Myc oncogene in breast cancer cells. To test this hypothesis, we will address the following specific aims.

Aim 1.: To measure the G4R1 resolving/binding activity on unimolecular quadruplex DNA/RNA structures.

Aim 2.: To stabilize c-Myc quadruplex structure by potassium chloride (KCl) *in vitro*.

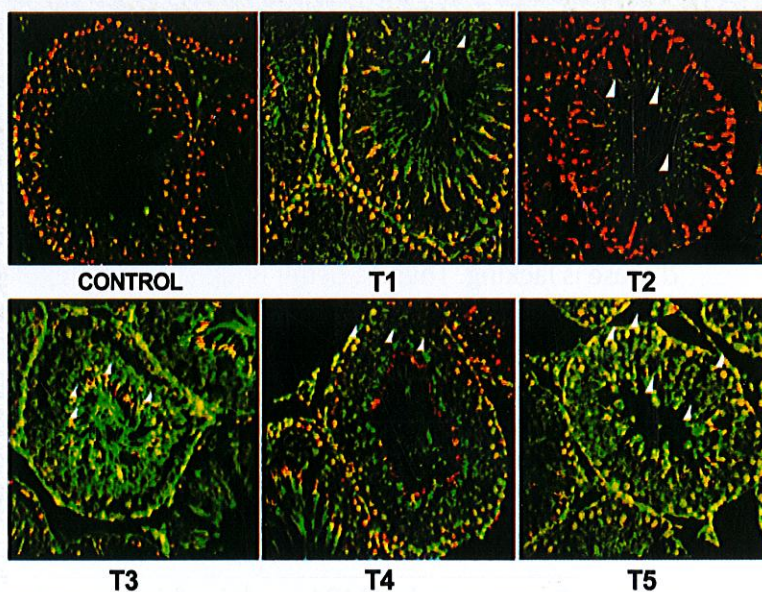
Aim 3.: To study the effect of small interfering RNA (siRNA) mediated G4R1 silencing in breast cancer cells. We will investigate the c-Myc promoter in breast cancer cells because of its high potential to form G4 quadruplex structures. Stabilization of quadruplex structures in the promoter region of c-Myc by KCl may decrease the expression of this oncogene. Furthermore, knocking down G4R1 by siRNA will also be beneficial in stabilizing quadruplex structures in c-Myc.

The development of this novel strategy to stabilize the quadruplex structures of c-Myc promoter by increasing KCl concentrations and down regulating expression of G4R1 offers a potential avenue to inhibit c-Myc overexpression in breast cancers cells.

- b. Bulk metals do not provide fluorescence property. However, metals at nano scale provide fluorescence when conjugated to macromolecules such as DNA. Smaller noble metal clusters have even larger fluorescence quantum yields as well as high photo stability and large absorption cross section, making them ideal chromophores. Silver clusters stabilize the I-motif (cytosine rich sequence) structure of DNA. The proposal of this project is to develop an ideal optical probe for rapid screening and diagnosis at point of care settings.

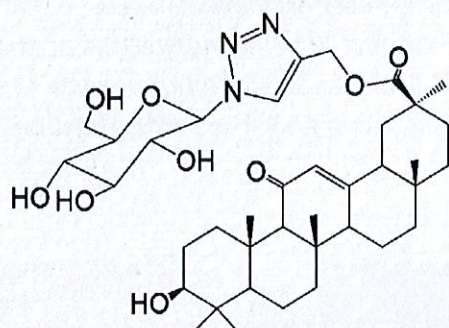
**Germ cell and Leydig cell apoptosis by benzo(a)pyrene: A molecular approach :
Dr. Kuladip Jana in collaboration with Dr. P. C. Sen**

Testicular toxicity of benzo(a) pyrene have been demonstrated in male and that are mediated by the aryl hydrocarbon receptor (AhR). This study related to testicular steroidogenic acute regulatory gene (StAR) expressions and caspases expressions, glutathione depletion as well as germ cell and Leydig cell apoptosis in relation to the benzo(a)pyrene treatment (DST-SERC First Track Young Scientist Project (2012-2015))

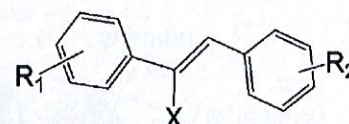
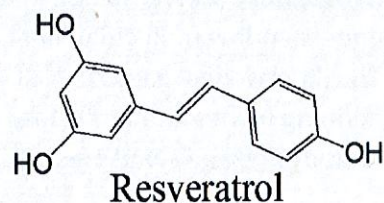


Synthesis and bio-evaluation of natural product analogs for anticancer activity :
Dr. Kuladip Jana in collaboration with Dr. A. K. Misra and Dr. Kaushik Biswas

- A series of glycosyl triazolyl terpenoid derivatives were synthesized and anticancer activity of these derivatives are currently ongoing.
- A series of analogs of Resveratrol, a well known anticancer agent were prepared and their evaluation of biological activity is ongoing.



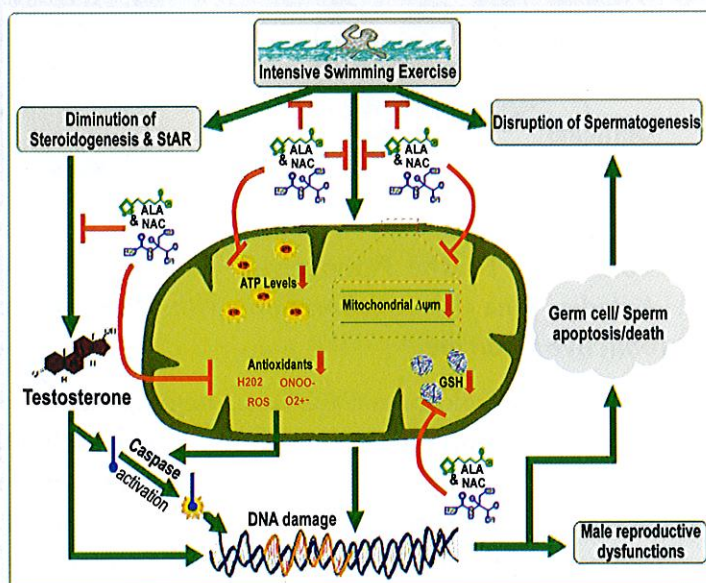
Glycosyl triazolyl glycyrrhizine derivatives.



Resveratrol derivatives

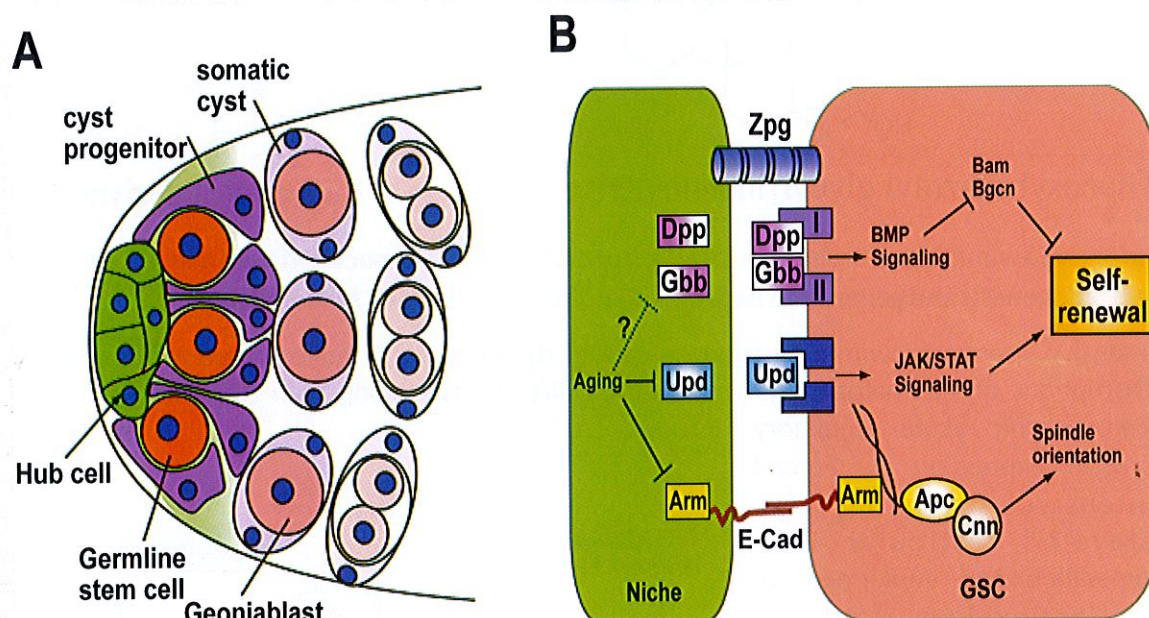
Intensive swimming exercise mediated germ cell depletion associated with the alteration of steroidogenesis and generation of pro-oxidants in rat testis : Dr. Kuladip Jana

Intensive strenuous swimming exercise caused dysfunctions in male reproductive system². Disruptions of spermatogenesis and sperm DNA damage along with steroidogenesis and steroidogenic acute regulatory protein expression $\Leftrightarrow$ Forced intensive swimming also elevated testicular ROS generation and impairment of the antioxidant status $\Leftrightarrow$ Exhausted swimming resulted impairment of testicular mitochondrial membrane potential ($\Delta\psi_m$) along with caspase activation $\Leftrightarrow$ Moreover, alpha lipoic acid and N-acetyl cysteine protected the exhaustive swimming exercise mediated testicular abnormalities following diminution of ROS generation.



Molecular Mechanisms of Germ-line Stem Cell Regulation : Dr. Kuladip Jana in collaboration with Dr. Partha Roy, Dept. of Biotechnology, Indian Institute of Technology (IIT), Roorkee, U.T.K.

Germ-line stem cells (GSCs), which can self-renew and generate differentiated progeny, are unique stem cells in that they are solely dedicated to reproduction and transmit genetic information from generation to generation. Through the use of genetic techniques in *Drosophila*, *Caenorhabditis elegans*, and mouse, exciting progress has been made in understanding molecular mechanisms underlying interactions between stem cells and niches. The knowledge gained from studying GSCs has provided an intellectual framework for defining niches and molecular regulatory mechanisms for other adult stem cells. Our focus is to study the conserved mechanisms underlying GSC self-renewal and differentiation.



Molecular Cues To The Pathogenesis Of PCOS: The Role Of Hyperhomocysteinemia : Dr. Kuladip Jana in collaboration with Prof. Baidyanath Chakravarty, Institute of Reproductive Medicine

Polycystic Ovary Syndrome (PCOS) is a heterogeneous entity comprised of broad spectra of ovarian disorders and metabolic syndrome (MS) including anovulation, hyperandrogenism with a frequent association of insulin resistance (IR), obesity and dyslipidemia to name a few. Recent studies document that a significant population of PCOS women do also suffer from hyperhomocysteinemia (HHcy), which has been known to be a close associate of IR as well as an independent risk factor of MS. Despite frequent associations between PCOS, IR and HHcy,

the cause and effect relationships between these three entities still remain elusive and it remains yet to be resolved if HHcy is a mere co-existence or after-effects of the disease or it has any contributory role in the pathogenesis of the disease. Nevertheless, we have observed that a moderate degree of HHcy induced by oral administration of homocysteine (Hcy) through drinking water replicates the full morphologic and metabolic spectra of PCOS.



Targeted delivery of nano-conjugated Methylglyoxal to cancer cells and understanding the bioenergetics difference between normal and malignant cells at the molecular level (DST sponsored Project : Dr. Kuladip Jana in collaboration with Prof Manju Ray, CSIR-Emeritus Scientist & Bhatnagar Awardees, Bose Institute, Kolkata.

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 production and study of a nano-conjugated methylglyoxal drug which can be more effective. Also the ability of the compound in restoring the downregulated levels of the energy buffering enzyme creatine kinase in sarcoma tissue indicates its role in energy metabolism in neoplastic cells which has to be studied further to understand the importance of creatine kinase and creatine in neoplastic cells.

A role of CD11b⁺Gr1⁺ MDSCs in *Leishmania donovani* infected BALB/c mice : Syamdas Bandyopadhyay and Dr. Subrata Majumdar

CD11b⁺Gr1⁺ MDSCs (Myeloid derived suppressor cells) generate protective hum advance immunity against experimental visceral leishmaniasis because of suppressed naïve T cell functions by them. MDSCs from SLA-immunized mice are less suppressive in function. This

nature of suppression is accompanied with the F4/80+ sub-population of MDSCs. Inhibition of the function of this population restores the capacity in BALB/c mice to combat against *L. donovani* infection.

Antigen-pulsed CpG-ODN-activated dendritic cells induce host-protective immune response by regulating the T regulatory cell functioning in *Leishmania donovani*-infected mice : Saikat Majumder and Dr. Subrata Majumdar

We established that SLA-CpG-DCs vaccination results in the significant decrease in regulatory T cells (Treg) cell population in *Leishmania* infected mice. Vaccination with these antigen-stimulated dendritic cells results in the decrease in the secretion of TGF- β by these Treg cells by possible regulation of the SMAD signaling. Moreover, we demonstrate that a CXC chemokine, IFN- γ -inducible protein 10 (IP-10; CXCL10), has a direct role in the regulation of CD4⁺CD25⁺ Treg cells in SLA-CpG-DC-vaccinated parasitized mice.

Immunomodulatory Role of Arabinosylated Lipoarabinomannan (Ara-LAM) against Tuberculosis : Involvement of Protein Kinase C (PKC) Mediated Signaling : Shibali Das and Dr. Subrata Majumdar

We found that pretreatment of *M. tuberculosis*-infected macrophages with Ara-LAM caused a significant increase in the cPKC expression along with the active association of cPKCs with TLR2. All these events culminated in the up-regulation of proinflammatory response, which was abrogated by treatment with PKC- α and P-38 inhibitors. Moreover, Treatment of macrophages with Ara-LAM abrogated the IL-10 production while restored MHC-II expression in the infected macrophages. This study demonstrates that Ara-LAM confers protection against tuberculosis via TLR2/PKC signaling crosstalk.

The host-protective effect of Arabinosylated lipoarabinomannan against *Leishmania donovani* infection is associated with different T-cell responses : Bidisha Paul Chowdhury and Dr. Subrata Majumdar

Ara-LAM, a cell wall glycolipid isolated from *Mycobacterium smegmatis*, restored IFN- γ responsiveness through enhanced IFN- γ R α expression and its downstream JAK1/2-STAT1 signaling, followed by NO generation and Th1 cytokine production in *L. donovani*-infected BALB/c mice. It differentially regulated IRF4 and IRF8 expression and induced IFN- γ secreting CD4⁺ and CD8⁺T-cells in an organ dependent manner. All these host-protective mechanisms were significantly suppressed by IFN- γ R α silencing due to absence of effective IFN- γ signaling. Ara-LAM is also predicted to suppress the regulatory T-cell generation along with higher cytotoxic T-cell activation and proliferation for better parasite clearance.

Co-administration of Glycyrrhizic Acid with the antileishmanial drug Sodium Antimony Gluconate (SAG) cures SAG-resistant visceral leishmaniasis : *Amrita Bhattacharjee and Dr. Subrata Majumdar*

Combination therapy with Glycyrrhizic acid (GA) and Sodium Antimony Gluconate (SAG) successfully restricted infection with SAG-resistant *L. donovani* in a synergistic manner (FICI < 0.5). GA suppressed the expression and efflux activity of P-gp and MRP1, which correlated with greater intracellular antimony retention. Moreover, co-treated infected mice exhibited significant parasite burden reduction. Further, GA and SAG induced a Th1 phenotype by augmenting pro-inflammatory cytokines. This study aims to provide an affordable leishmanicidal alternative to expensive antileishmanial drugs required for drug resistant leishmaniasis.

Identification of the host cell factors responsible for survival and death of *Leishmania donovani* : *Shabina Parveen and Dr. Subrata Majumdar*

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.

Role of Protein Kinase C isoforms in the regulation of T cells subsets during *Leishmania donovani* infection : *Junaid Jibran Jawed and Dr. Subrata Majumdar*

We have tried to find out the role of several PKC isoforms in regulation of CD4 + Foxp3 + Treg cell and Th-17 cells which play immune-suppressive and host protective roles respectively during *Leishmania donovani* infection. Since several distinct sets of cytokines are responsible for the establishment of different T cells subsets lineage such as IL-6, TGF β , IL-23 and IL-1 β for the generation of IL-17 specific Th-17 cells and TNF α and TGF β for Treg cell, where as IL-6 has been found to play a differential role in suppression of Treg cells and generation of Th-17 cells, hence, here we are trying to find out the role played by PKC isoforms in the regulation of these cytokines during *Leishmania donovani* infection.

***Mycobacterium indicus pranii* (Mw) inhibits invasion by reducing matrix metalloproteinase via PI3K/AKT- and PKC α -mediated signaling: a potential candidate in melanoma cancer therapy : Kuntal Halder and Dr. Subrata Majumdar**

Heat killed *Mycobacterium indicus pranii* (MW) found to inhibit proliferation and invasion of B16F10 melanoma. Mw regulates MMP-9 expression by (NF-kB) via (PI3K)/Akt and (AP-1) activation through (ERK) 1/2. PKC α inhibition decreases MMP-9 secretion and cell invasion, as well as ERK/AP-1 activation and MW reduced PKC α membrane localization. In vivo administration of MW led to a substantial decrease in tumor volume, expression of MMP-9 and PKC α . Hence, MW inhibits invasion by reducing MMP-9, mainly via the PI3K/Akt/NF-kB and PKC α /ERK/AP-1 pathways in B16F10 cells and blocks tumor growth.

Role of Hsp70 in cellular protein quality control : Dr. Atin Kumar Mandal

Molecular chaperone Hsp70 facilitates folding of proteins and targets immature or misfolded proteins for degradation, and thus maintains the overall cellular protein quality control. But, how Hsp70 synchronizes these functions whether to fold or degrade depending on the status of the cells is not clearly understood. We address this question using protein kinase as substrate in the yeast system. By pulse-labeling studies with radioactive [S^{35}]methionine, we found that Hsp70 assists in maturation of kinases by helping autophosphorylation of its conserved phosphorylation residues. Thus, Hsp70 facilitated folding of newly synthesized protein kinases to achieve its functional active state. However, Hsp70 also promoted the degradation of folded kinases in their regular protein turnover or during stressed conditions when kinases were denatured. Hsp70 here stimulates ubiquitinylation of substrates and acts as a mediator to deliver the substrate to the ubiquitin ligases.

Further studies found that Hsp70 protected the kinases from nonspecific interaction that resulted in insoluble aggregates. These aggregates formed by the Hsp70 impairment were deposited in the perivacuolar area of the cells as insoluble protein deposits (IPOD) which is quite distinct from juxtanuclear aggregates (JUNQ) formed by the Hsp90 inhibitions. Partition of soluble and insoluble fractions supports this observation. Kinases were accumulated in the insoluble fraction upon Hsp70 impairments in contrast to the Hsp90 inhibitions where kinases were accumulated mainly in the soluble fraction.

Overexpression of Hsp70 solubilized these aggregates in compartment-specific manner. Insoluble aggregates were mobilized to more soluble, ubiquitinylated JUNQ compartment and then degraded by the proteasome, whereas juxtanuclear aggregates were defragmented first and then cleared via the proteasome. Thus, Hsp70 plays a critical role in cytoprotection and protein quality control in various cellular conditions.

Raf1 quality control and development of pathological condition : Dr. Atin Kumar Mandal

Raf1 is highly regulated MAP3K and essential for various cellular functions. Deregulation of Raf1 often causes diseases mainly hypertrophic cardiomyopathy or cancer where mutation of mammalian Raf1 kinase attains gain of function. Our aim is to identify the underlying mechanism of enhanced activity of mutant Raf1 that cause disease progression and whether quality control apparatus has any role behind this phenomenon. To establish this we have studied the quality control of WT Raf1 and pursuing how it alters in the case of mutants. We are addressing this question by using the yeast system, and also in mammalian cell culture. Expression of Raf1 in yeast showed that Raf1 stability is highly dependent on chaperones Hsp90 and Cdc37. This result confirms the previously reported mammalian cell culture data and suggests that yeast could be used as a model system to study Raf1 homeostasis. Then, we have tested the effect of other cochaperones such as Ydj1 (Hsp40), Aha1, Sse1 (Hsp110), Sba1 (P23) and they did not show any effect in the stability of Raf1. The dependence of Raf1 on Hsp90 and Cdc37 was also established in mammalian NKE cells using Hsp90 inhibitors, geldanamycin and celastrol that reduce interaction between Cdc37 and Hsp90. Thus, disruption of any of these two chaperones leads to the rapid degradation of Raf1. To elucidate the function of Hsp90 and Cdc37 we have used temperature sensitive *hsp90* and *cdc37* mutant yeast strains. We identified that these two chaperones are required for autophosphorylation of S621 residue that is essential for Raf1 stability. This result was confirmed in NKE cells by inhibiting Hsp90 with geldanamycin or silencing Cdc37 with siRNA.

Hsp90 and Cdc37 were also required for maintaining the Raf1 kinase activity. Interestingly, we have found that cochaperones Ydj1 (Hsp40), Sti1 (HOP) and Aha1 (Aha1) also modulate Raf1's kinase activity. The Kinase activity of Raf1 almost abolished in Sti1 and Aha1 knocks out strains, but reduced about 50% in the case of Ydj1 deletion yeast strain. This result suggests that other cochaperones are involved in maintaining the Raf1 in the active state. However, these cochaperones had no effect on S621 phosphorylation or the stability of Raf1. In contrast to these chaperones, Hsp70 was involved in the degradation of Raf1. This degradation is channelized via the proteasome and required the assistance of nucleotide exchange factor, Snl1 (mammalian homologue of Bag1).

To determine whether mutants of Raf1 behave similar way we have constructed several Raf1 mutants in CR2 and CR3 domains in both yeast vector as well as mammalian expression vector. These mutants are responsible for causing hypertrophic cardiomyopathy, particularly Noonan Syndrome. All of these mutants were expressed and showed higher basal kinase activity in yeast. The difference in quality control mechanism of WT and mutant Raf1 is under way.

**Established assay system to screen small molecule modulator of Hsp70 :
Dr. Atin Kumar Mandal**

Hsp70 plays a major role in maintaining quality control of proteins and becomes a potential drug target. We have aimed to develop modulators of Hsp70. Hsp70 has low intrinsic ATPase activity and this activity is increased by assistance with Hsp40 that catalyze ATP hydrolysis of Hsp70 and nucleotide exchange factor (NEF) which exchange ATP to ADP. We have planned to use *Mycobacterium tuberculosis*'s DnaK (Hsp70), DnaJ (Hsp40) and GrpE (Hsp110) in order to screen small molecule modifier of Hsp70 which modulates ATPase activity of Hsp70. His-tagged DnaK and DnaJ plasmid was obtained. GrpE was cloned in PET28 vector containing His-tag. All these constructs were successfully expressed in bacteria and purified in homogeneity by nickel/cobalt affinity resin.

Achievements from Marine Biotechnology research : Dr. Nripendranath Mandal

DNA markers linked to disease resistance in marine shrimp, *Penaeus monodon*:

Aquaculture of giant black tiger shrimp, *Penaeus monodon*, one of the most economic aquaculture industries of the world, including India, is frequently destroyed by White spot disease caused by white spot syndrome virus (WSSV), without any possible remedy. From our **Marine Biotechnology** research program, one microsatellite DNA marker (71 bp) and one RAPD-SCAR marker of 457 bp have been developed to identify disease resistant population of shrimp, *P. monodon* for the first time with plausible remedy. Practicability of these markers, tested by WSSV challenge experiment, showed $\sim 10^3$ fold higher WSSV propagation among disease susceptible as well as greater survivability among disease resistant population of *P. monodon*. Moreover, both WSSV prevalence and disease resistant prevalence were studied among the *P. monodon* samples collected from four different places, viz. Digha, West Bengal; Chilika, Orissa; Visakhapatnam, Andhra Pradesh; Chennai, Tamil Nadu at three different seasons in the period of 2011-2013 from East coast of India. The cumulative WSSV prevalence at four places was the lowest (0%) at pre-monsoon, whereas it was the highest (21.2%) during post-monsoon season. Quantitative real time PCR showed the average copy number of WSSV to be the highest ($\sim 10^3$ copy/ μ g shrimp genomic DNA) at post-monsoon season. Additionally, estimated disease resistant prevalence was the highest in Visakhapatnam (79%) and lowest in Digha (21%).

Achievements from Medical Biotechnology research : Dr. Nripendranath Mandal

Importance of medicinal plants for non-communicable diseases in human system:

Research output from the field of **Medical Biotechnology** program suggested that **nine** medicinal plants/natural resources out of **twenty nine** have been found to be effective in

developing anticancer medicines against various cancer types. Among them, mechanistic evaluation of the anticancer activity has been done for *Spondias pinnata* and *Terminalia belerica* against lung and breast adenocarcinoma, whereas *Acacia catechu* and *Parmotrema reticulatum* in breast adenocarcinoma. The results showed an interesting finding; that the crude extracts of the plants/lichen were selective in killing cancer cells only, without harming normal cells, in contrast to the purified compounds isolated from the extracts those lost their selectivity while killing normal cells as well. Therefore it is suggested that this kind of approach will be a better alternative than chemotherapy to combat cancer.

Synthesis and bioevaluation of organic small molecules and complex oligosaccharides of microbial origin : *Dr. Anup Kumar Misra*

(a) 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, JNU, SINP, NICED, CDRI).

(b) Our laboratory has also been engaged in developing chemical synthetic strategies for the synthesis of several complex oligosaccharides found in the cell-wall of pathogenic bacteria for their use in the preparation of glycoconjugate derivatives. In the current scenario, 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).

Understanding regulation of heat shock factor 1 (HSF1) in human cancer cells in response to heat shock : *Dr. Mahadeb Pal*

Cells normally activate a specialised machinery to neutralise effect of proteotoxic stress induced by variety of stressors including elevated temperature, peroxide, ethanol and heavy metals. Various pathologies including cancer, and Alzheimer's disease associate with inefficient regulation of proteotoxic stress response. HSF1, a transcription activator, mediates cellular proteotoxic stress response 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. It is not yet clear on the set of factors HSF1 engages in complete response to heat shock stress. We have taken both genetic and proteomic approach to understand players and their mode of function in HSF1 mediated gene activation in response to heat shock.

Understanding the role of positioned nucleosome in stress induced gene expression in human cells : *Dr. Mahadeb Pal*

In a healthy cell the majority of cellular stress-induced genes including the targets of various oncogenes and tumor 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 genomewide 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 inducible gene transcription in human cells : *Dr. Mahadeb Pal*

We have noticed that DNA-dependent protein kinase (DNA-PK) associates with preinitiation complex by a masspec analysis. DNA-PK is well known player in double stranded non homologous DNA-break repair in the cell. We found by biochemical assay that DNA-PK might be involved in the dissociation of initiation factors following initiation of transcription. While we are pursuing this aim in in vitro transcription, we wanted to test at the same time by parallel experiments if transcription of genes inducible by different stressors also requires DNA-PK. I found our assumption to be true. At present we are exploring the mechanism of recruitment of DNA-PK as well as its mode of action in the process of induction of genes induced by multiple signals including heat shock.

Isolation and understanding active compounds in medicinal plant extracts : *Dr. Mahadeb Pal*

Plant extract containing various medicinal values have been known and methodically used since the genesis of human civilisation. India is believed to a wealthy source of medicinal plants on the globe. Because understanding gene deregulation in cancer cell is an objective in our lab we planned to check if we find activity in plant extracts specific to an transcription factor or an oncogene. To this end we have devised sensitive cell based reporter system responsive to various transcription factors to assay, purify, and identify an activity specific to a transcription factor. Isolation/purification involves use of extraction of activity with solvents of various polarities and chromatography based methods.

BRAF perturbation channelizes oncogenic RAS-induced proliferative-signaling towards apoptotic-signaling : Dr. Gaurisankar Sa

Although active-mutant RAS is primarily attested with potent transforming ability, the RAS oncogene has, in addition to its mitotic potential, an apoptogenic activity still yet poorly-understood. So, exploring the signaling circuit for the shift of RAS signals from pro-proliferative to death-effector pathways may provide us the molecular roots for the “missing link” between mitogenic and apoptogenic mechanisms. Our theoretical and experimental studies unveil that while perturbation of RAF/ERK pathway in mitogen-stimulated wild-type RAS-expressing cells resists apoptosis, intervention of this proliferative pathway sensitizes active-mutant RAS-expressing cells by channelizing oncogenic RAS-signal towards p38MAPK/JNK1 pro-death-circuitry. Such apoptogenic signal ensures phosphorylation of p53 for optimal activation of this tumor suppressor protein. Cumulatively, our findings delineate hitherto unexplained but critical mechanisms in the role of active-mutant RAS as a signal-switch molecule that oscillates between survival and apoptogenic cascades and thereby decides the fate of transformed cells. Uncontrolled RAS activation is a very frequent genetic defect in human cancers; our findings thus constitute a specific novel approach to tumor regression through the differential regulation of different MAP kinase family members downstream of RAS, may have a critically potential for therapeutic significance.

Andrographolide-mediated ERK inhibition prevents tumor-induced T-regulatory cell augmentation : Dr. Gaurisankar Sa

Tumor progression is associated with immune-suppressive conditions, which facilitates the escape of tumor cells from the regime of immune cells, subsequently paralyzing the host defence mechanisms. CD4⁺CD25⁺FoxP3⁺T-regulatory (Treg) cells are induced from naïve conventional CD4⁺ T cells in periphery under the influence of tumor microenvironment. Induction of Treg cells has been implicated in tumor immune escape mechanism, but targeting Treg cells in anti-cancer treatment remain to be elucidated. However phytochemical research has been considered as an alternative therapeutic approach in this regard. Andrographolide, the bioactive derivative of medicinal plant *Andrographis paniculata* was accredited as a promising drug candidate for manipulating inflammatory milieu in tumor microenvironment but the tumorsuppressive activity of and rographolide, yet to be deciphered. Here we used both *in vitro* and *in vivo* model to define the interaction between tumor and immune system that leads to the induction of adaptive Treg cells in tumor microenvironment which functionally induce immunosuppression and was found to be reversed by and rographolide treatment. A two-step model for Treg cell differentiation has been suggested in tumor environment where, first, a TGF- β signal resulted in up-regulation of CD25 through phosphorylation of Smad3,

making Treg precursor competent to receive IL-2 signal, and then induce Foxp3 expression in a STAT5-dependent manner. It was found that and rographolide inhibit TGF β induced nuclear translocation of p-SMAD3/SMAD4 complex that lead to declining of CD25/IL2R on CD4⁺ T cell surface. Mechanistically it was established that and rographolide decreases the TGF β mediated hyper-activation of ERK-signalling that leads to decrease in phosphorylation of SMAD3. As a result high-affinity binding of IL2 on those cells was prohibited, causing lack of STAT5 activation required for FoxP3 expression. This work represents an interesting contribution in an effort to restore the full-fledged anti-tumor immune response that may result in a better clinical outcome of immunotherapy in tumors.

**Involvement of nifetepimine in motility and capacitation of caprine spermatozoa :
Dr. Parimal C. Sen**

Activation of sperm motility and capacitation are essential pre-requisite for successful fertilization. Elucidation of the biochemical mechanisms underlying these processes is central to our understanding of reproductive pathology affecting the male gamete and the development of novel approaches to fertility control. A key element of capacitation is the spontaneous increase in protein phosphorylation observed during sperm capacitation. If this protein phosphorylation event is suppressed, then sperm capacitation does not occur and the spermatozoa lose their ability to respond their physiological agonist essential for successful fertilization. The aim of our present study is to elucidate the effect of a dihydropyrimidone derivative, ethyl-4-(3-nitro)-phenyl- 6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5 carboxylate (nifetepimine) in sperm motility and capacitation using caprine model. Results show that nifetepimine significantly reduces sperm motility by modulating cAMP dependent protein kinase (PKA) activity and the content and/or localization of motility associated ser/thr/tyr phosphorylated proteins. Nifetepimine significantly decreases the tyrosine-serine phosphorylation of proteins and changes their distribution pattern under capacitating condition. Also, the co-localization of nifetepimine with AKAP3 and PKA-RII subunit in caprine spermatozoa illuminate the mechanistic pathway by which nifetepimine modulates sperm function. In the present study we have explored how the sperm motility and capacitation are affected by nifetepimine, a synthetic dihydropyrimidone.

**Regulation of PKC mediated signaling by Calcium during Visceral Leishmaniasis :
Dr. Parimal C. Sen in collaboration with Dr. Subrata Majumder**

The intracellular Ca²⁺ homeostasis is affected during visceral leishmaniasis which is caused by protozoan parasite *Leishmania donovani*. Different Ca²⁺ pumps help in maintaining the intracellular Ca²⁺ homeostasis, activated by Ca²⁺ ATPases. Two Ca²⁺-ATPases, plasma

membrane calcium ATPase (PMCA) and sarco/endoplasmic reticulum calcium ATPase (SERCA) play different roles in pumping intracellular Ca^{2+} . We have worked with PMCA4 and SERCA3 to study their effect during leishmaniasis. In this study we observed that during leishmaniasis, intracellular Ca^{2+} concentration was increased and this enhanced Ca^{2+} was further controlled by both PMCA4 and SERCA3. Activation of PMCA4 also helped in accelerating the parasite burden. Enhanced intracellular Ca^{2+} also found to be harmful for host cell parasites, amastigotes, due to inhibition of these two Ca^{2+} -ATPases. It was also found that Ca^{2+} plays a crucial role on pro- and anti-inflammatory cytokines. These results clearly demonstrated that these two Ca^{2+} -ATPases involved in regulating the intracellular cell function during visceral leishmaniasis.

Studies on the bio-active molecules in organ pathophysiology : *Dr. Parames C Sil*

Main objectives

Research in our laboratory encompasses several major areas of organ pathophysiology: hepatotoxicity, cardiotoxicity, neurotoxicity, reproductive toxicity and nephrotoxicity. However, special emphasis is placed upon:

- Drug and chemical-induced mechanisms of cell injury and cell death in multiple vital target organs both in vivo and in vitro.
- Studies on the signal transduction mechanism of cell death and survival in organ pathophysiology.
- Unraveling the mechanisms and exploring the antitoxic/antioxidant potentials of phytochemicals (natural and man-made antioxidants).

Role of taurine against nano copper induced hepatic pathophysiology

Earlier, we reported the mechanism of action of protective role of taurine (2-aminoethanesulfonic acid), in part, against nano copper induced hepatic injury through its strong ROS scavenging and anti-oxidative properties. Here we report that nano copper administration increased intracellular reactive oxygen species (ROS) and NO production, decreased GSH level and induced apoptotic cell death by mitochondria dependent pathways. Signal transduction studies showed that nano copper exposure significantly elevated the expression of NF κ B, I κ B κ , iNOS, Bax, cytochrome c, caspase 9 and caspase 3. However, taurine exert its anti-apoptotic effect by down regulating the NF- κ B, cleaved caspase 9, cleaved caspase 3 and other mitochondrial dependent signaling molecules, as well as by up-regulating the expression of Bcl-2. In summary, we would say that taurine could afford protection against nano copper induced hepatic damage by its antioxidant potential as well as other pathways involved in apoptotic cell death [Ghosh et al., *Toxicol Res* 3: In press, DOI: 10.1039/C4TX00030G, 2014].

Role of quercetin against iron oxide nanoparticles

Studies on cell signaling mechanism of FeONPs (iron oxide nano particles) induced oxidative stress and cytotoxicity in vitro using hepatocytes were carried out. In addition, the cytoprotective action of quercetin in this pathophysiology has also been investigated. Dose-dependent studies suggest that incubation of hepatocytes with FeONPs significantly decreased the cell viability as well as intra-cellular antioxidant ability. Besides, the study also showed that FeONPs exposure caused hepatocytes death via the apoptotic pathway. Incubation of hepatocytes with quercetin prior to 1 hour of FeONPs exposure protects the cells from altering activities of antioxidant indices, cytotoxicity and apoptotic death. We conclude that mitochondria-dependent apoptotic death via the inhibition of PI3K/AKT is one of the major pathways in FeONPs induced cytotoxicity. Quercetin could provide some cellular protection via both the increased Bad phosphorylation and Nrf2 translocation in this pathophysiology [Sarkar et al, *Food Chem Toxicol* 71:106-115, 2014].

Drug delivery through silica nanoparticle

We have already synthesized mesoporous silica nano particles from TEOS, CTAB and ammonia solutions. We have functionalized it by adding AEAPS and characterized it by Transmission electron microscopy, Scanning electron microscopy, Dynamic light scattering, X-ray diffraction etc. Then we have incorporate quercetin into it. We are also trying to make pegylated quercetin. In future our aim will be to compare the activity of naked quercetin, mesoporous silica loaded quercein and pegylated quercetin to see is there any increasing activity after loading it with nano particles, and the activity in lower amount.

Besides, we are currently working to check the toxicity of copper oxide nano particles invitro in different alcohol stressed cell line.

Differential effect of Cadmium (Cd^{2+}) on both cell proliferation and cell death

Cadmium (Cd^{2+}) is a major nephrotoxic environmental pollutant, affecting mostly proximal convoluted tubule (PCT) cells of the mammalian kidney, while conditionally Cd^{2+} could also elicit protective responses with great variety and variability in different systems. The present study was designed to evaluate the molecular mechanism of Cd^{2+} toxicity on human PCT derived Renal Cell Carcinoma (RCC), SK-RC-45 and compare its responses with normal human PCT derived cell line, NKE. Exposure of SK-RC-45 cells with different concentrations of CdCl_2 (e.g. 0, 10 and 20 μM) in serum free medium for 24 h generate considerable amount of ROS, accompanied with decreased cell viability and alternations in the cellular and nuclear morphologies, heat shock responses and GCLC mediated protective responses. Also phosphatidylserine externalization, augmentation in the level of caspase-3, PARP, BAD, Apaf1

and cleaved caspase-9 along with decreased expression of Bcl2 and release of cytochrome c confirmed that, Cd^{2+} dose dependently induces solely intrinsic pathway of apoptosis in SK-RC-45, independent of JNK. Furthermore, the non-toxic concentration (10 μM) of Cd^{2+} induced nuclear translocation of Nrf2 and increased expression in the level of HO-1 enzyme suggesting that at the milder concentration, Cd^{2+} induces protective signaling pathways. On the other hand, exposure of NKE to different concentrations of CdCl_2 (e.g. 0, 10, 20, 30 and 50 μM) under the same conditions elevate stronger heat shock and SOD2 mediated protective responses. In contrary to the RCC PCT, the normal PCT derived cell follows JNK dependent and extrinsic pathways of apoptosis. Cumulatively, these results suggest that Cd^{2+} exposure dose dependently elicit both cell proliferative and cell death related responses in SK-RC-45 cells and is differentially regulated with respect to normal kidney epithelia derived NKE cells [Sinha et al, *Toxicol In vitro*, 2014].

Role of Mangiferin in Pb-induced cardiopathy

Cardiac dysfunction induced by various environmental toxins and drugs is a major concern worldwide because of its complex pathogenesis. In spite of tremendous volume of research work, the problem still persists. A significant part of this pathophysiology is contributed by various heavy metals including lead. However, little is known about the mechanism of lead-induced cardiac abnormalities and its remedy using possible protective agents, like antioxidants and others. A naturally occurring polyphenol, mangiferin (2-C- β -D-glucopyranosyl-1,3,6,7-tetrahydroxyxanthone) has been reported to possess a wide range of antioxidant and anti-apoptotic activities along with the reduction of oxidative stress and prevention of the release of pro-apoptotic proteins and transcription factors. The present study has, therefore, been designed and carried out for investigating the underlying mechanism of the beneficial role of mangiferin in lead-induced cardiac oxidative damage and cell death. Lead exposure altered a number of biomarkers related to cardiac oxidative stress, activities of various antioxidant enzymes and GSH level, increased reactive oxygen species (ROS) production, lipid peroxidation and apoptotic cell death by mitochondria dependent caspase-3 activation. Mangiferin treatment, post to lead exposure, however, suppressed all these oxidative stress and apoptotic actions, suggesting its protective role in lead-induced myocardial pathophysiology and could possibly provide a protection against lead-induced cardiovascular burden [Sinha et al, *J Org Biomol Chem*, 2013].

Role of *Phyllanthus niruri* protein against iron induced hepatotoxicity

In this study we investigated the beneficial role of *Phyllanthus niruri* protein (PNP) against iron (FeSO_4) induced oxidative damage in murine hepatocytes. Hepatocytes are exposed to FeSO_4

at a particular dose for certain period of time enhanced reactive oxygen species (ROS) generation and induced alteration in biochemical parameters related to hepatic oxidative stress. Hepatocytes were exposed to iron intoxication and that exposure caused elevation of reactive oxygen species (ROS) production, enhanced lipid peroxidation and protein carbonylation, depleted glutathione levels, decreased the antioxidant power (FRAP) of the cells and reduced cell viability. Iron mediated cytotoxicity disrupted mitochondrial membrane potential ($\Delta\psi_m$) as well as the phosphorylation of ERKs and p38 MAP kinases. In addition, iron-induced cytotoxicity disrupted the normal balance of Bcl-2 family proteins in hepatocytes. Incubation of hepatocytes with PNP, however, protected the cells from iron mediated cytotoxic effect. Results of this study showed that PNP could be a protective agent against iron mediated toxicity in hepatocytes. [Bhattacharyya et al, Food Chem Toxicol, 2013]

Role of *Phyllanthus niruri* protein against aspirin mediated toxicity on liver and spleen

The role of aspirin on gastro-intestinal injury has been extensively studied although the molecular mechanisms underlying aspirin-induced liver and spleen pathophysiology are poorly defined. The present study has been conducted to investigate whether PNP possesses any protective role against aspirin mediated liver and spleen tissue toxicity, and if so, what signaling pathways it utilizes to convey its protective action. Aspirin administration in mice enhanced serum marker (ALP) levels, reactive oxygen species (ROS) generation, reduced antioxidant power and altered oxidative stress related biochemical parameters in liver and spleen tissues. Moreover, we observed that aspirin intoxication activated both the extrinsic and intrinsic apoptotic pathways, as well as down regulated NF- κ B activation, and the phosphorylation of p38 and JNK MAPKs. Histological assessments and TUNEL assay also supported that aspirin induced tissue damages are apoptotic in nature. PNP treatment after aspirin exposure effectively neutralized all these abnormalities via the activation of survival PI3k/Akt pathways. Combining, results suggest that PNP could be a potential agent for the protection of liver and spleen from the detrimental effects of aspirin [Bhattacharyya et al, PLOS ONE 2014].

Role of atorvastatin in hepatic pathophysiology

Atorvastatin (ATO), a 3-hydroxy-3-methylglutaryl-CoA reductase inhibitor, is used widely for the treatment of hypercholesterolemia and hypertriglyceridemia. Application of this drug has now been made somehow limited because of its several acute and chronic side effects. Earlier studies suggest that ATO-induced anti hypercholesterolemia and hepatic tissue toxicity do not follow identical mechanism. Here we report the dose-dependent hepatic tissue toxicity in ATO induced oxidative impairment and cell death. Administration of ATO enhanced ALT and ALP levels, increased reactive oxygen species (ROS) production and altered the pro oxidant-

antioxidant status of liver by reducing intracellular GSH level, anti-oxidant enzymes activities and increasing intracellular lipid peroxidation. Our experimental evidence suggests that ATO markedly decreased mitochondrial membrane potential, disturbed the Bcl-2 family protein balance, enhanced cytochrome c release in the cytosol, increased the levels of Apaf1, caspase-9, caspase-3, cleaved PARP protein and ultimately led to apoptotic cell death. Besides, ATO distinctly increased the phosphorylation of p38, JNK, and ERK MAPKs, enhanced caspase-12 and calpain level. Histological studies and DNA fragmentation analysis also support the dose-dependent toxic effect of ATO in these organs pathophysiology. These results, for the first time, reveal that ATO induces hepatic tissue toxicity via MAPKs, mitochondria and ER dependent signaling pathway, in which calcium ions and ROS act as the pivotal mediators of the apoptotic signaling [Communicated].

DSL ameliorates arsenic induced oxidative stress in hepatic and renal tissue

Arsenic is one of the ubiquitous environmental pollutants and a well-known toxic heavy metal which affects nearly all organ systems mainly by its exposure through underground drinking water. Here we report the hepato-protective and nephro-protective role of D-Saccharic acid 1,4-Lactone (DSL), a derivative of *D-glucaric acid*, against arsenic induced oxidative damages in liver and kidney. Previous studies from our laboratory confirmed the effectiveness of DSL in attenuating tBHP induced oxidative stress and hence toxicity. Administration of sodium arsenite at a dose of 10mg/kg body weight for 1 week abruptly increased ROS, the primary cause leading to oxidative stress, and significantly reduced the activities of antioxidant enzymes viz. superoxide dismutase, catalase, glutathione S-transferase, glutathione reductase and glutathione peroxidase as well as depleted the level of reduced glutathione and total thiols. In addition, sodium arsenite also increased the activities of serum marker enzymes, alanine transaminase and alkaline phosphatase, enhanced protein carbonyl content, lipid peroxidation end-products and the level of oxidized glutathione. Moreover, it was also found that arsenic induced apoptotic cell death pathway in hepatocytes and kidney cells. Treatment with DSL at a dose of 110 mg/kg body weight for 5 weeks after arsenic administration decreases ROS production attenuates the alterations of the activities of all antioxidant indices and levels of the other parameters studied. Additionally, DSL also protects against this arsenic induced apoptosis. Histological studies revealed disintegrity of hepatic lobules with disrupted hepatocytes in the liver, disorientation of glomerulus of kidney cells in arsenic exposure; whereas post-treatment with DSL reduces all these abnormalities. Effects of a known antioxidant, N Acetyl cysteine, have been included in the study as a positive control. In conclusion, the results suggest that DSL possesses the ability to ameliorate arsenic-induced oxidative stress in murine liver and kidney probably via its antioxidant activity.

Role of silymarin against thioacetamide

Silybum marianum, commonly known as milk thistle, has been used for long time for the treatment of liver and gallbladder disorders, hepatitis, cirrhosis, jaundice etc. Silymarin has been shown to possess a wide range of biological and pharmacological effects, including antioxidant activity, stimulation of protein synthesis, cell regeneration and anticancer effects against several human carcinoma cell lines. Moreover, silymarin also shows anti-hyperglycemic activity, cardioprotection, anti-inflammatory, hypolipidemic, neuroprotective and immune modulative effects. Thioacetamide (TAA) is a well documented liver toxin. To elicit its hepatotoxic effects, TAA requires oxidative bioactivation, leading first to its S-oxide (TASO) and then to its chemically reactive S,S-dioxide (TASO₂) form, which ultimately modifies amine-lipids and proteins. So, our study has been designed in a TAA exposed mice model to investigate whether silymarin could protect liver cells against TAA exposed cellular damage and oxidative stress and if so, what molecular pathways it utilizes for its protection. For this study, we have performed western blot analysis to detect different proteins. We also have performed flow cytometry analysis and DNA fragmentation analysis. We have measured the antioxidant enzyme activities and mitochondrial membrane potential and also measured the intracellular ROS levels. Our next goal is to perform RT-PCR analysis to detect change in different genes at mRNA level.

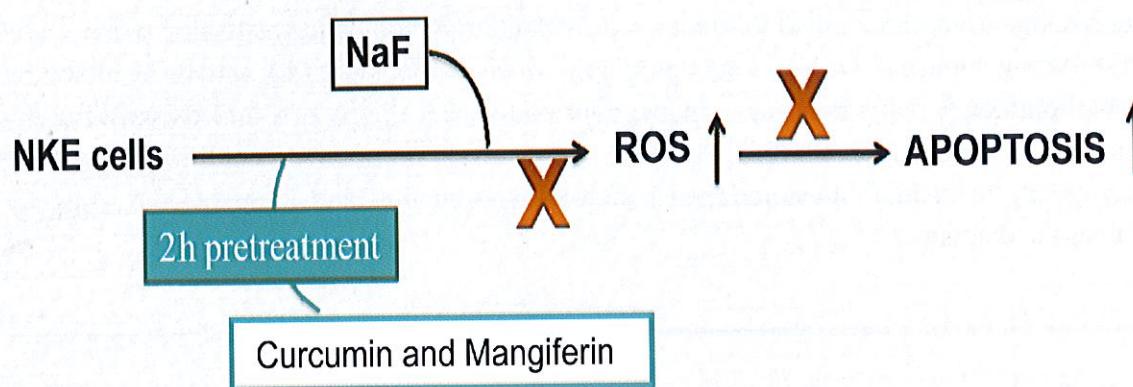
Role of morin in NSAID-induced gastropathy

Severe oxidative stress and inflammation contribute to the pathogenesis of nonsteroidal anti-inflammatory drugs (NSAIDs)-induced gastropathy. Unfortunately, most of the prescribed anti-ulcer drugs generate various side effects. In the present study, we found that morin, a potent safe, anti-inflammatory and antioxidant flavonoid, protects gastric mucosa from indomethacin (a commonly used NSAID)-induced gastric damages. Morin decreased oxidative stress and the expression of inducible nitric oxide synthase, proinflammatory cytokines, monocyte chemoattractant protein-1, intercellular adhesion molecule-1 and related neutrophil infiltration. It also activated I κ B kinase and induced localization of the p65 subunit of nuclear factor- κ B into the nucleus of IND-induced gastric mucosa. Morin, on the other hand, could restore the level of catalase in the IND-induced gastric mucosa and inhibit mitochondrial dysfunction in IND-exposed AGS cells. Besides, morin significantly decreased IND-induced extracellular apoptotic signaling pathway by down regulating caspase-8 activation in gastric mucosa. Studies suggest that morin might be useful in prevention of NSAIDs-induced gastropathy [Communicated].

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 (NKE) and human hepatoma cell lines (HepG2). 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 investigating whether these polyphenols could restore the phase II antioxidant enzyme level in the NaF exposed cells and 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.

Role of curcumin on cellular stress induced pancreatic dysfunction and associated testicular damage in diabetes

In the modern civilization, incidence of diabetes increases day by day and has become a major concern of research. Evidences suggest, this pathophysiology is associated with cellular stress (oxidative, nitrosative and ER stress) and inflammation. It has also been found that most of the available commercial drugs in the market show a number of side effects. Previously, we observed, the protective effect of taurine, an antioxidant, on alloxan induced oxidative stress mediated hepatic damage in diabetic animals (Rashid et al, Food Chem Toxicol, 2013). Next we focused on curcumin, a dietary component, as it possesses antioxidant, anti-inflammatory and antitumor activities. This study, therefore, has been designed and conducted to find out the beneficial role of curcumin against cellular stress induced diabetes and its associated complications. In the present study, STZ was used to induce diabetes in the experimental rats.

We have found that curcumin decreased oxidative stress in the pancreas and testis of the diabetic group by increasing the activities of antioxidant enzymes (SOD, CAT, GPx, GST and GR) and decreasing cellular stress markers (lipid peroxidation, protein carbonylation, intracellular Ca^{2+} in both pancreas and testis, and nitric oxide in pancreas only). This active molecule of turmeric also reduced blood glucose level and serum markers of testis (testosterone and sorbitol dehydrogenase) in dose and time dependent manner showing its antihyperglycemic property. In addition, curcumin protects pancreatic and testicular cells from inflammatory cytokines ($\text{TNF-}\alpha$ and $\text{IL-1}\beta$) induced $\text{NF}\kappa\text{B}$ dependent cellular damages suggesting its anti-inflammatory activity. It provided protection by the activation of Nrf-2 and PI3K/Akt signaling pathways. Besides, curcumin showed its antiapoptotic activity by inhibiting mitochondria/ER dependent and independent pathways of apoptosis and diminishing the expression of active caspases (9, 3, 12 and 8). These results proposed curcumin as a promising therapeutic in cellular stress induced pancreatic dysfunction and its associated testicular damage in diabetes.



5th Blood Donation Camp was organized by Bose Institute Blood Donation Committee on 10th September 2013 in the Seminar Room of Centenary Campus

V. Basic and Applied Microbiology

The mycobacterial protein SepF interacts with FtsZ : *Dr. Joyoti Basu in collaboration with Dr. Manikuntala Kundu*

The bacterial divisome is a multiprotein complex. In order to understand the cell division machinery in detail, we have previously characterized the protein Rv2147c of *Mycobacterium tuberculosis* using various biochemical and genetic techniques. Rv2147c (or SepF) interacts with FtsZ through its C-terminus. We have now developed tools to show that SepF localizes to the site of division. Knockdown of SepF is possible only in the presence of an additional copy of the gene. Knockdown leads to severe restriction of growth and elongation of cells. SepF also interacts with MurG, a peptidoglycan synthesizing enzyme which is required for synthesis of septal peptidoglycan. We hypothesize that FtsZ-SepF-MurG interactions are temporally and spatially coordinated for appropriate septation in growing mycobacteria.

Exploring the mycobacteriophage proteome : *Dr. Sujoy K. Das Gupta*

Mycobacteriophages infect mycobacteria and therefore they have been used widely as tools for understanding its molecular biology. Mycobacteriophages themselves are very exciting to study. In recent times a large number of mycobacteriophage genome have been sequenced. Mycobacteriophage L5 gene 56 encodes a putative thioredoxin family protein. Phylogenetic analysis revealed that Gp56 and related proteins are distantly related to NrdH - a glutaredoxin homolog which has thioredoxin like properties. To understand its function the recombinant version of the protein was biochemically characterized. A mycobacterial thioredoxin TrxB was included in the study comparison. Results indicate that Gp56 can be reduced by DTT, but only at a higher concentration as compared to TrxB, indicating that its standard redox potential may be lower as compared to TrxB. The reduced protein can subsequently act as a reductant of protein disulphide bond. It can also be reduced by NADPH with the help of thioredoxin reductase (TrxR) but less efficiently as compared to TrxB. The comparative abilities of Gp56 and TrxB to reduce Gp50, the L5 encoded Ribonucleotide reductase was examined. It was found that while both reduces Gp50, but Gp56 needs more reducing equivalents compared to TrxB to function efficiently. The results indicate that L5Gp56 represents a new class of NrdH like proteins which function optimally in a reducing environment.

Biochemical and molecular characterization of bacterial catabolic potential : *Dr. Tapan K. Dutta*

Metabolic pathway(s) for the assimilation of various recalcitrant aromatic pollutants have been elucidated from different bacterial strains belonging to genus *Sphingobium*, *Burkholderia* and *Cupriavidus*. Crucial catabolic enzymes involved in different catabolic pathways in these

organisms have also been identified and characterized. Substrate specificities of the five different oxygenases from multiple aromatic hydrocarbon degrading *Sphingobium* sp. strain PNB have been determined accounting for the broad range of substrate preference of the organism. Some of the oxygenases have been characterized for the first time. In addition, structural uniqueness of the sole set of electron transport components complementing each of the oxygenases has also been revealed. Moreover, real-time PCR analyses have put a way forward to understand the complex regulation of degradative genes and coordinated catabolic network in the management of a variety of aromatic hydrocarbon degradation in strain PNB. While in *Burkholderia* sp. strain BC1, a novel non-oxidative decarboxylase was characterized in the degradation pathway of 2-hydroxy-1-naphthoic acid via 2-naphthol. Structurally similar, both 2-naphthol and naphthalene have been assimilated by similar but mutually exclusive distinct sets of enzymes. Genes responsible for metabolism of both the compounds have also been identified by genomic and proteomic approaches. Key enzymes, 2-hydroxy-1-naphthoic acid decarboxylase, gentisaldehyde dehydrogenase and gentisate dioxygenase, have been cloned and purified for further characterization. Another bacterium, characterized as *Cupriavidus* sp., has been found to be capable of mineralizing different nitrobenzoic acids. Preliminary biochemical and molecular analyses indicate involvement of novel pathway(s) and/or enzymes in the assimilation of these anthropogenic pollutants.

In another study, we have isolated the gut microbiota of *Tenualosa ilisha* (hilsa). The isolates have been screened for industrially important enzymes like α -amylase, protease, cellulase, esterase, fatty acid desaturase and phytase. On the other hand, the total metagenomic DNA isolated from the gut sample has been subjected to next gen sequencing to understand the bacterial diversity present in the gastrointestinal tract of this migratory oily fish, rich in protein and essential fatty acids (omega-3 fatty acids).

With an aim to monitor environmental pollution in situ, a promoter-trap vector containing dual reporter system (EGFP and mCherry) has been constructed. The construct is currently being used to screen a variety of metagenomic DNA samples to identify biotechnologically important constitutive promoters as well as inducible promoters to identify industrially important enzyme, like fatty acid desaturase as well as to design reporter strains specific for different health hazard pollutants in the environment.

Understanding protein translocation under extreme conditions : Dr. Abhrajyoti Ghosh

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 : Dr. Abhrajyoti Ghosh, in collaboration with Prof. Maitree 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.

Functional and structural studies on archaeal Actin-like protein : Dr. Abhrajyoti Ghosh, in collaboration with Dr. Gautam Basu, Dept. of Biophysics, Bose Institute

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.

Microbial exploration of analogs of ancient ecosystems : Dr. Wriddhiman Ghosh

As one of the many components of this project we investigated the ecological amplitudes and niche specializations of various prokaryotic and eukaryotic microbial groups that inhabit the thermocline of a boratic stromatolite-forming sulfur spring of Puga valley, Ladakh. We used microscopic methods in tandem with high-throughput metagenomic DNA sequencing techniques to compare and contrast the structures and functions of eleven spatially discrete geothermal microbial communities, starting from the aquatic community at the hot water venting point to the mat communities in the distal apron environment.



Figure 1. Ecological niches along the thermoclines in and around the so-called 'Shivlinga' stromatolite in the Puga geothermal area.

In another component of this program we have used high-throughput metagenomic DNA sequencing techniques to compare and contrast the structures and functions of three

spatiotemporally-separated versions of a geothermal microbial mat community (GMMC) from the travertine-precipitating, neutral pH hydrothermal system of Tapovan, Uttarakhand. We correlated the community dynamics data with the fluctuating geochemical parameters of the hot spring system and revealed some interesting facts about the metabolic potentials and preferences of circumneutral GMMCs thriving on hydrothermal discharges typically poor in dissolved solids, sulfide, silicate and chloride, but rich in sodium, sulfur, thiosulfate and sulfate. Besides identifying the niche opportunities and constraints that govern the stability and sustainability of GMMCs in the face of waning geothermal resources, our observations highlighted some important aspects of population response to environmental fluctuations within a given community framework.

Regulation of expression of the resuscitation promoting factors (Rpfs) of *Mycobacterium tuberculosis* : Dr. Manikuntala Kundu in collaboration with Dr. Joyoti Basu

In our attempts to understand how the expression of the Rpfs of *M. tuberculosis* are regulated, we have identified putative MtrA binding sites on the promoters of Rpfs A and B. We have validated MtrA binding with promoters of RpfA and RpfB by electrophoretic mobility shift assay. Overexpression of His-tagged MtrA in mycobacteria followed by ChIP analysis confirmed its binding to specific regions of the promoters of RpfA as well as RpfB. Delineation of the physiological role of such binding is under progress.

Construction of Effective Microbial Consortium for Bio-augmentation and Waste Management : Dr. Anuradha Lohia

Effective Microorganism (EM) was identified by Prof T. Higa initially and consists of a consortium of beneficial and naturally occurring microbes that can be used for improvement of agriculture, bioremediation, wastewater treatment, solid waste management and household uses. Manipulating or engineering the composition of microbes in the consortium to address specific issues can be used to solve any of these problems.

In the present study, we have isolated a species of LAB i.e. *Lactobacillus casei* and two species of Yeast i.e. *Candida ethanolica* and *Pichia deserticola* from an EM solution sent from Clover Organics Pvt. Ltd., Dehradun. Subsequently, from the local farm soil we isolated a number of beneficial microbes. These were- a) *Bacillus megaterium*; b) *Penibacillus sp* and c) the Photosynthetic bacteria *Rhodospseudomonas palustris* using Winogradsky Column technique in presence of sunlight. All isolates were then identified using 16S (for bacteria), 18S & 26S (for yeasts) rDNA sequencing technique. We have formulated a low cost broth medium containing molasses, peptone and NaCl for growing the isolates individually and also in consortium. After growing all isolates together in molasses broth medium for 9 days it was found that, *L. casei* and

two yeasts were growing very well together at 30°C/RT in aerobic condition and in presence of light. However, the photosynthetic bacteria *R. palustris* did not survive with other microbes. *R. palustris* grew very well individually at 30°C/RT in micro-aerophilic condition and in presence of light. We also found that *B. megaterium* and yeasts could grow well together.

Using various permutation and combination we intend to formulate EM variations that will be useful for bio-augmentation of the agricultural soil or for other uses such as wastewater and solid waste management.

Investigations into the Function of the Ribosome Binding Protein HflX from *E.coli* : Dr. Pradeep Parrack

E. coli hflX encodes a ribosome-associated GTPase whose cellular function is unknown. Recently, we have demonstrated that perturbation by Mn induces an unprecedented influx of Zn and Fe in $\Delta hflX$ cells and hence reduces the frequency of lysogenisation of the phage by activating the Zn-containing metalloprotease HflB, a key determinant of the lysis-lysogeny switch. Further studies led us to conclude that HflX maintains Mn homeostasis in *E. coli* independent of *mntR* regulon, though the molecular mechanism for the process remains unknown.

Unlike wild type MG1655 *E.coli* cells, DAPI-stained $\Delta hflX$ cells showed an abnormal elongation at different concentrations of Mn^{++} , indicating a delay in partitioning of nucleoids, consequently leading to an arrest of the cell septation process. In the presence of Mn, FACS profiles of actively dividing $\Delta hflX$ cells exhibited alterations in cell length, size and morphology due to improper cell septation and hence defective cell division in the absence of *hflX*.

Confocal microscopic imaging showed that unlike a wild type cell with a condensed nucleoid, a mutant ($\Delta hflX$) cell shows several fluorescent bands of diffused nucleoids throughout the length of a filament implying that FtsZ rings are unable to assemble at the sites of partitioning due to a delay in the partitioning of nucleoids during cell division and defective cell segregation in the absence of the gene *hflX*.



Fig. 1

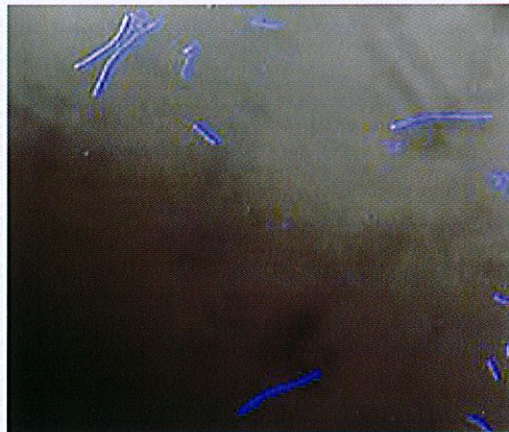


Fig. 2

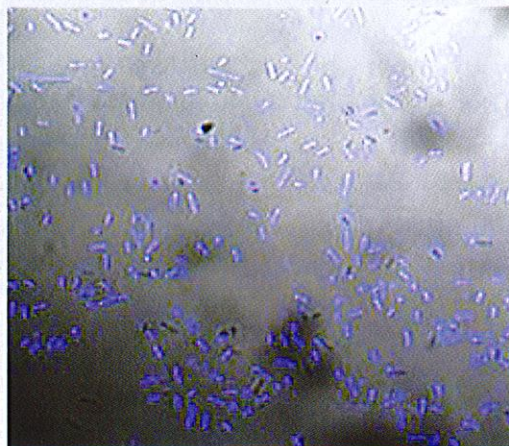
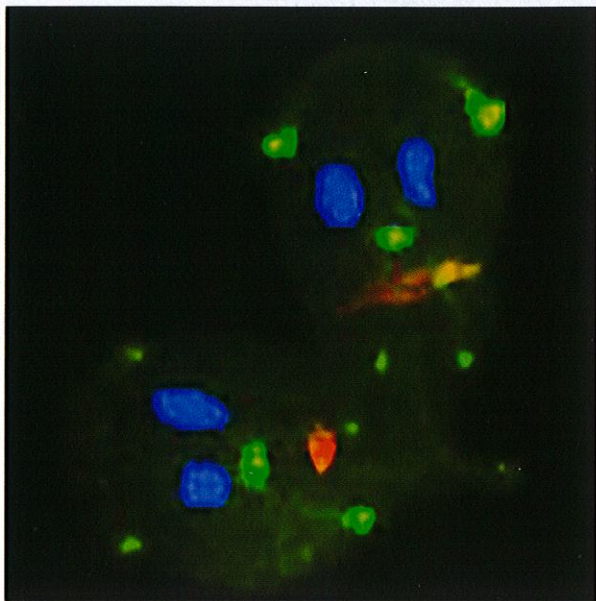


Fig. 3

Confocal microscopy of *E. coli* cells grown in the presence of $50\ \mu\text{M}\ \text{Mn}^{++}$, showing wild type cells (1), elongation of mutant (ΔhflX) cells (2) and reversion to normal growth upon complementation of ΔhflX cells with a plasmid expressing the *HflX* protein (3).

***Giardia lamblia*: thriving with less : Dr. Srimonti Sarkar**

G. lamblia, a flagellated protozoan exoparasite, colonizes the gut of its vertebrate hosts and causes the diarrheal disease giardiasis. Its genome (~11.7 Mb) is roughly 200X smaller than mammalian genomes. Yet it has genes for sustaining two different life forms (trophozoite and cysts) and also for maintaining four pairs of flagella, each of which is functionally unique. Our goal is to understand how this organism can accomplish this level of complexity with such a small genome. The data support the notion that this parasite has possibly undergone reductive evolution whereby it has not only simplified various multi-

subunit complexes (such as the proteasome and endosome-associated complexes), but may have even truncated domains compared to the canonical forms present in most eukaryotes. Thus, this organism may provide a blueprint of how to thrive with less.

Studies on the bacterial DNA/drug binding proteins : Dr. Subrata Sau

FKBP22, an *E. coli*-encoded isomerase involved in the protein folding and virulence, binds two immunosuppressive drugs such as rapamycin and FK506. To see the effects of drug on the structure, folding/unfolding mechanism, and stability of FKBP22, a recombinant FKBP22 (rFKBP22) was investigated by various probes. Our data revealed that rapamycin binding caused a minor structural alteration of rFKBP22. Both urea-induced and thermal unfolding of the rapamycin-bound rFKBP22 occurred via the synthesis of intermediates. In contrast, the rapamycin-unbound form of this protein unfolded by a two-state mechanism in the presence of either denaturant. Unfolding of the drug-saturated/unsaturated rFKBP22 was reversible in nature. In addition, rapamycin binding enhanced the stability of rFKBP22 substantially.

Bacteriophage $\phi 11$, a temperate phage that uses *Staphylococcus aureus* as its host, synthesizes one repressor protein (namely, CI) for maintenance of its lysogenic pathway. Previously, we reported that CI is composed of an N-terminal domain (NTD), a hinge, and a C-terminal domain (CTD). The DNA binding activity of CI is possibly in the NTD as it harbors a putative helix-turn-helix motif. To understand the structure and function of this DNA binding domain clearly, we have purified a recombinant form of NTD (designated rNTD) to homogeneity.

Preliminary investigation revealed that rNTD possesses the DNA binding activity like that of intact repressor.

Mycobacteriophage L1, a temperate phage that grows in *Mycobacterium smegmatis*, encodes a repressor protein (namely, CI) for maintenance of its lysogenic development. CI, like other phage repressors, carries an N-terminal domain (NTD) and a C-terminal domain (CTD). While CTD is involved in the dimerization, NTD is involved in the DNA binding activity of CI as it is composed of a tentative helix-turn-helix (HTH) motif. To determine whether the putative HTH motif is involved in the DNA binding activity of CI, several CI point mutants were constructed by replacing the HTH motif-forming residues with an 'Ala' residue. Some of the point mutants were purified to homogeneity.

Staphylococcus aureus, a Gram-positive bacterium that causes various diseases to human and other animals, encodes numerous virulence factors. Expression of the virulence factors are primarily regulated by two global regulatory loci such as *agr* (accessory gene regulator) and *sar* (staphylococcal accessory regulator). SarA, synthesized by the *sar* locus, up or down-regulates the virulence factor-encoding genes primarily by binding to their promoters. To understand the domain structure and folding/unfolding mechanism of SarA, a recombinant SarA variant (rSarA) was purified to homogeneity. rSarA appeared to possess a specific DNA binding activity.



CIF Lab.

VI. Systems Biology

Fluctuations in bi-functional two-component system : *Dr. Suman K Banik*

We have presented a generic analytical scheme for the quantification of fluctuations due to bifunctionality-induced signal transduction within the members of a bacterial two-component system. The proposed model takes into account post-translational modifications in terms of elementary phosphotransfer kinetics. Sources of fluctuations due to autophosphorylation, kinase, and phosphatase activity of the sensor kinase have been considered in the model via Langevin equations, which are then solved using the framework of linear noise approximation. The resultant analytical expression of phosphorylated response regulators are then used to quantify the noise profile of biologically motivated single and branched pathways. Enhancement and reduction of noise in terms of extra phosphate outflux and influx, respectively, have been analyzed for the branched system. Furthermore, the role of fluctuations of the network output in the regulation of a promoter with random activation-deactivation dynamics has been analyzed.

MicroRNAs (miRNAs) in *M. tuberculosis* infection : *Dr. Joyoti Basu in collaboration with Dr. Manikuntala Kundu and Dr. Zhumur Ghosh*

miRNAs play an important role in the immune response including the development and differentiation of immune cells, antibody production, and innate immunity regulation. Network analysis connecting miRNA and mRNA identified the let-7 family of miRNAs among the miRNAs downregulated during *M. tuberculosis* infection. We have made an important advance in identifying the NF-kappa B pathway inhibitor A20 as a target of let-7f. We observe that let-7f is downregulated as Mtb infection progresses in mice. Concomitantly, A20 levels rise. Using A20 knockout macrophages, we show that A20 favours the survival of Mtb in macrophages. The A20 interaction network shows pathways such as inflammation, that are of likely importance in tuberculosis pathology. Repression of let-7f also favours the survival of Mtb in macrophages. using A20 knockout macrophages or forced expression of let-7f, we conclude that the let-7f-A20 axis regulates the production of inflammatory cytokines such as TNF and IL-1 beta, as well as the production of nitric oxide.

MicroRNA regulatory networks in *Mycobacterium tuberculosis* : *Dr. Zhumur Ghosh 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 MAGIA 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.

***Helicobacter pylori* links unfolded protein response to autophagy in gastric epithelial cells : Dr. Manikuntala Kundu in collaboration with Dr. Joyoti Basu**

Autophagy is a process that is involved in cellular homeostasis under conditions of stress or other pathological conditions. Environmental stress, accumulation of misfolded proteins trigger autophagy. Earlier we demonstrated that the secreted antigen, HP0175, a peptidyl prolyl cis trans isomerase could induce apoptosis in epithelial cells. At present, we are delineating the role of HP0175 in the induction of autophagy. Microarray data suggested the induction of autophagy related genes in the early time point of infection with *Helicobacter pylori*. HP0175 dependent transcriptional upregulation of autophagy related genes like MAP1LC3B, ULK1, Beclin1 and ATG5 has been found to be linked with the unfolded protein response. We also observed that inhibition of autophagy by transfection with siRNA against Beclin1 led to enhanced apoptosis of epithelial cells strengthening the view that there is a cross talk between autophagy and apoptosis.

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

Mycobacterium tuberculosis uses two component signal transduction systems for sensing environmental signals and responding to these signals. Two component systems consist of paired histidine kinases and response regulators (RRs). We observed the involvement of the two component system (TCS), SenX3-RegX3 in the survival of mycobacteria under phosphate depletion. In order to develop a network among the genes controlled by RegX3, a RegX3 knock out strain of *M. tuberculosis* has been generated in collaboration with Dr. Ramandeep Singh, THSTI. The knock out and wild type strain were grown in the presence and absence of

phosphate and RNA was isolated for microarray analysis. Development of network on the basis of microarray analysis is under progress.

Systems Biology : Dr. Indrani Bose

Different cell types in a mammalian system are characterized by different gene expression profiles. Recent comprehensive analysis of human expression data has identified a motif which plays a key role in cell fate determination. The motif consists of a genetic toggle switch in which the protein products of two genes repress the expression of each other. The individual genes additionally autoactivate their own expression. A number of mathematical models have been proposed so far to demonstrate the differentiation of a progenitor cell into specific lineages. We have developed a simple model of cell differentiation which assumes no cooperativity in the regulation of gene expression by transcription factors. The latter repress each other's activity directly through DNA binding and indirectly through the formation of heterodimers. The deterministic dynamics of the model give rise to a supercritical pitchfork bifurcation from an undifferentiated stable steady state to two differentiated stable steady states. The results of the stochastic simulation of our model are consistent with recent experimental observations, thus providing a physical basis for understanding some hitherto-unexplained phenomena seen in experiments. We have further proposed experimental measurements of quantities like the variance and the lag-1 autocorrelation function in protein fluctuations as the early signatures of an approaching bifurcation point in the cell differentiation process (the study has been carried out under the Institutional Programme VI). We have developed models of biological switches based on the genetic toggle motif with transcriptional and microRNA-based regulation of gene expression respectively and compared the functional characteristics of the two types of switch

High throughput approach to Identify of genes regulated by each sigma factor of *M. tuberculosis* : Dr. Jayanta Mukhopadhyay

The sophisticated infection cycle of *M. tuberculosis* is thought to be achieved by its complex regulation of gene expression – one set of genes being expressed in the latent bacilli, whereas another set of genes being expressed during its infection cycle. One or more alternative σ factors (*M. tuberculosis* contains 13 σ factors; one principal σ factor and 12 alternative σ factors) are thought to control RNA polymerase in expressing various genes during its dormancy or infection cycle. Therefore, to know the role of alternative σ factors in *M. tuberculosis* gene regulation is extremely important to understand the organism's infection mechanism and to identify novel targets for antibacterial therapy.

Results taken from the quantitative reverse-transcription PCR/ microarray technology, and chromatin immune-precipitation assay, allowed the partial characterization of seven σ factors and proposed consensus sequences of six σ factors. These methods have proven not be successful in characterizing other σ factors, yet. 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 σ^A), 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 σ^A . Identical approach would be followed for each of the 13 σ factors.

Aqueous-deficient dry eye disorder : Dr. Soumen Roy

Aqueous-deficient dry eye is a common and painful eye disorder. We analyze the Ocular Surface Temperature (OST) fluctuation (ΔT) difference between dry eye patients and healthy volunteers. OST was recorded for both groups. Mean OST fluctuation (ΔT) for both the right and left eye was greater for dry eye patients in comparison to control group mean (ΔT) fluctuation. The mean ΔT difference between dry eyes and eyes of healthy volunteers is less than 1 °C. Using mathematical and computational techniques developed for this dataset, gathered in a non-invasive manner; we are able to successfully distinguish between dry eye and healthy eye.



MALDI

VII. Basic and Applied Problems in Physical and Environmental Sciences

I. Theoretical Research : *Dr. Somshubhro Bandyopadhyay*

A. Unambiguous discrimination of linearly independent quantum states

In the problem of unambiguous discrimination of N linearly independent pure quantum states with prior probabilities, the goal is to find a measurement that maximizes the average probability of success. The analytical solution is known only for $N=2$, and some special cases when $N \geq 2$. We have derived an upper bound on the optimal average probability of success using a result on optimal local conversion between two bipartite pure states. It is proved that for any $N \geq 2$ an optimal measurement saturates our bound except for interior singular and boundary point optimal solutions. For these exceptions the bound is shown to be tight. However, we have also shown that the bound is not saturated in general by an optimal boundary solution.

B. Limits on Separable measurements from cone programming :

Joint with John Watrous group at the Institute for Quantum Computing, University of Waterloo

We provide a general method through which upper bounds on the success probability of separable measurements for state discrimination problems may be obtained, and give several examples illustrating the usefulness of this method. The method is based on the notion of cone programming, which is a generalization of semidefinite programming that also possesses a useful duality theory, applied to the cone of separable operators.

II. Quantum Optics Laboratory : *Dr. Somshubhro Bandyopadhyay*

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 first batch of our Integrated M.Sc. - Ph.D. students did experiments in this lab as part of their M.Sc. curriculum.

Interdisciplinary Physics : *Dr. Indrani Bose*

A series of studies has been initiated to demonstrate how fluctuations theorems like the Jarzynski equality and Crooks' theorem provide new insights on well-known biological phenomena and processes.

**Studying the emissions from ^{241}Am gamma source using superheated emulsion detectors :
Dr. Barun K. Chatterjee**

It was observed that the ^{241}Am gamma-source (which also emits alpha) caused bubble nucleation in R12 superheated emulsion detector (R12-SED) at close range at room temperature and at atmospheric pressure. Since any alpha particle would not be expected to penetrate the steel casing of the source and the glass vial of the R12-SED and since R12-SED does not respond to gamma rays at room temperature and atmospheric pressure, such a phenomenon was puzzling. Experiments seem to confirm that the bubble nucleation in R12-SED was due to neutrons, probably generated from the $\text{C}(\alpha, \text{xn})\text{O}$ reaction in the steel casing of the source.

Fluctuations and correlations of conserved charges have been calculated using Excluded Volume Hadron Resonance Gas model (EVHRG) : Subhasis Samanta, Dr. Supriya Das, Dr. Sanjay K. Ghosh, Dr. Rajarshi Ray with External Collaborator : Dr. Abhijit Bhattacharya (University of Calcutta)

The motivation of this analysis is to study dependency of hard core radii on fluctuations and correlations. Variation of fluctuations and correlations with temperature have been compared with Lattice QCD data. We have seen that Lattice QCD data matches quite well with EVHRG model near $T = 150\text{--}160$ MeV, if we consider radii of hadrons between $0.2\text{--}0.3$ fm. Products of moments, such as ratio of variance to mean (σ^2 / M), product of skewness and standard deviation ($S\sigma$), product of kurtosis and variance ($\kappa\sigma^2$), for net-proton, net-kaon and net-charge have been evaluated on the phenomenologically determined freeze-out curve and have been compared with the experimental data measured by STAR experiment. Proper transverse momentum and rapidity/pseudo rapidity cut is used in model. The dependence of the model result on the hadronic radius parameter has also been studied.

This work has been reported in [arxiv : 1310.2793 \[hep-ph\]](#) / [PRC90 \(2014\) 034909](#)

Contribution from thermal dileptons in nuclear collisions at FAIR energies : Subhasis Samanta, Dr. Supriya Das, Dr. Sanjay K. Ghosh with external collaborators : Dr. Partha Pratim Bhaduri and Dr. Subhasis Chattopadhyay (Variable Energy Cyclotron Center, Kolkata)

Thermal dilepton contribution is estimated at FAIR energy (finite chemical potential is considered). One dimensional Bjorken flow is considered in this analysis for simplicity. Our estimated dilepton spectrum is used as an input for CBM MUCH simulation. This analysis will help us to disentangle thermal continuum from the combinatorial background.

Testing of large GEM prototype detector for muon tracking chamber of CBM experiment : Ramaprasad Adak, Dr. Supriya Das with external collaborators : Dr. Subhasis Chattopadhyay, Anand K. Dubey, Joginder Saini (Variable Energy Cyclotron Center, Kolkata)

A test beam experiment has been conducted by VECC, Kolkata and Bose Institute for the FAIR, CBM Collaboration at COSY, Germany using 2.36 GeV/c proton beam. The main aim was to test first time the performance of 31 cm X 31 cm GEM detector to be used in CBM experiment using high intensity beam. Experimental data were collected using nXYTER based self-triggered read out DAQ system. The highest intensity of the beam was close to the peak intensity expected at the 1st Muon Chamber Detector of CBM. After detail analysis of the data, efficiency of the large GEM was found to be 98% in high intensity beam. Gain of the detector in high and low intensity beam are almost same and gain is increasing with increase of the voltage across the GEM foil.

Soft and hard interactions in proton-proton collisions at LHC energies : Dr. Sidharth K. Prasad, Dr. Rajarshi Ray, Dr. Sanjay K. Ghosh, Dr. Supriya Das with external collaborator : Dr. Premomoy Ghosh (Variable Energy Cyclotron Center, 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 advanced stage and the results obtained so far using simulations have been presented in various national/international meetings/conferences.

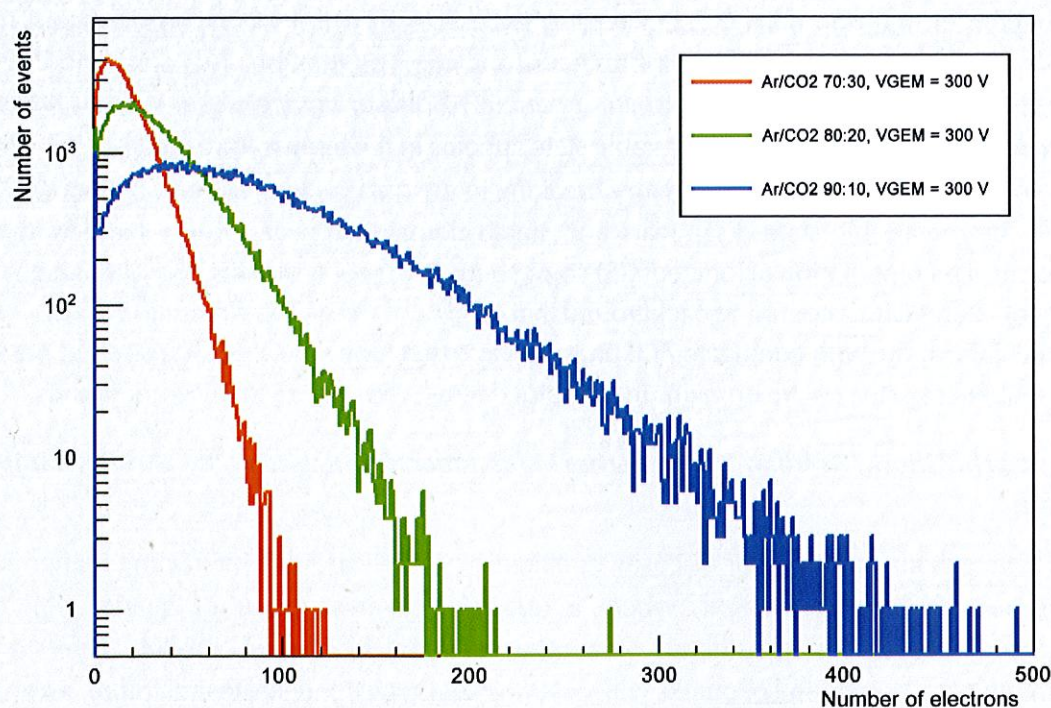
Fabrication of small (10cm x 10cm) triple GEM prototype as a part of R&D for ALICE TPC upgrade program : Dr. Supriya Das

A small prototype detector using triple GEM foils (10 cm x 10 cm) has been fabricated using the RD51 laboratory facility at CERN, Geneva. A provision for adding one more layer of GEM foil as required for ALICE TPC is kept in this prototype. The cathode plane has strips capable of XY position readout. A resistive voltage divider is used to bias all the planes (1 anode plane, 6 GEM surfaces) from a single HV channel.

Study of fluctuation in single electron avalanches using Garfield : **Dr. Supriya Das**

As a part of ALICE TPC upgrade program, a thorough study of fluctuation in single electron avalanche created in GEM detector is being carried out. The electric field distribution inside the detector is produced using Ansys. Properties of the gas have been implemented using Magboltz and the electron transfer is simulated using Garfield + +. Variation of shape of the electron distribution for different voltages between the two conducting planes of GEM as well as different gas mixtures such as Ar, Ne, CO₂ etc. is being studied. This is very useful for finalizing the design parameters of the upgraded ALICE TPC.

Number of electrons



Distribution of number of electrons for different gas mixtures.

Induced Fluid Layer/ Hexatic Tilted Smectic Phases in Cholesterol Ester Binary Mixtures : **Dr. Pradip Das**

Induced Fluid Layer/ Hexatic Tilted Smectic Phases, e.g. smectic-C* and smectic-I* phases, which are likely candidates for the exhibition of ferroelectricity, have been found in binary mixtures of monounsaturated cholesterol esters, e.g., cholesteryl oleate and cholesteryl oleyl carbonate. Each of these components has a cooling phase sequence: Isotropic → cholesteric → smectic → crystal, and a warming phase sequence: crystal → cholesteric → Isotropic, thereby indicating a metastable smectic phase. The binary phase diagram has been chalked

out on the basis of polarized light microscopy, XRD and DSC studies. Theoretical studies explore the origin of the induced phases, which are potentially ferroelectric.

Physics of strongly interacting matter : Dr. Rajarshi Ray and Dr. Sanjay K. Ghosh with external collaborators: Chowdhuri Aminul Islam, Raktim Abir, Dr. Munshi G. Mustafa

Based on quantum statistical mechanics, we show that the $SU(3)$ color singlet ensemble of a quark–gluon gas exhibits a $Z(3)$ symmetry through the normalized character in fundamental representation and also becomes equivalent, within a stationary point approximation, to the ensemble given by Polyakov Loop. In addition, a Polyakov Loop gauge potential is obtained by considering spatial gluons along with the invariant Haar measure at each space point. The probability of the normalized character in $SU(3)$ vis-a-vis a Polyakov Loop is found to be maximum at a particular value, exhibiting a strong color correlation. This clearly indicates a transition from a color correlated to an uncorrelated phase, or vice versa. When quarks are included in the gauge fields, a metastable state appears in the temperature range $145 \leq T(\text{MeV}) \leq 170$ due to the explicit $Z(3)$ symmetry breaking in the quark–gluon system. Beyond $T \geq 170$ MeV, the metastable state disappears and stable domains appear. At low temperatures, a dynamical recombination of ionized $Z(3)$ color charges to a color singlet $Z(3)$ confined phase is evident, along with a confining background that originates due to the circulation of two virtual spatial gluons, but with conjugate $Z(3)$ phases in a closed loop. We also discuss other possible consequences of the center domains in the color deconfined phase at high temperatures.

Sabyasachi Ghosh, Anirban Lahiri, Sarbani Majumder, Dr. Rajarshi Ray and Dr. Sanjay K. Ghosh

We have calculated the shear viscosity coefficient η of the strongly interacting matter in the relaxation time approximation, where a quasiparticle description of quarks with their dynamical masses is considered from the Nambu-Jona-Lasinio model. Due to the thermodynamic scattering of quarks with pseudoscalar-type condensate (i.e., pion), a nonzero Landau damping will be acquired by the propagating quarks. This Landau damping may be obtained from the Landau cut contribution of the in-medium self-energy of a quark-pion loop, which is evaluated in the framework of real-time thermal field theory.

Dr. Mohammed Younus in Collaboration with Dr. Sanjay K. Ghosh, Dr. Rajarshi Ray and Physics Group-QGP/ QCD team

Heavy Quarks are produced in the early pre-equilibrium phase of heavy ion collision before QGP is formed. This is because of their heavy masses. Hence a heavy quark jet might serve as the probe when it travels through the equilibrated medium and bring out the information. The heavy quark evolution can be observed by studying final D mesons and non-photonic electron

spectra with the observables, nuclear modification factor, ' R_{AA} ', azimuthal anisotropy, ' V_2 ' and azimuthal correlation, ' $C(\Delta\phi)$ '. These observables have turned out to be of contemporary interests.

- a) The above observables are being calculated using some phenomenological models being developed over past years.

These techniques use some rigorous calculations for determining energy loss for heavy quark and which will ultimately affect the final heavy meson spectra.

- b) Some *transport models such as Boltzmann transport equation and Langevin equation* are also being used to calculate various transport coefficients to better understand the collisional/elastic and radiative/inelastic energy loss mechanisms, evolution, momentum broadening of heavy quark. The work is intended for both finite temperature and finite baryon density sectors.

Another project or proposal was to understand the behavior of de-confined matter at the phase-transition stage from QGP to hadron sector. The project is to study NJL and PNJL models. This project is done in lead by Mr. Soumitra Maity, a Ph.D. student under Dr. Sanjay K. Ghosh and Dr. Rajarshi Ray. I am an associate in this major study. Till date the work is done only for light quarks sector with SU(2) like symmetry and also incorporates strange quark for SU(3) like symmetry. The project is intended to include heavy quarks notably charm, and beauty quarks into these calculations for SU(2) symmetry picture. The work is in progress.

Atmospheric Science Studies :

Dr. A. Chatterjee, C. Sarkar, A. Adak, Dr. S. K. Ghosh, Dr. S. Raha with external collaborator: Dr. U. Mukherjee

The effect of firework activities on air quality was assessed from the ambient concentrations of PM_{10} , water soluble ionic species, metals and SO_2 over Kolkata metropolis, India during Diwali festival in November 2010. PM_{10} concentrations on Diwali night were found to be ~ 5 times higher than the normal day night-time average concentration. The increase in night-time concentrations of the metals on Diwali spanned over a wide range (Al, Zn, Pb and Cd showed 5–12 times, Cu, Fe and Mn showed 25–40 times and Co and V showed 70–80 times increase in concentrations) compared to night-time concentrations on normal day. The water soluble ionic species showed 1.5–6 times higher concentrations on Diwali night than normal day. The remarkable increases were found for K^+ , Ca^{2+} , Mg^{2+} and SO_4^{2-} . The diurnal variation of PM_{10} and SO_2 was also studied in one of the sites which showed their maximum concentrations on Diwali night during 8 P.M.–3 A.M. indicating maximum firework activities during this period. PM_{10} and SO_2 concentrations increased by ~ 5 times than normal day during this period at this site. The extensive use of firecrackers during Diwali festival was found to have significant effect

on the high increase of these air pollutants which could be associated with the serious health impacts and thus use of firecrackers in this kind of festival in a highly populated metro-city like Kolkata, India needs to be controlled where air pollution is an acute problem through-out the year.

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

We continued the study of ^7Li abundance anomaly. A nuclear physics solution is searched to resolve this anomaly in the cosmos. The enhancement of nuclear reaction rates by nuclear resonances plays a vital role in nuclear astrophysics. 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. We would carry out an experiment (ISOLDE active experiment code IS554) at HIE-ISOLDE at CERN, Geneva, Switzerland. We are presently involved in the simulations of this experiment with GEANT4.

Breakup of ^7Be in presence of heavy targets : *Dr. Dhruba Gupta and Dr. Swapan K Saha*

Production of ^7Li is linked to the production of ^7Be , which in turn, is related to the reaction $^3\text{He} + ^4\text{He} \rightarrow ^7\text{Be} + \gamma$. Measuring this reaction rate is of utmost importance to shed light on ^7Li abundance anomaly. 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. Study of the above reaction in the framework of prior-form DWBA is currently being carried out.

**Study of resonance states of ^{11}Be with isospectral bound state microscopic potential :
*Dr. Dhruba Gupta and Dr. Swapan K Saha***

The theoretical procedure of supersymmetric quantum mechanics (SQM) is adopted for the first time to study quasi-bound states of a weakly bound nuclear system using microscopic potential. The density dependent M3Y (DDM3Y) effective interaction was found earlier to give a satisfactory description of radioactivity, nuclear matter and scattering. In the present work, we have generated a two-body potential microscopically in a single folding model using the DDM3Y effective interaction. From this potential, SQM generated a family of isospectral potentials for ^{11}Be ($^{10}\text{Be} + n$). We investigated the $5/2^+$, $3/2^-$ and $3/2^+$ resonance states of ^{11}Be . The experimental data and the present calculations of excitation energies of the above resonance states are found to be in good agreement.

Collaborator: Dr. S. K. Dutta (B. G. College, Berhampore, Murshidabad)

Foundations of Quantum Mechanics and Quantum Information : *Dr. Dipankar Home*

1. The Leggett-Garg inequality (LGI) as a temporal analog of Bell's inequality, derived using the notion of realism, is studied in a hitherto unexplored context involving weak-interaction-induced two-state oscillations of decaying neutral kaons and neutrinos. The maximum violation of the LGI obtained from the relevant quantum mechanical results is significantly higher for oscillating neutrinos compared to that for kaons. Interestingly, the effect of CP noninvariance for the kaon oscillation is to enhance this violation, while, for neutrinos, the violation is sensitive to the value of mixing parameter.

2. The Bell-type (spatial), Kochen-Specker (contextuality) or Leggett-Garg (temporal) inequalities are based on classically plausible but otherwise quite distinct assumptions. For any of these inequalities, satisfaction is equivalent to a joint probability distribution for all observables in the experiment. This implies a joint distribution for all pairs of observables, and is indifferent to whether or not they commute in the theory. This indifference underpins a unification of the above inequalities into a general framework of correlation inequalities. When the physical scenario is such that the correlated pairs are all compatible, the resulting correlation is nonsignaling, which may be local or multi-particle, corresponding to contextuality or Bell-type inequalities. If the pairs are incompatible, the resulting correlation corresponds to Leggett-Garg (LG) inequalities. That quantum mechanics (QM) violates all these inequalities suggests a close connection between the local, spatial and temporal properties of the theory. As a concrete manifestation of the unification, we extend the method due to Roy and Singh (J. Phys. A, 11 (1978) L167) to derive and study a new class of hybrid spatio-temporal inequalities, where the correlated pairs in the experiment are both compatible or incompatible. The implications for cryptography and monogamy inequalities of the unification are briefly touched upon.

Multifragmentation model for the production of astrophysical strangelets : *Dr. Parthasarathi Joarder*

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.

Collaborators : Mr. Sayan Biswas (Ph.D student, Department of Physics, Bose Institute), Professor Sibaji Raha (Senior Professor and Director, Bose Institute), Dr. J.N. De (Saha Institute of Nuclear Physics), Dr. Debapriyo Syam (CAPSS, Bose Institute), Dr. Arunava Bhadra (Director, High Energy and Cosmic Ray Research Centre, North Bengal University, Siliguri, West Bengal).

Random Fragmentation (A Brief Review) : Dr. Parthasarathi Joarder

Fragmentation is usually a random process in the sense that the number and sizes of the fragments cannot be foretold. The same is true of the time intervals between successive decays of a radioactive substance. It is, nevertheless, possible to find the probability that the said time interval will lie within a given range. Similarly, it is possible to deduce the probable distribution of fragment sizes in a given situation.

Collaborators : Mr. Sayan Biswas (Ph.D student, Bose Institute), Dr. Debapriyo Syam (CAPSS, Bose Institute).

Origin and acceleration of galactic cosmic rays : Dr. Parthasarathi Joarder

A re-examination of the prevailing paradigm for the origin and acceleration of galactic cosmic rays up to the knee energy has been undertaken with external collaborators. Preparatory work in this direction is in progress.

Project IRHPA : Studies on rain drop-size distribution (DSD) at Darjeeling (27°01'N, 88°15'E) and determination of rain DSD model : Shyam Mehta, Soumendra Singh, Dr. Amitabha Mitra, Dr. Sanjay K Ghosh and Dr. Sibaji Raha

The rain rate (R) pattern over hilly region of Darjeeling (27°01'N, 88°15'E) is studied using vertical rain profile data from micro-rain radar (MRR-2, METEK, Germany) for radar reflectivity (Z) profile during 2009-2010 season. Coefficients A and b of Z-R Relationship ($Z = AR^b$) available from measured data have been determined during pre-monsoon (May & June of 2009-10), south west monsoon (July to September of 2009-10) & post-monsoon (October & November of 2009-10) periods. There is a distinct variation observed for A & b values obtained during these three seasons. The typical values for A are obtained as 16.9-20.9 (~ 150m) to 9.4-14.3 (~ 4km) while for b values these are 0.2-0.5 (~ 150m) to 0.09-0.2 (~ 4km) for stratiform rain events. Similarly a different set of A & b values have been obtained for different height for convective rain events. The study of Z-R relationship not only reveals different set of coefficients A , b for the type of rain, stratiform or convective, but also it varies with seasons over Darjeeling. The rain classification procedure assumes that stratiform

rain tends to spread fragile with low intensities while rain, originated from atmospheric convective mechanism, displays high intensities. In general, rain rate up to 10 mm/hr ($R = < 10$) is considered to be stratiform in nature while that greater than 10mm/hr is considered as convective ($R > 10$) rain.

Also from instantaneous rain rate(mm/hr) data and DSD profiles, which are obtained from the continuously monitored Radar reflectivity data from vertically pointed Micro-rain radar, on analysing shows that rain DSD follows *gamma distribution* in general with varying distribution constants like shape & slope parameters over the altitude at Darjeeling.

Project SMS(DRDO) : A Precise Method for Unknown Target RCS Calibration and Pulsed Radar Implementation for Efficient Clutter Rejection at Shyamnagar (22.84°N, 88.39°E) Outdoor Range : Dr. Amitabha Mitra, Soumendra Singh, Vineet Surana*, A. Chakraborty, Dr. Sanjay K Ghosh and Dr. Sibaji Raha

*The Institution of Engineers(India), Kolkata

Transmitting radio waves through appropriate hardware and its *reception* after being negotiated by different objects is essentially the working principle of radar. The properties of received radio waves can be considered as the signature of the physical properties of the *objects* which are being reflected by the radio signals. Characterizing Radar Cross Section (RCS) of an isolated *OBJECT* of interest in an outdoor environment, in presence of other fixed scatterers; which give rise to heavy clutter (scattered wave from unwanted objects), has always been a challenge for scientists. In order to characterize RCS of unknown object under plane wave condition 170m outdoor RCS measurement facility which includes an ogive-structured reinforced cement concrete pylon (like a pedestal for holding an object) with metal jacket, has been developed at Bose Institute Shyamnagar Campus. A two-axis (Azimuth & Elevation) precision *Positioner* with its controller is used to rotate an *object* in desired Az-El direction with small incremental angles. Normally, aspect insensitive reference Spheres or broad aspect constant RCS corner reflectors/Luneberg lens of different dimensions are preferred for RCS calibration in an outdoor range. However, such labour intensive method often attracts various errors resulting non-linearity of calibration curve due to varying background signals during different measurement events under clutter environment. A *convenient method* of RCS calibration technique at the outdoor RCS range using ISAR technique with a stepped frequency pulsed/cw radar configuration through Network Analyzer using only one reference flat plate has been done successfully at Shyamnagar outdoor range. This method of calibration utilizes the return signals corresponding to peaks of the aspect dependent referenced flat plate pattern. Also it shows a correlation of the order of 0.99 under repeated measurement events under clutter when compared with the computed theoretical curve.

Spark spectrometry of toxic smokes: towards a portable, inexpensive, and high-resolution environment monitoring instrument : Soumendra Singh, Nabarun Polley*, Samir Kumar Pal* and Dr. Amitabha Mitra

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Air pollution related to inhaling of CO, SO₂, NO₂, and Pb including "smoking" have been attributed to a common cause of breathing problem beside its role in the diseases of heart and lung cancer, etc. Inductively coupled plasma mass spectrometry (ICP-MS) and laser-induced breakdown spectroscopy are the most popular techniques for monitoring toxic gases in the environment. Apart from sensitivity and resolution of these techniques, these sensors have certain shortcomings; neither these do come in comfortable size nor these are cost effective. Characterization of these toxic gases in the environment through low cost portable sensor was realized through indigenous design which is based on spark spectrometry. The capabilities of the instrument for online analysis, unlike of ICP-MS, of suspended particulate matter as well as various gaseous elements in the smoke have also been investigated. Software has also been developed for its practical interface. The apparatus has been successfully tested to monitor several toxic fumes including cigarette smoke and NO_x. The apparatus has been demonstrated, through spectroscopic study, to detect the role of water vapor (solvation) in the ionization of potassium, which is an active ingredient of toxic smokes. The sensitivity of such spark spectrometer based instrument is found to be sub-ppm (0.27 ± 0.13 ppm) in case of cigarette smoke in ambient condition. The simplicity and cost-effective design could provide an alternative method of detection of fumes in air and could serve as one of the cheap alternatives for costly/bulky bench-top instruments. Further improvements in detection sensitivity and resolution are under progress.

Radiofrequency reflective property characterization of Trihedral corner reflector at C band for on line ground truth calibration for RISAT-1 SAR satellite : Soumendra Singh, Vineet Surana¹, Ayona Chakraborty, Mayank Misra², Parul Patel², H S Srivastava³ and Dr. Amitabha Mitra

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In order the Remote Sensing Satellites to discriminate different ground truth (characteristics of land and soil, water body, vegetation, rock, etc.) through remote sensing on the basis of their reflective properties, the on-board receivers of the satellites need calibration. A set of pre-calibrated strong radio reflectivity scatterers are used to calibrate the satellite receiver not only before launching but also it needs calibration during its rotation along its orbit. These set of strong scatterers are placed on ground at some predefined coordinates along the satellites' swath width periodically to determine the quantitative nature of *reflectivity contrast* with

respect to the location corresponding to the coordinates. Thus it is important to characterize these strong scatterers (generally conductive Trihedral Corner reflectors) on ground through reflectivity measurement by vector radio frequency field at outdoor for different polarization (VV, HH, HV and VH). The Shyamnagar outdoor range has completed its first phase of experimental study in C as well as in X band towards characterizing these Trihedral Corner reflectors together with its theoretical computation using commercially available electromagnetic solvers. A report has been generated and communicated to SAC, ISRO.

Edge proximity metric in complex networks : *Dr. Soumen Roy*

We propose a new network metric called edge proximity, for which we demonstrate important consequences in complex networks. We show that removal (due to damage, disruption etc.) of edges with higher edge proximity value is responsible for drastic internal efficiency loss in a number of important real-world networks. These findings are obviously important for rational design of real-world networks with increasing functionality and robustness. Edges with high edge proximity are observed to have important biological functions in a wide range of biological networks.

High pressure Raman study of wurtzite InAs nanowires : *Dr. Achintya Singha and Ms. Dipanwita Majumdar*

As a thermodynamic parameter pressure plays an important role in structural phase change which has a large impact on the physical properties of a system. Application of external pressure can tune the electronic and structural properties of a semiconductor. Here we have investigated the pressure dependent Raman response of InAs nanowires up to 58 GPa. We have determined the mode Grüneisen parameters and Born's transverse effective charge. At higher pressures the Raman spectra show an indication of structural phase transition. High pressure X-ray diffraction measurements confirm that the nanowires at 21 GPa exhibit a phase transition from wurtzite to orthorhombic crystal structure.

Optical properties of mono/few layers Molybdenum disulfide (MoS₂) decorated with metal nanoparticles : *Dr. Achintya Singha and Mr. Shib Shankar Singha*

Molybdenum disulfide (MoS₂) is widely known as layered transition-metal dichalcogenides (LTMD). It is composed of covalently bonded S-Mo-S layers that are bound by weak van der Waals interaction. Bulk MoS₂ is an indirect band gap semiconductor with an energy gap of ~ 1.2 eV. Remarkable changes in electronic structures have been observed with reducing number of MoS₂ layers. The band gap changes from indirect to direct when the thickness reaches to few/monolayer. Because of its interesting electronic properties MoS₂ are widely used in photocatalysis and photodetection applications. However, monolayer or few layer

MoS₂ films turn into weak light emitter due to the thickness reduction. We have synthesized mono and few layers of MoS₂ using very simple method. The MoS₂ layers have been decorated with noble metal nanoparticles. The metal nanoparticles decorated MoS₂ exhibits a huge enhancement of the optical emission and the layer acts as an ultrasensitive trace detector.

Dielectric relaxation of perovskite oxides : Dr. T. P. Sinha

The dielectric relaxation (a conduction process) at various temperatures of synthesized *complex and double* perovskite oxides (strongly correlated electronic materials) has been investigated in frequency and time domains. The relaxation phenomena are modelled either by Cole-Cole or Davidson-Cole or Havriliak-Negami techniques. In these materials it has been observed that the interaction between the electronic spins, their charges and orbitals, and the lattice produce a rich variety of electronic phases and self organization via their responses to the external fields (electrical, thermal, magnetic and optical).

Collective vibrational modes and photophysical behaviour of perovskite oxides : Dr. T. P. Sinha

The density functional theory under generalized gradient approximation has been employed to understand the various interactions leading to the optical, vibrational and magnetic properties in the perovskite oxides. The calculated density of states is compared with the experimental density of states obtained by x-ray photoemission spectroscopy. The interband contribution to the optical properties of these perovskite oxides has been analyzed. The zone centre phonon mode calculations have been performed which is used to explain the observed vibrational modes by Raman and infrared spectroscopy of the materials.

Photoluminescence behaviour of nanoceramics and nanoparticles : Dr. T. P. Sinha

Nanoceramics of some rare-earth orthoferrites NdFeO₃ and NdMnO₃ are synthesized by sol-gel technique. Nanoparticles of II-VI semiconductor (CdSe) doped with transition metal oxides have also been synthesized by soft chemical route. The size dependent band gap energy of these materials is obtained from the UV-visible absorption spectra. The modulation of electronic energy structures and transient probabilities of the system due to the presence of localized dopant levels have been analyzed by photoluminescence study.

Antiferromagnetism in perovskite oxides : Dr. T. P. Sinha

Magnetic properties of some rare-earth and transition metal based perovskite oxides have been investigated by measuring the magnetic susceptibility in the zero-field cooled and field cooled conditions. Spin polarized calculations have been performed using density functional theory. The spin-orbit coupling and the on-site Coulomb potential are considered in the calculation to analyse the observed magnetic moments.

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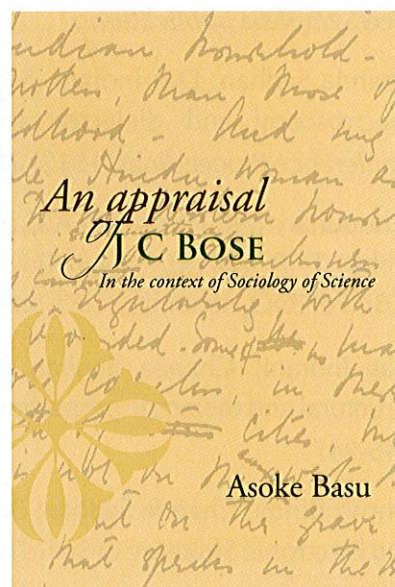
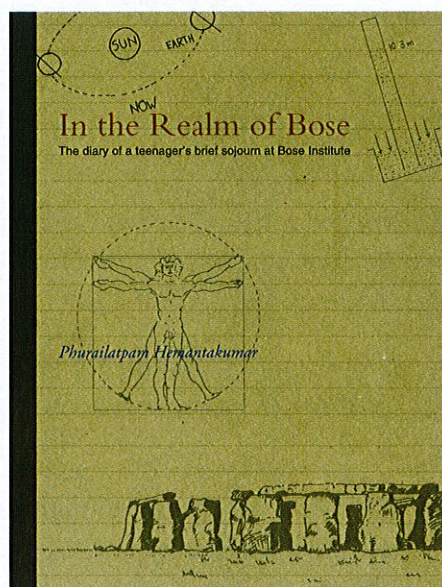
Conference/Symposia publications:

1. Chanda Sadhan, Das Indrani, Saha Sujoy and Sinha T P (2013). Structural, Raman spectroscopy and dielectric relaxation study of nanoceramics NdFeO_3 , *AIP Conference Proceedings*, 1512, 216-217.
2. Choudhary B K, Himanshu A K, Kumar U, Bandyopadhyay S K, Sen P, Singh S N and Sinha T P (2013). Magnetic and ferroelectric studies of double perovskite $(\text{KBi})(\text{FeNb})\text{O}_6$ ceramics, *AIP Conference Proceedings*, 1512, 1268-1269.
3. Das Indrani, Chanda Sadhan, Dutta Alo, Banerjee S and Sinha T P (2013). Structural and dielectric properties of $\text{Y}_{1/2}\text{Er}_{1/2}\text{FeO}_3$, *AIP Conference Proceedings*, 1512, 946-947.
4. Ghosh Binita, Chanda Sadhan, Sakhya A P and Sinha T P (2013). Vibrational modes and Electronic Structure of $\text{Sr}_2\text{GdTaO}_6$, *AIP Conference Proceedings*, 1512, 814-815.
5. Himanshu A K, Bahuguna R, Ray D K, Bandyopadhyay S K and Sinha T P (2013). Synthesis and dielectric studies of polyorthotoluidine-polyvinyl pyrrolidone conducting polymer composites, *AIP Conference Proceedings*, 1512, 174-175.
6. Saha Sujoy, Sakhya A P, Das Sayantani and Sinha T P (2013). Structural and transport properties of NdCrO_3 nanoceramics, *AIP Conference Proceedings*, 1512, 930-931.

Library

1. Biswas S K and Chakraborty A K (2012) The role of academic library and librarian in information literacy. In West Bengal College Librarians' Association (WBCLA) Golden Jubilee Celebration 1962-2012 & XXV Annual Conference & Seminar, 2nd December, 2012, Kolkata, 39-40.
2. Biswas S K and Chakraborty A K (2013). The College Libraries West Bengal and Laws of Library Science: Prospects and Problems; *College Libraries (An English Quarterly)*; 28:I-IV, 5-12.

New Publications of Bose Institute



The publication unit of Bose Institute recently published two new books. **In the Realm of Bose: The diary of a teenager's brief sojourn at Bose Institute** by Phurailatpam Hemantakumar. The book is a diary maintained by the author when he was only 14 years old and had visited Bose Institute from Manipur to attend a ten-day hands-on Science Camp. **An Appraisal of J. C. Bose in the Context of Sociology of Science** by Asoke Basu, Emeritus Professor, California State University. The book is a case analysis of the life and work of Sir. J. C. Bose, in the context of contemporary culture and social history.

Students Awarded With Ph.D. Degree

Name of the Student (University/Year)	Title of thesis	Supervisor
Biochemistry Department		
Sucharita Dey (C. U., 2013)	Bioinformatic analysis of protein structures and interactions	Dr. P. Chakrabarti
Soumyananda Chakraborti (C. U., 2013)	The effect of ZnO nanoparticles on proteins and cells, and the recognition of curcumin by tubulin	Dr. P. Chakrabarti
Mr. Jaspreet Singh Grewal (J.U., 2013)	Novel proteins that regulate chromosome segregation and cell division in <i>Entamoeba histolytica</i> .	Dr. A Lohia
Sumana Banerjee (IISER-Kolkata 2014)	Molecular evolution of protein domains involved in protein turnover in eukaryotes: A comparative genomics and OR Feomics approach	Dr. Srimonti Sarkar
Mr. Biswanath Jana (J.U., 2013)	Biochemical, biophysical and genetic characterization of a dimeric Mip-like peptidyl-prolyl cis-trans isomerase from <i>Escherichia coli</i> .	Dr. S. Sau Dr. P. K. Parrack (Co-supervisor)
Bioinformatics Centre		
Soumita Podder (J.U. 2013)	Studies of the origin of evolutionary rate heterogeneity in the human disease and non-disease proteome.	Dr. T. C. Ghosh
Division of Molecular Medicine		
Pinki Nandi (J.U., 2013)	Process of Fertilization of Caprine Spermatozoa : Involvement of a Low Molecular Mass Protein and a Synthetic Dihydropyrimidone	Dr. P. C. Sen

Bibhabasu Hazra (J.U., 2013)	Study of various medicinal plants to establish scientific evidences for Indian system of complementary and alternative medicine	Dr. N. Mondal
Abhishek Santra (C.U., 2013)	Synthesis of oligosaccharides corresponding to the bacterial cell wall polysaccharides	Dr. Anup Kumar Misra
Abhijit Sau (C.U., 2014)	Synthetic studies on microbial complex oligosaccharides	Dr. Anup Kumar Misra

Division of Plant Biology

Amit Roy (C. U., 2013)	A Proteomic approach to elucidate the mechanism of action of different plant lectins on the agriculturally important sucking pests.	Dr. Sampa Das
Anirban Kundu (C. U. 2013)	MYMIV-resistance- introgression in Vigna mungo susceptible cv. T9: Agro morphological and molecular characterization of the recombinant inbred lines.	Dr . Amita Pal
Suparna Ghosh (C. U. 2013)	Identification of proteins expressed during in vitro regeneration of Vigna radiata through proteomic approach	Dr. Amita Pal
Subhabrata Ghosh (C.U 2013)	Molecular Documentation and Evaluation of different species of Ginger and Bamboo from Eastern and North Eastern India	Dr. Swati Sen-Mandi

Microbiology Department

Jayita Sarkar (J.U., 2013)	Metagenomic strategy for accessing the genetic and functional diversity of uncultured soil microorganisms	Dr. Tapan K. Dutta
Debajyoti Ghosal (J.U., 2013)	Studies on bacterial degradation of polycyclic aromatic hydrocarbons in the development of biosensor strain to monitor these priority pollutants in the environment	Dr. Tapan K. Dutta

Physics Department

Amit Kumar Pal (C.U., 2014)	Ground and thermal state properties of novel spin systems	Dr. Indrani Bose
Sarbani Majumder (J.U., 2013)	Study of phase transition in Astrophysics and Heavy-ion collisions	Dr. Sanjay K. Ghosh
Nishant Kumar (T.M. Bhagalpur University, Bhagalpur, 2013)	Dielectric relaxation in some complex perovskite oxides.	Dr. T. P. Sinha



The Bioinformatics Centre organized a one day symposium entitled **HIGH PERFORMANCE COMPUTING: Accelerating science with Tesla GPU** on July 26, 2013, coordinated by Dr. S. Ghosh Dastidar.

Grants-in-aid Schemes

Investigator/ Co-Investigator	Title of the Scheme	Name of the Dept./Section
Scheme funded by Aeronautical Development Agency (ADA), Ministry of Defence		
Dr. S. Raha <i>Principal Coordinator</i> Dr. A. Mitra <i>Investigator-in-Charge</i>	Millimeterwave Scattering(MWS-Phase-III)- Development of Radar Reflectivity Measurement & Diagnostic Imaging Facility at Multifrequency Band	CAPSS/ Physics
Schemes funded by CSIR		
Dr. Srimonti Sarkar	Functional characterization of the lipid-binding FYVE protein from <i>Giardia lamblia</i>	Biochemistry
Dr. Subrata Sau	Isolation of the conditional lethal mutants of mycobacteriophage L1 repressor possessing high operator binding affinities and development of an expression vector for mycobacterial systems	Biochemistry
Dr. A Bhunia	Structural Study of <i>De Novo</i> Designed Novel Antifreeze Peptides From <i>Leucosporidium Antarcticum</i> Antifreeze Protein-1 (Afp-1).	Biophysics
Dr. G. Basu	Theoretical and experimental analyses of bacterial GlxRS/tRNA-Glx/gatCAB co-evolution and the molecular basis of their interaction	Biophysics
Dr. J. Basu (PI) Dr. M Kundu (Co-PI)	Role of microRNAs in the immune response to mycobacterial infection (1.7.2011-31.6.2014)	Chemistry
Dr. Kaushik Biswas	Molecular mechanisms of tumor progression : role of tumor derived products in mediating tumor cell growth, motility and metastasis	Division of Molecular Medicine
Dr. Subrata Majumdar	Mechanistic insights into dendritic cell maturation and its role in <i>Leishmania donovani</i> : Emphasis on dendritic cell cased anti- leishmanial therapy	Division of Molecular Medicine

Dr. A. K. Misra	Synthesis of oligosaccharides corresponding to <i>Shigella dysenteriae</i> for the preparation of glycoconjugates to treat Shigelosis	Division of Molecular Medicine
Dr. G. Sa (PI) Dr. T. Das (Co-PI)	Molecular mechanisms of immune evasion by tumor: Role of curcumin in ameliorating dendritic and T-regulator cell-mediated immune dysfunction	Division of Molecular Medicine
Dr. Shubho Chaudhuri	Investigating the role of ARID/HMG4 (At1g04880) protein in transcription regulation of cold stress responsive gene	Division of Plant Biology
Dr. Swati Gupta-Bhattacharya	Diagnosis of mold allergy among inhabitants of urban and rural peoples of the gangetic plane of West Bengal through aerobiological and immunochemical studies	Division of Plant Biology
Dr. Amita Pal	Understanding molecular mechanism of MYMIV-resistance in <i>Vigna mungo</i> through genomic approach	Division of Plant Biology
Dr. W. Ghosh	Understanding the origin(s), evolution and interaction(s) of different molecular mechanisms of chemotrophic sulfur oxidation: Elucidating the metabolic strategies of early Life	Microbiology

Scheme funded by CCRH

Dr. T. Das Dr. G. Sa	Role of homeopathic medicine in cancer regression and rejuvenation of depressed immune system: A mechanistic study	Division of Molecular Medicine
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Schemes funded by DAE

Dr. Subrata Sau (PI) Dr. T. K. Dutta (Co-PI)	Studies on the DNA binding mechanism of a global virulence regulator SarA of <i>Staphylococcus aureus</i> .	Biochemistry/ Microbiology
Dr. P C Sen (PI) Dr. T. Das (Co-PI)	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.	Division of Molecular Medicine

Dr. S R Sikdar	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> .	Division of Plant Biology
Dr. T. K. Dutta (PI)	Exploration of promoters of biotechnological importance from metagenomic DNA	Microbiology

Schemes funded by DBT

Dr. Srimonti Sarkar	Identification and characterization of a 19S proteasomal component of the early diverging eukaryote <i>Giardia lamblia</i>	Biochemistry
Dr. S. Ghosh Dastidar	Mechanistic insight into the role of conformational Modulations in driving BC12s apoptotic network: Structural dynamics to therapeutic design	Bioinformatics
Dr. T C Ghosh	Role of protein complexes and protein protein interaction network in eukaryotic protein evolution	Bioinformatics
Dr. G. Basu	Setting up of a State-of-the-art 600 Mhz FT-NMR with Cryoprobe facility at Bose Institute	Biophysics
Dr. A Bhunia / Dr. Subhrangsu Chatterjee	Biophysical and Structural Aspects of Oncogenic G-Quartets Bound to Drugs: Screening, High Resolution NMR and Low Resolution Spectroscopy.	Biophysics
Dr. J. Basu (PI) Dr. M. Kundu (Co-PI)	Sys TB: A Network Programme for Resolving the Intracellular Dynamics of Host Pathogen Interaction in TB Infection	Chemistry
Prof. M. Kundu, (PI) Prof. J. Basu (Co-PI)	The role of two component systems and cell division proteins in mycobacterial physiology	Chemistry
Dr. S. Banik (PI) Dr. Jayanta Mukhopadhyay Dr. M.Kundu	In vitro study of input-output robustness of MprAB signalling pathway in <i>Mycobacterium tuberculosis</i>	Chemistry
Dr. Jayanta Mukhopadhyay (PI) Dr. R Sen, CDFD	Characterization and design of inhibitors of <i>Mycobacterium tuberculosis</i> transcription	Chemistry

Dr. A. Bhunia	Biophysical and Structural Aspects of Oncogenic survival and death of leishmania Spectroscopy.	Biophysics
Dr. Kaushik Biswas	Studies on the efficacy of flavonoid and non-flavonoid polyphenols against chronic inflammation induced disease pathogenesis.	Division of Molecular Medicine
Dr. T Das (PI) Dr. G. Sa	Binning stochastic phenotypic states of cancer cell population in different color box	Division of Molecular Medicine
Dr. S. Majumdar	Identification of the host cell factors responsible for survival and death of leishmania,	Division of Molecular Medicine
Dr. S. Majumdar	Immunomodulatory role of Arabinosylated Lipoarabinomannan Against Visceral Leishmaniasis	Division of Molecular Medicine
Dr. S. Majumdar	Host phosphatases and kinases participating in CD40-induced anti-leishmanial Vs Pro-leishmanial pathways	Division of Molecular Medicine
Dr. N. Mandal	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 (funded by DBT-NER Twinning)	Division of Molecular Medicine
Dr. N. Mandal	Purification and characterization of bioactive natural antioxidant, immunomodulator and anticancer products from <i>Dioscorea alata</i> L., of North Eastern region of India (funded by DBT-NER Twinning)	Division of Molecular Medicine
Dr. Mahadeb Pal	Role DNA-dependent protein kinase in transcription control in human cells	Division of Molecular Medicine
Dr. Sampa Das (Programme Co-ordinator)	Biotic stress in Plants: A concerted approach based on functional genomic, proteomic and transgenic techniques. DBT Programme Support (December 2006- 4 th December- 2011 5 th December 2011- March 2014)	Division of Plant Biology

Dr. Swati Gupta Bhattacharya Dr. T. K. Ghose	Studies on the mould spore diversity as environmental allergen in outdoor and indoor environments of urban and rural areas of Agartala, Tripura	Division of Plant Biology
Dr. P. Kundu (PI) Dr. Sampa Das (Co-PI)	Regulation of microRNA transcription and biogenesis by fungal-stress in tomato	Division of Plant Biology
Prof. A. N. Lahiri Majumder (Co-ordinator and PI Project No.-I & II)	Generation of salt-tolerant rice plants: A translational approach.	Division of Plant Biology
Prof. D. N. Sengupta (PI Project No.-III) Dr. Shubho Chaudhuri (PI Project No.-IV)		
Dr. Amita Pal, P.I. Dr. Sampa Das (Programme Coordinator)	Identification of genetic loci for the development of MYMIV-resistance in <i>Vigna</i> .	Division of Plant Biology
Dr. T. K. Dutta (PI)	Carbon monoxide conversion using native hydrogenogenic microorganisms for sulphate rich wastewater treatment	Microbiology

Scheme funded by DBT's Twinning programme for NE

Dr. Tapash C Ghosh	Understanding causes of codon usage bias in organisms	Bioinformatics
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Schemes funded by DBT-RGYI

Dr. Zhumur Ghosh	Micro-regulatory networks in leukemia stem cells	Bioinformatics
Dr. Jayanta Mukhopadhyay	Role of alternative sigma factors in gene regulation of <i>M. tuberculosis</i>	Chemistry

Schemes funded by DRDO, Ministry of Defence

Dr. S. Raha Principal Coordinator Dr. A. Mitra Investigator-in-Charge Dr. S. K. Ghosh Co-Investigator	Studies on Microwave Scattering(SMS)	CAPSS / Physics
Dr. T. P. Sinha	Transport Properties of Double Perovskite Oxides	Physics

Schemes funded by DST		
Dr. P. Chakrabarti	J.C. Bose National Fellowship	Biochemistry
Dr. M.Kundu (PI)	Stress induced regulation of extracytoplasmic	Chemistry
Dr. J.Basu (Co-PI)	Sigma factors in mycobacteria	
Dr. Mahadeb Pal	Molecular mechanism of HSF1 mediated chromatin remodeling during transcriptional induction of human hsp70 by different stressors	Division of Molecular Medicine
Dr. T. Das (PI)	Mapping the molecular mechanisms of resistance-	Division of Molecular Medicine
Dr. G. Sa	to-apoptosis switch over of non small-cell lung carcinoma by curcumin: An approach towards chemo-sensitization	
Dr. G. Sa	Targeted alteration of MAPK family members	Division of Molecular Medicine
Dr. T. Das	ERK and p38MAPK/JNK to channelize oncogenic Ras-induced proliferative-signaling into apoptotic-signaling	
Dr. S. R. Sikdar	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.	Division of Plant Biology
Dr. S. Raha	ALICE–Operation and Utilization	CAPSS/ Physics
Dr. S. Das		

Scheme funded by DST under IRHPA, Govt. of India

Dr. S. Raha (PI)	Study of Cosmic ray interactions and	CAPSS/ Physics
Dr. S. K. Ghosh	Cosmic Ray–Aerosol–Cloud connection	
Dr. A. Chatterjee	in the context of regional climate change	
Dr. S. Das		
Dr. Amitabha Mitra		
Dr. S. Bandyopadhyay		
Dr. R. Ray		

Scheme funded by DST-INSPIRE Faculty Scheme

Dr. Anupama Ghosh	Survival strategies of the corn smut fungus <i>Ustilagomaydis</i> during host colonization (starting date: 10.10.2013)	Division of Plant Biology
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Schemes funded by DST, SERB Fast Track

Dr. A Bhunia	Design, Synthesis and Mechanistic Insights of Novel Antimicrobial Peptides (AMP) Using High Resolution NMR Spectroscopy: Role of Outer Membrane Permeability and DNA Binding.	Division Molecular Medicine
Dr. D.N.SenGupta (PI) Dr. Pallob Kundu (Co-PI)	Functional analysis of the DNA polymerase lambda gene and the protein from indica rice cultivars	Division of Plant Biology
Dr. Sonali Sengupta	Study of plant mechanosensitivity using <i>Mimosa pudica</i> as a model: with special reference to calcium signalling in touch reception and relay"	Division of Plant Biology
Dr. Wriddhiman Ghosh	Comprehensive Geomicrobiology of two High Temperature Hydrothermal Systems of India: Paradigms of Primitive Metabolisms and Biogeochemical Evolution, Prospects of Biotechnological Resource.	Microbiology

Schemes funded by DST, SERB Ramanujan Fellowship

Dr. Abhrajyoti Ghosh	Understanding protein translocation under extreme conditions	Biochemistry
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Schemes funded by DST, SERC

Dr. K. Jana	Molecular Signalling Involved in Patho-physiological 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	Division Molecular Medicine
Dr. A. K. Misra	Synthesis of oligosaccharide antigens of the Enterohemorrhagic <i>Escherichia coli</i> (EHEC) strains for the preparation of glycoconjugates	Division Molecular Medicine

Scheme funded by DST-Women Scientists

Dr. Tanaya Chatterjee	Biophysical studies on proteins of <i>Vibrio Cholerae</i> and their interactions with small molecules for possible therapeutic applications	Biochemistry
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Scheme Funded by Wellcome Trust-DBT India Alliance

Dr. Ajit B. Datta	Intermediate Fellowship titled "Understanding the structural basis of the substrate and the E2 specificities of ubiquitin E3 ligases" (01.08-2011-31.08.2016)	Biochemistry
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Schemes funded by ICMR

Dr. Zhumur Ghosh Dr. Sudipto Saha	Systematic identification of regulatory networks in pluripotent cells integrating coding and noncoding world	Biocinformatics
Dr. J. Basu (PI) Dr. M Kundu (Co-PI)	Understanding cell division in mycobacteria	Chemistry
Dr. M. Kundu (PI) Dr. J. Basu (Co-PI)	Role of secretory antigen in <i>Helicobacter pylori</i> Mediated induction of autophagy	Chemistry

Scheme funded by Indo-Korean collaborative programme (DST)

Prof. J. Basu (PI)	<i>Mycobacterium tuberculosis</i> infection: understanding the role of microRNAs in regulating the immune response of macrophages	Chemistry
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Schemes funded by Indo-Swedish Collaborative Programme

Dr. Joyoti Basu (PI)	Latency of <i>Mycobacterium tuberculosis</i> : evaluating drugs and drug targets using innovative	Chemistry
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Scheme funded by ICAR, National Fund

Dr. Sampa Das (P.I.) Dr. D. Basu (Co PI)	Development of pod borer resistant transgenic pigeonpea and chickpea	Division of Plant Biology
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Scheme funded by Ministry of Earth Science (MoES)

Dr. N. Mandal	Study on white spot syndrome virus (WSSV) prevalence and diversity of disease resistant population among wild giant black tiger shrimp (<i>Penaeus monodon</i>) of the entire coastal area of India	Division of Molecular Medicine
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Participation in Conferences/Symposia/Workshops & Invited Talks Delivered at Various Organizations

Dr. P. Chakrabarti (Biochemistry) presented papers/attended at (i) the seminar on Successful Indo-French S & T Cooperation: CEFIPRA, Paris, May 17, 2013; (ii) Facets of Insilico Chemical Biology for Novel Therapeutics, IICB, June 18, 2013; (iii) Workshop on Computational Biology and Protein Structure Prediction, Heritage Institute of Technology, Kolkata, September 23-27, 2013; (iv) TWAS 24th General Meeting, Buenos Aires, Argentina, October 1-4, 2013; (v) India-France Technology Summit, New Delhi, October 23-24, 2013; (vi) 42nd National Seminar on Crystallography and International Workshop on Application of X-ray Diffraction for Drug Discovery, New Delhi, November 21-23, 2013; (vii) The 12th Conference of the Asian Crystallographic Association, Hong Kong, December 7-10, 2013. He chaired sessions at (viii) International Symposium on Challenges in Chemical Biology, IICB, Kolkata, January 27 – 29, 2013; (ix) National Conference on Molecular Architecture, Dynamics and Assembly in Living Systems (MADALS 2014) at SINP, Kolkata, February 7-10, 2014; (x) Macromolecular Structures, Methods & Mechanisms, IICB, Kolkata, March 31, 2014.

Participation of conferences by Prof. P. Chakrabarti's group member.

Aritrika Pal, Dr. Debadrita Mukherjee, Dr. Tanya Chatterjee, Dr. Debamita Paul attended Facets of Insilico Chemical Biology for Novel Therapeutics, IICB, June 18, 2013; Dr. Debadrita Mukherjee and Aritrika Pal attended the conference on Bacterial Expressions, NCBS, Bangalore, October 22-25, 2013; Devlina Chakravarty and Jesmita Dhar attended the IIT Madras – Tokyo Tech Joint Symposium on Techniques and Applications of Bioinformatics, Chennai, September 27-28, 2013; Devlina Chakravarty and Jesmita Dhar attended the Satellite Workshop on Advances in Molecular Dynamics of Biomolecules, JNU, New Delhi, December 3-4, 2013; Dr. Tanya Chatterjee attended The 12th Conference of the Asian Crystallographic Association, Hong Kong, December 7-10, 2013.

Dr. Abhrajyoti Ghosh (Biochemistry) (i) acted as the Resource person of Plant Science in the North-East States Students' Training on Basic Science 2014 (NESST-BASE 2014) at Mayapuri Campus of Bose Institute, Darjeeling on 26-28th May'2014; (ii) invited to deliver lectures on Recombinant DNA technology to the M.Sc. students of Department of Biotechnology, Department of microbiology and Department of Neuroscience, University of Calcutta, Kolkata, India.

Dr. Subrata Sau and Mr. Anindya Biswas (Biochemistry) presented a poster entitled "Studies on the structures and functions of the repressor proteins of temperate *Staphylococcus aureus* phage $\phi 11$ " at the 82nd Annual Meeting of the Society of Biological Chemists held at the University of Hyderabad, Hyderabad, on 2nd-5th December 2013;

Dr. Subrata Sau (Biochemistry) delivered a talk at the 101st Indian Science congress, held at the University of Jammu, Jammu, on 3rd-7th February 2014.

Dr. T. C. Ghose (Bioinformatics) talk delivered on (i) *Use of Recombinant DNA in Modern Biotechnological Research at National Institute of Technology, Durgapur during December 2013*; (ii) BTISnet annual Coordinators meeting at Goa during February 2014.

Dr. Zhumur Ghosh's group members (Bioinformatics) : (a) Ranjan Kumar Maji presented a poster at 2013 NextGen Genomics and Bioinformatics Technologies (NGBT) conference at IGIB, Delhi (November 14-16, 2013); (b) Arijita Sarkar and Sohini Chakraborty attended (i) inStem workshop on Mouse Embryology workshop: Stem cells to Organogenesis March 10-12, 2013 organised by instem, NCBS, Bangalore. (ii) 4th international conference on stem cells and cancer (ICSCC-2013): Proliferation, Differentiation and Apoptosis 19th-22nd October, 2013, Organized by: International Centre for Stem Cells, Cancer and Biotechnology (ICSCCB), Pune, India

Dr. Shubhra Ghosh Dastidar (Bioinformatics) delivered (i) a talk and conducted hands-on session in the workshop "Modeling and Drug Designing" to be held during 18-22nd November, 2013 held in Kalyani University and (ii) a popular lecture at District Science Centre (Purulia) on National Science Day.

Dr. Sudipto Saha (Bioinformatics) (i) conducted a national workshop on computational proteomics, 3-4th March, 2014 at Bioinformatics Centre, Bose Institute; (ii) delivered two talks on 3-day workshop on Design and Statistical Analysis for Biomedical Research on 26th, March, 2014 at Biomedical Informatics Center, NICED, Kolkata.

Dr. G. Basu (Biophysics) delivered invited lectures on (i) Electrostatic steering of protein-protein association captured in a single geometric parameter at Annual Meeting of Indian Biophysical Society (MADALS 2014), SINP, Kolkata, Feb 7-10, 2014; (ii) The role of electrostatic discrimination in protein-protein interactions at BioWorld 2013: Computational Biology in Disease and Disorder, IIT Delhi, 9-11, Dec 2013; (iii) Modulation of cis/trans equilibrium of peptidyl-prolyl conformation by CH $\times \times \times$ p interactions: A combined study by NMR and MD simulations at International Conference on Biomolecular Simulations & Dynamics: Recent Advances & Future Perspectives, IIT Madras, Nov 30, 2013 IIT Madras, 28th-30th Nov, 2013; (iv) Watching Molecules Dance to Newton's Second Law at Presidency University, Kolkata, Dec 15, 2013; (v) Electrostatic steering of protein-protein association captured in a single geometric parameter at IICB-CSIR, Kolkata, March 31, 2013.

Dr. Debjani Roy (Biophysics) (i) presented poster "A bidirectional drug repositioning approach for Parkinson's disease through network-based inference" at symposium 'Frontiers in Modern Biology 2013' (FIMB 2013) organized by IISER, Kolkata, Nov 9-10, 2013. This poster was awarded the 'Best Poster' in the symposium; (ii) Delivered a talk on "Study of microRNA network in Parkinson's Disease" at 'Asian Congress on Biotechnology 2013' (ACB 2013) organized by IIT Delhi, Dec 15-19, 2013.

Dr. S. Banik (Chemistry) (i) participation in "Current Trends in Biochemical and Biophysical Modeling" at S N Bose National Center for Basic Sciences, Kolkata (October 7-8, 2013); (ii) participation in "National Symposium on Nonequilibrium Statistical Physics and Nonlinear Dynamics" at Indian Association for the Cultivation of Science, Kolkata (January 2-4, 2014); (iii) invited lecture in "Current Trends in Biochemical and Biophysical Modeling" at S N Bose National Center for Basic Sciences, Kolkata (October 7-8, 2013); (iv) invited lecture in "National Symposium on Nonequilibrium Statistical Physics and Nonlinear Dynamics" at Indian Association for the Cultivation of Science, Kolkata (January 2-4, 2014).

Dr. Joyoti Basu (Chemistry) (i) visited Chungam National University School of Medicine, South Korea in connection with Indo-Korean joint Program from February 24 to 29, 2014; (ii) delivered a lecture in the meeting Systems Biology of Infection held in Ascona, Switzerland from June 26 to 29, 2013; (iii) delivered a lecture in the IUBMB 10th International Symposium on Biochemical Roles of Eukaryotic Cell Surface Macromolecules organized by Saha Institute of Nuclear Physics from January 20 to 24, 2014.

Dr. K. P. Das (Chemistry) (i) participated in Prof. Sushil Mukherjee birth centenary celebration held at CU and Bose Institute during 29-30 July 2013 as members of the organizing committee. Also attended a one day symposium entitled Frontiers of Physical Chemistry : Colloids, Electrode Processes, Biointerfaces and Soil Processes held at Bose Institute on 30th July 2013 on this occasion; (ii) attended one day symposium on Trends in Surface Science and Related Areas (TSSRA) held at Department of Pharmaceutical Technology, Jadavpur University on 3rd June 2013 as members of the organizing committee. My student Victor Banerjee gave an oral presentation entitled: "Inhibition of insulin fibrillation by a peptide NK9" at the symposium; (iii) gave an invited talk entitled "Role of small molecules in controlling insulin fibrillation" at the 5th Asian Conference of Colloid and Interface Science (ACCIS) held at North Bengal University during November 20-23, 2013; (iv) gave an invited talk entitled "Molecular mechanism of stabilization of micellar protein α -crystallin by Zn^{+2} " at the 16th National Conference on Surfactants Emulsions and Biocolloids (NATCOSEB) held at Central Leather Research Institute, Chennai during November 28-30, 2013.

Dr. M. Kundu (Chemistry) (i) presented a paper in the Gordon Research conference on Tuberculosis Drug Development held from July 21 to 26th, 2013 in Lucca, Italy; (ii) delivered invited lecture in the conference "Genomics, biology and therapeutics in tuberculosis and other mycobacterial diseases" held in Patan Mahal, Rajasthan from March 22 to 24th, 2014.

Dr. Soumen Roy (Chemistry) delivered invited talks at (i) "Nonlinear dynamics in Biology", organised by National Mathematics Initiative and IISER Mohali at IISc Bangalore during July 8-13, 2013; (ii) 'Conference on Statistical methods for nano-researchers' organised by Centre for Research in Nanoscience and Nanotechnology (CU) & CSIR-South Africa during December 9-12, 2013.

Mr. Arnab Bandyopadhyay (CSIR-SRF) (Chemistry) participated in "The Seventh q-bio Summer School" at University of California, San Diego, USA (July 21-August 6, 2013)

Victor Banerjee, SRF (Institute) (Chemistry) participated in the Annual Conference of the Biophysical Society held at San Francisco, CA during February 15-19, 2014 and presented a poster entitled "Inhibition of insulin fibrillation by a non-toxic peptide NK9".

Dr. Sujit Roy, CSIR pool scientist (Chemistry) gave a talk entitled "Understanding the molecular mechanism of DNA damage repair and maintenance of genome stability in higher plants in response to abiotic and genotoxic stress" at Central Food Technological Research Institute (CSIR-CFTRI) on January 3, 2014.

Dr. Tanya Das (Division of Molecular Medicine) (i) delivered lecture at the annual meeting of *Molecular Immunology Forum* held at Bose Institute, Kolkata, in January, 2014; (ii) invited for delivering a talk in the 100th Indian Science Congress held at Jammu University, Jammu, February, 2014; (iii) invited for chairing a scientific session as well as to deliver a lecture at the *International Conference on Angiogenesis*, Bhubaneswar, February, 2014; (iv) delivered *Raj Kristo Dutta Memorial Award* lecture at the Indian Science Congress Association auditorium, Kolkata, February, 2014; (v) chaired a scientific session and delivered a talk at the *International Stem Cell Meeting*, Mumbai, October, 2013; (vi) invited to chair a scientific session at the *Young Scientist Conclave* organized by DST at S. N. Bose Institute, March, Kolkata, 2014; (vii) chaired a scientific session at the annual meeting of Society for Biological Chemists (Kolkata chapter), Kolkata, April, 2014.

Dr. Kuladip Jana (Division of Molecular Medicine) Deliver Invited Lecture in "5th International Symposium on Non-Surgical Contraceptive methods of Pet Population control" in Portland, Oregon, USA on Jun 20-22, 2013 (Young Scientist Travel Award from ACC&D, Portland Oregon, US).

Dr. Subrata Majumder (Division of Molecular Medicine) (i) invited speaker in the 10th IUBMB symposium on cell surface macromolecules during Jan. 20-24, 2014 at Panchwati, Kolkata; (ii) invited speaker at Vivekananda Circle, Ramakrishna Mission, Golpark on the auspices occasion of 150th Birthday Anniversary of Swami Vivekananda on 31st Oct., 2013; (iii) invited speaker at Jadavpur University, Pharmacology Department, AICTE programme on 'Future Direction of Pharmaceutical Studies and Research' July and Nov. 2013

Dr. Nripendranath Mandal (Division of Molecular Medicine) (i) participated and delivered a special invited lead lecture on "Present scenario of Medical Biotechnology in India: Importance of Medicinal plants to control iron-overload-induced hepatotoxicity and cancer" at the National symposium on "Emerging trends in Biotechnology: Present scenario and future dimensions", March 29 – March 31, 2014 organized by Post Graduate Dept. of Biotechnology, Utkal University, Odisha; (ii) participated and delivered a special invited lead lecture on "Importance of various DNA markers for the development of specific pathogen resistant (SPR) *Penaeus monodon*" at the National conference on "Current trends in Life Sciences research and challenges ahead", February 28 – March 02, 2014 organized by Dept. of Life Sciences, Sambalpur University, Odisha; (iii) participated and delivered a special invited Lecture on "Importance of patents in scientific research: A case study of microRNA research" in the International conference on "Global IPR System and WTO Issues", November 16-17, 2013 organized by Dept. of Biotechnology, Ch. Charan Singh University, Meerut (UP), India; (iv) participated and delivered a special invited Lecture on "Iron chelation by *Terminlia chebula*: New remedies from an age-old plant" in the International conference on "Biologically active substances and materials: fundamental and applied problems of production and application", May 27-June 01, 2013 Crimea, in the Novy Svet, Ukraine organized by Education-Science Center "Institute of Biology", Taras Shevchenko National University of Kyiv, Ukraine.

Dr. Anup Kumar Misra (Division of Molecular Medicine) (i) participated 27th International Carbohydrate Symposium held at Indian Institute of Science, Bangalore during January 12-17, 2014; (ii) visited Abo Academy University, Finland under DBT-Academy of Finland exchange program during August 01-October 31, 2013 on study leave.

Dr. Mahadeb Pal (Division of Molecular Medicine) (i) attended 82nd Annual Conference of SBCI held in University of Hyderabad, Science City, Dec 2-5 Kolkata. Presented a poster; (ii) attended the 4th International Conference on Stem Cells and Cancer (ICSCC-2013): Proliferation, Differentiation and Apoptosis, scheduled from Oct 19, 2013 to Oct 22, 2013 at Durbar Hall, Haffkine Institute, Parel, Mumbai – 400012.

Dr. Gaurisankar Sa (Division of Molecular Medicine) (i) organized *Molecular Immunology Forum Meeting 2014* in January 2014 in Kolkata, (ii) delivered an invited lecture at *Indian Association of Cancer Research Annual Conference* at Tiruvantapuram in January 2014. He has delivered an invited lecture at JNCIRSIR, Bangalore in January 2014. (iii) invited for delivering

a talk in the 100th Indian Science Congress held at Jammu University, Jammu, February, 2014. (iv) chairing a scientific session as well as to deliver a lecture at the *International Conference on Angiogenesis*, Bhubaneswar, February, 2014. (v) chaired a scientific session and delivered a talk at the *International Stem Cell Meeting*, Mumbai, October, 2013. (vi) chaired a scientific session at the annual meeting of Society for Biological Chemists (Kolkata chapter), Kolkata, April, 2014.

Dr. P. C. Sen (Division of Molecular Medicine) (i) delivered invited lectures at 3rd MolMed-2013 International Conference on Mol-Med-2013 in Haikau, China during November 13-16, 2013 and 11th Annual Congress of International Drug Delivery Science & Technology-2013 (IDDST-2013) in Haikau, China during November 13-16, 2013; (ii) delivered lecture at the 101st Indian Science Congress meeting held in Jammu during February 2-7, 2014 as President of the New Biology (including Biochemistry, Biophysics & Molecular Biology and Biotechnology) Section.

Ms. Shahana Mitra (Division of Molecular Medicine) obtained the best poster award in the 82nd Annual Meeting of 'The Society of Biological Chemists (India)' held at the School of Life Sciences, University of Hyderabad, Hyderabad, India, December 2-5, 2013

Dr. Sampa Das (Division of Plant Biology) (i) delivered invited talk on "Food Security & GM Crop" on 20th September, 2013 at RAMAKRISHNA MISSION VIVEKANANDA CENTENARY COLLEGE, Rahara, Kolkata; (ii) delivered invited talk on Crop Genetic Engineering : A Powerful Technology for Agricultural Revolution in a National seminar on "Food Security" on 29th September, 2013 at Visva Bharati University; (iii) attended and delivered at 11th International Rice Functional Genomics Symposium during 20-23rd November, 2013 on a topic "BACTERIAL LEAF BLIGHT OF RICE: XANTHOMONAS- RICE PATHOSYSTEM" at New Delhi; (iv) delivered an invited talk in Agriculture and Forestry Science session of 101st Science Congress at Jammu on 6th February, 2014 on a topic "Elucidating the initial molecular interaction between Cry1Ac toxin and insect midgut derived alkaline phosphatase receptor leading to insect mortality"; (v) delivered invited talk on Reactive Oxygen Species (ROS): The key player in signaling events of Chickpea (*Cicer arietinum* L.)-*Fusarium oxysporum* f. sp. *ciceris* race 1 (Foc1) interplay in International Symposium on Plant Signaling & Behaviour at Delhi University on 10th March, 2014.

Dr. Gaurab Gangopadhyay (Division of Plant Biology) (i) acted as the Coordinator and Resource person of Plant Science in the North-Eastern States Students' Training on Basic Science 2013 (NESST-BASE 2013) at Mayapuri Campus of Bose Institute, Darjeeling from 29th April –1st May 2013. Compiled and prepared the booklet for the trainees; (ii) 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 2013 (taken three theoretical classes in the Personal Contact Programme); (iii) invited as "Guest speaker" on the occasion of

'Banomahotsav' organized by Institute of Education for Women (Govt. of West Bengal), Hastings House, Alipore on 26.07.2013; delivered lecture on "Van mahotsav – not a 'utsav' – a mission"; (iv) participated in the workshop on "Awareness building and sensitization Workshop on National Fund for Basic, Strategic and Frontier Application Research in Agriculture (NFBSFARA)" organized by ICAR at National Institute for Research on Jute and Allied Fibers Technology (NIRJAF), Kolkata on 23rd August 2013; (v) presented a proposed collaborative research project entitled "Development of linkage map of Mulberry correlating yield with morphological and molecular markers" to Dr. S. Nirmal Kumar, Director at Central Sericultural Research & Training Institute, Berhampore on 11.11.2013; (vi) acted as one of the mentors in the DST-INSPIRE Internship Science Camp 2014 for school students on 11.01.2014 organized by JBNSTS (Jagadis Bose National Science Talent Search), Kolkata; (vii) oral presentation entitled "A simple algorithm for phenomic identification of the ideal Sesame plant type with novel architecture and an image analysis based seed phenomics for predictive Sesame Marker Assisted Breeding" in the 3rd International Plant Phenotyping Symposium organized by IPPN (International Plant Phenotyping Network) and MSSRF (M S Swami Nathan Research Foundation) held at Chennai, India on 17 – 19th February 2014.

Dr. Anupama Ghosh (Division of Plant Biology) participated in the 25th Annual General Meeting of Plant Physiology Forum and 23rd Prof. S.M. Sircar Conference held on 4th April 2014 at Bose Institute.

Dr. Tapas Kumar Ghose (Division of Plant Biology) (i) Seminar given on Genetic diversity analysis of a set of rice landraces using SSR markers in *India Biodiversity Meet 2013* held at Indian Statistical Institute Kolkata from March 14 – 16, 2013; (ii) *Seminar given on the topic Genetic Diversity of Bacterial Leaf Blight Disease in a Set of Rice Landraces of West Bengal in International Congress on Agriculture, Food Engineering and Environmental Sciences-Sustainable approaches (AFEESSA- 2014) held at Jawaharlal Nehru University, New Delhi on 29th and 30th March*; (iii) poster presented on "Genetic diversity and population structure of rice landraces from Eastern and North Eastern States of India" in *International Symposium of Rice Functional Genomics* held during November 20th – 23rd, 2013 at hotel "The Grand", New Delhi, India.

Dr. A.N.Lahiri Majumder (Division of Plant Biology) delivered invited talks at (i) the 7th International Rice Genetics symposium, organized by the International Rice Research Institute, during November 3 – November 9, 2013 in Manila, Philippines; (ii) International Symposium in Rice Functional Genomics at Delhi during November 20 – November 23, 2013; (iii) Annual meeting of the Society of Biological Chemists, India at Hyderabad during December 3 – December 5, 2013; (iv) delivered the 21st Prof S M Sircar Memorial Lecture of the Botanical Society of Bengal on January 8, 2014 at the Department of Botany, Calcutta University.

Dr. Swati Gupta Bhattacharya (Division of Plant Biology) invited to deliver a speech and to give hands on training in Aerobiological techniques in a session of "Palaeobotany and Palynology" in March, 2014 as a part of Centenary Celebration of Dept. of Botany, University of Calcutta.

Dr. Pallob Kundu (Division of Plant Biology) Invited lecture on Regulation of microRNA transcription by *Alternaria* sp.: significance in fungal pathogenesis at Genotypic Pvt. Ltd., India, Sept. 2013

Dr. Sonali Sengupta (Division of Plant Biology) (i) A history of technical advances in proteomics : A powerful biological tool. **Sonali Sengupta**. Techniques in Proteomics" workshop, National Workshop, North Eastern Hill University, Shilong, Meghalaya, India (Invited resource speaker), Feb 20-28, 2014; (ii) recent breakthroughs in plant proteomic research. **Sonali Sengupta**. Techniques in Proteomics" workshop, National Workshop, North Eastern Hill University, Shilong, Meghalaya, India (Invited resource speaker), Feb 20-28, 2014; (iii) Manipulation of Inositol metabolic cycle : Emerging role of inositol as a signalling molecule for abiotic stress tolerance in plants. **Sonali Sengupta and Arun Lahiri Majumder**, invited talk, Indo-Japanese Joint Workshop on "Signal Sensing and Transduction in Photosynthetic Organisms from Cyanobacteria to Land Plants", Dec 16-18, 2013, University of Hyderabad, Hyderabad, India; (iv) Mechanosensory reception in plants: plant neurobiology: integrated evaluation of Darwin's root brain hypothesis. **Sonali Sengupta**, invited oral presentation, 5th Indian Youth Science Congress, Dec 6-9, 2013, Visvabharati University, Shantiniketan, India. (v) Expression of Rice Galactinol Synthase genes; a form of Regulated Unproductive Splicing and Translation (RUST)? **Sonali Sengupta**, Sritama Mukherjee, Abhishek Mukherjee and Arun Lahiri Majumder (Oral presentation) ASPB Plant Biology 2013, July 20-24, 2013, Providence, USA,

Dr. Amita Pal (Division of Plant Biology) (i) elected Fellow of the West-Bengal Academy of Science and Technology; (ii) Member of the DBT Task Force Committee on Bioinformatics, Computational and Systems Biology; (iii) Associated Editor of Plant Cell Tissue and Organ Culture: A journal of Plant Biotechnology; (iv) Associated Editor, Journal of Integrated OMICS (Spain); (v) Member of the Editorial Boards of World Journal of Agriculture Sciences, Journal of Plant Biochemistry and Biotechnology and Journal of Bamboo and Rattan; (vi) Selected for the Indira Gandhi Sadbhavana Gold Medal award, 2013 by GEPRA, India.

Dr. P. K. Saha (Division of Plant Biology) delivered invited lecture entitled- "Relationship in Phenotypic and Genetic diversity of cultivated and wild Indian sesame" in the 101st Indian Science Congress held in University of Jammu, Jammu during 3rd to 7th January, 2014.

Dr. Swati Sen-Mandi (Division of Plant Biology) (i) delivered invited lecture on DNA Fingerprinting based authentication of plants from NE India and development of diagnostic DNA Markers associated with useful traits in a symposium on "Sixty Years of the Double Helix: Its impact on science and society" organized by DNA Society of India at Bose Institute on 27th September, 2013; (ii) delivered an invited lecture on "Molecular Documentation and Diagnostics of Medicinal Potential in Plants" at Indian Phytomed Summit 2014 on 25th February 2014, at the Gateway by Taj, Kolkata.

Dr. S.R. Sikdar (Division of Plant Biology) delivered invited talk on i) "Application of Biotechnology & Rural Biotechnology for the development of Tea industry" in the National Conference on 'Tea Culture and Science – special reference to present scenario of Indian Tea' organized by Department of Plantation Management and Studies, Sikkim University on April 9, 2013, ii) "Rural Biotechnology: A parallel approach of Transgenic crop for food security and poverty alleviation" in the Department of Biotechnology, Visva Bharati, Santiniketan on October 31, 2013, iii) "Plant Tissue Culture – A Biotechnological Technique for Crop Improvement" in the Department of Botany, Scottish Church College, Kolkata on March 6, 2014, iv) "How to grow edible mushroom" in the Department of Environmental Studies, Visva Bharati, Santiniketan on March 19, 2014.

Bodhisattwa Saha (Division of Plant Biology) attended Annual Congress of EAACI-WAO June, 2013, at Milan, Italy to give Poster presentation in Thematic poster session and awarded with EAACI travel grant. Bodhisattwa Saha attended 5th Annual Congress of Proteomics Society of India for Poster presentation held in IISC, Bangalore in November 2013.

Gaurab Sircar (Division of Plant Biology) attended Annual Congress of EAACI-WAO June, 2013, at Milan, Italy to give Oral and Poster presentation in Poster discussion session and awarded with EAACI travel grant. Gaurab Sircar attended 5th Annual Congress of Proteomics Society of India for Poster presentation held in IISC, Bangalore in November 2013.

Kavita Ghosal (Division of Plant Biology) attended Annual Congress of EAACI-WAO 2013, at Milan, Italy to give Poster presentation in Thematic poster session and awarded with Bose Institute travel grant.

Arunava Mandal, Deepti Sarkar and Pallob Kundu (Division of Plant Biology) Transcriptional regulation of a cell expansion gene upon Tomato Leaf Curl virus infection, American Society for Virology (ASV) 32nd Annual Meeting, 2013 Penn State University, State College, Pennsylvania, Student Travel grant awarded to Arunava Mandal.

Souvik Dhar (Division of Plant Biology) presented poster entitled "Silicon localized peculiar epidermal structures revealed by SEM and EDAX as phenomic markers to screen desirable Mulberry (*Morus alba* L.) genotypes as feeds for Silkworm (*Bombyx mori* L.) rearing" by S. Dhar,

V. Arora, **G. Gangopadhyay** and M.K. Ghosh in the International Conference on Electron Microscopy, organized by Saha Institute of Nuclear Physics (SINP) and Electron Microscope Society of India (EMSI), held at SINP, Kolkata during 3 – 5 July 2013.

Vivek Kumar (Division of Plant Biology) (i) participated in the “Workshop on FSSAI standards of edible oils and developed products vis-à-vis analytical methodologies” (27th to 28th February 2014) held at Department of Chemical Technology, University of Calcutta; (ii) delivered an oral presentation entitled “Towards deciphering molecular factor behind higher level of 'Basmati' fragrance in *Pandanus amaryllifolius* Roxb., a wild monocot” by V. Kumar, V. Arora, M. Sultana and **G. Gangopadhyay** at The International Congress on “Agriculture, Food Engineering and Environmental Science – Sustainable Approaches” (29th - 30th March 2014) organized by “Krishi Sanskriti” at JNU, New Delhi.

Marufa Sultana (Division of Plant Biology) (i) participated in Workshop on Computational Proteomics (3rd to 4th March 2014) held at CoE in Bioinformatics, Bose Institute, Kolkata; (ii) delivered an oral presentation entitled “Looking for novel proteins associated with *in vitro* morphogenesis of Pineapple” by M. Sultana and **G. Gangopadhyay** at The International Congress on “Agriculture, Food Engineering and Environmental Science – Sustainable Approaches” (29th - 30th March 2014) organized by “Krishi Sanskriti” at JNU, New Delhi.

Vivek Arora (Division of Plant Biology) delivered an oral presentation entitled “SSR markers for assessing the hybrid nature of two high yielding Mulberry varieties” by V. Arora, M.K. Ghosh and **G. Gangopadhyay** at The International Congress on “Agriculture, Food Engineering and Environmental Science – Sustainable Approaches” (29th - 30th March 2014) organized by “Krishi Sanskriti” at JNU, New Delhi.

Dr. Abhijit Chatterjee (Environmental Science) Oral presentation on Surface Ozone over Eastern Himalaya, India in International Conference called “Changing Chemistry in Changing Climate (C4)” held during 1-3 May, 2013 at Indian Institute of Tropical Meteorology, Pune, India.

Mr Chirantan Sarkar (Environmental Science) Oral Presentation on Black Carbon Scavenging over Eastern Himalaya, India in International Conference called “Changing Chemistry in Changing Climate (C4)” held during 1-3 May, 2013 at Indian Institute of Tropical Meteorology, Pune, India.

Mr Arindam Roy JRF under the supervision of Dr Abhijit Chatterjee (Environmental Science) visited Dr D. M. Chate's laboratory at IITM, MoES, Pune for a collaborative work on aerosol scavenging and aerosol-Rain interaction studies over eastern Himalaya. Visit has been made during November, 2013 for 10 days and the study is going on at present.

Dr. S. Bandyopadhyay (Physics/CAPSS) (i) visited The Institute of Mathematical Science, Chennai in June 2013 (one week), August 2013 (1 week) and in January 2014 (one week); (ii) visited Indian Institute of Technology, Jodhpur in December 2013 (one week); (iii) visited Institute of Physics, Bhubaneswar in February 2014 (3 days); (iv) invited talk on Tight bounds on the distinguishability of quantum states by separable measurements at IPQI 2014, at the Institute of Physics, Bhubaneswar, February 2013; (v) invited talk on Tight bounds on the distinguishability of quantum states by separable measurements at IPQI 2014, at the Institute of Physics, Bhubaneswar, February 2013; (vi) invited talk on Tight bounds on the distinguishability of quantum states by separable measurements at the International Meet on Quantum Correlations and Logic, Language and Set Theory 2013, IIT Jodhpur, December 2013; (vii) invited talk on Local distinguishability of quantum states at the Satellite Meeting on Quantum Correlation and its application in Communication and Cryptography at the Indian Statistical Institute, September 2013; (viii) Long Contributed talk on Tight bounds on the distinguishability of quantum states by separable measurements at AQIS 2013, Chennai, August 2013.

Dr. I. Bose (Physics) (i) delivered on invitation a talk on "Early signatures of sudden regime shifts in gene expression dynamics" at International Conference on Perspectives in Nonlinear Dynamics, University of Hyderabad, Hyderabad (July 15-18, 2013); (ii) a talk on "Biological Physics: A search for physical principles" at National Seminar on Advancement in Modern Physics organized by the Department of Physics, Ramkrishna Mission Residential College, Narendrapur (August 23-24, 2013); (iii) a talk on " Sudden regime shifts: early signatures" at National Symposium on Nonequilibrium Statistical Physics and Nonlinear Dynamics at IACS, Kolkata (January 2-4, 2014) (iv) a talk on "Early signatures of sudden regime shifts" at UGC-DSA funded National Seminar Probing Biology – in vivo, in vitro and in silico at the Department of Biophysics, Molecular Biology and Bioinformatics, University of Calcutta (February 28, 2014); (v) delivered on invitation a colloquium on "Tipping point transitions in complex dynamical systems" at the Biological Science Division, IISER, Kalyani on 3/4/13; (vi) eight lectures on statistical mechanics at the Refresher Course in Theoretical Physics (sponsored by the three Science Academies) at Assam University, Silchar (December 2-7, 2013) (vii) a talk on "The living cell: a playground for statistical physics and information theory at IISER, Kalyani in one-day meeting on condensed matter physics (December 20, 2013); (viii) the C. K. Majumdar Memorial Lecture on " Early signatures of sudden regime shifts" organized by PESA and NITTTR, Calcutta February 7, 2014); (ix) a colloquium on "Biological Physics: A search for physical principles" at the Physics Department, Maulana Azad College (March 14, 2014).

Dr. B. K. Chatterjee (Physics) (i) chaired a technical session on Bionics at Institute of Engineering and Management Conference *IEMCON-13* (August 23, 2013), at Science City,

Kolkata; (ii) participated in the panel discussion on “Enthusing experimental research: Present problems and possible solutions” at the National workshop on *Exploring Radiation in Many Splendors* (November 23-24, 2013), at the Saha Institute of Nuclear Physics, Kolkata.

Dr. Supriya Das (Physics) (i) participated in the 8th Physics Week of ALICE collaboration held during May 19 – 24, 2013 at PADOVA, Italy; (ii) visited RD51 Laboratory at CERN Geneva to work on R&D for ALICE TPC upgrade program during December 8 - 22, 2013.

Dr. Sanjay Kr. Ghosh (Physics) (i) participated in the 8th Physics Week of ALICE collaboration held during May 19 – 24, 2013 at PADOVA, Italy.

Dr. Dhruba Gupta (Physics) served as a member of the organizing committee of the Workshop and Winter School on Astroparticle Physics (WAPP 2013) held at Bose Institute, Darjeeling, December 17-28, 2013 and delivered an invited talk on “Interaction of Radiation with Matter” at WAPP 2013.

Dr. Dipankar Home (Physics) attended (i) 13th Asian Quantum Information Science Conference, Organized by the Institute of Mathematical Sciences (IMSc), Chennai, held on 25 – 30 August, 2013; (ii) Meeting on Quantum Information Processing and Applications, organized by Harish-Chandra Research Institute (HRI), Allahabad, held on 02 – 08 December, 2013; (iii) Quantum correlation: Foundations and applications, organized by Indian Statistical Institute (ISI), Kolkata, held on 04 – 05 March, 2014.

Dr. Parthasarathi Joarder (Physics) (i) delivered six lectures on “Basic plasma/magnetohydrodynamic processes” at the High Energy and Cosmic ray Research (HECRRC), North Bengal University (NBU), Siliguri, West Bengal during March 5, 2013 to March 10, 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; (ii) convener and principal organizer of the international meeting “8th Winter Work-shop and Winter School on astroparticle physics, 2013” jointly held by Bose Institute, Kolkata and Tata Institute of Fundamental Research (TIFR), Mumbai at the Centre for Astroparticle Physics and Space Science (CAPSS), Mayapuri, Darjeeling Campus, Bose Institute during December 17, 2013 to December 28, 2013. The workshop and school were attended by about 32 scientists and resource persons, six of whom were scientists from various institutions abroad. About 29 students, including fresh research students, postgraduate students and advanced undergraduate students from various institutions of India, attended the Winter school; (iii) attended the “National Symposium on Very High Energy Gamma Rays” during November 25, 2013 to November 27, 2013 at Bhaba Atomic Research Centre (BARC), Mumbai; (iv) attended the “International Conference on Matter at Extreme Condition: Then and Now” organized jointly by Bose Institute, Variable Energy Cyclotron

Centre (VECC), Kolkata, Saha Institute of Nuclear Physics (SINP), Kolkata and Calcutta University during January 15, 2013 to January 17, 2013 at Bose Institute, Kolkata. Jointly with Sayan Biswas, J.N. De, Sibaji Raha and Debapriyo Syam and a poster paper at that conference.

Dr. Swapan K. Saha (Physics) presented a talk on Breakup of ^7Be in presence of heavy targets at ISOLDE Workshop and Users Meeting 2013 at European Organization for Nuclear Research (CERN), Geneva, Switzerland, November 25-27, 2013.

Dr. Achintya Singha (Physics) delivered (i) invited talk in Exposure to Frontier Research in Science and Technology organized by JBNSTS at SCS Autonomous College, Puri during February 24 – 26, 2014 (ii) Academic Council Lecture Series at Bose Institute Main Campus on 30th October, 2013 (iii) attended India-UK Scientific Seminar "From Graphene Analogues to Topological Insulators" (GATI-2014), organized by Indian Association for the Cultivation of Science, Kolkata & Physics Department, Loughborough University, UK held in Vedic Village, Kolkata, India during 27-29 January 2014.

Dr. T. P. Sinha (Physics) delivered an invited talk on "Photophysical properties and vibrational modes of perovskite oxides" in National Conference on Condensed Matter Days 2013 at National Institute of Technology, Rourkela during August 29-31, 2013. He gave an oral presentation on "Optical dielectric function and vibrational modes of perovskite oxides" in the International Union of Materials Research Society - International Conference in Asia at Indian Institute of Science, Bangalore during 16-20 **December 2013**. Dr. Sinha delivered the Materials Research Society of India (MRSI) Medal Lecture on "Optical dielectric constant of perovskite oxides" in the Annual General Meeting of MRSI at Indian Institute of Science, Bangalore during 12-14 February 2014.

Dr. T.P. Sinha's group member:

Dr. Alo Dutta presented a paper on "Ac electrical properties of NdFeO_3 nanoceramic" in the International Conference on Electron Microscopy and XXXIV Annual Meeting of the Electron Microscope Society of India at Saha Institute of Nuclear Physics, Kolkata during 3-5 July 2013. Dr Dutta also presented a paper on "Electronic structure and phonon modes of $\text{Sr}_2\text{SmNbO}_6$ " in the International Union of Materials Research Society - International Conference in Asia at Indian Institute of Science, Bangalore during 16-20 **December 2013**. Dr. Dutta presented a paper on "Electronic structure and linear optical properties of Sr_2CdWO_6 through modified Becke-Johnson potential" in the Annual General Meeting of MRSI at Indian Institute of Science, Bangalore during 12-14 February 2014. Sujoy Saha presented a paper on "*Structural and dielectric properties of NdMnO_3 nanoparticles*" in the International Union of Materials Research Society - International Conference in Asia at Indian Institute of Science, Bangalore during 16-20 December 2013. Sadhan Chanda presented a paper on "Small polaron migration

associated multiple dielectric responses and Maxwell-Wagner relaxation in Y_2CrAlO_6 in the International Union of Materials Research Society - International Conference in Asia at Indian Institute of Science, Bangalore during 16-20 December 2013. Anup Pradhan Sakhya presented a paper on "Impedance spectroscopy, a.c. conductivity and electronic structure of NdAlO_3 : Experimental and first-principles approaches" in the International Union of Materials Research Society - International Conference in Asia at Indian Institute of Science, Bangalore during 16-20 December 2013. Saswata Halder presented a paper on "Dielectric relaxation of $\text{BaFe}_{1/4}\text{In}_{1/4}\text{Ta}_{1/2}\text{O}_3$ " in the International Union of Materials Research Society - International Conference in Asia at Indian Institute of Science, Bangalore during 16-20 December 2013.

Ms Dipanwita Majumder (Physics) (i) Attended and presented a poster in 6th International Conference On Nano Science And Technology (ICONSAT2014) held in Panjab University during 3-5, March, 2014. (ii) Attended India-UK Scientific Seminar "From Graphene Analogues to Topological Insulators" (GATI-2014), organized by Indian Association for the Cultivation of Science Kolkata & Physics Department, Loughborough University, UK held in Vedic Village, Kolkata, India during 27-29 January 2014.

Mr. Shib Shankar Singha (Physics) (i) participated one day seminar on Trends in Surface Science & Related Areas (TSSRA-2013) held in the Department of Pharmaceutical Technology Jadavpur University on 3rd May 2013, (ii) participated short term course on Modern Methods in Materials Processing and Characterization (M3PAC-2013) held in National Institute of Technology Durgapur, India, during September 17-21, 2013.

Dr. Sidharth K. Prasad (Physics) presentations (i) Soft and Hard interactions in proton-proton collisions at LHC energies, Poster presentation in the XXIV International Conference on Ultrarelativistic Nucleus-Nucleus Collisions "Quark Matter 2014", Darmstadt, (Germany), May 19 – 24, 2014; (ii) Jet measurements in High Energy Experiments, Talk in Indo-Fair Coordination Centre Workshop, January 20 – 25, 2014, Darjeeling (INDIA); (iii) Soft and Hard interactions at LHC energies, Poster presentation in an International Conference on Matter at Extreme Conditions: Then & Now, January 15 – 17, 2014, Bose Institute, Kolkata, (INDIA); (iv) Soft and Hard interactions at LHC energies, Talk in ALICE India Collaboration meeting, January 12 – 14, 2014, VECC Kolkata (INDIA); (v) Measurements of jet observables at LHC", Invited talk in a Workshop on High Energy Physics and Phenomenology, December 12 – 21, 2013, Blue Lily Beach Resort, Puri, Odisha, (INDIA); (vi) Measurements of jet production cross sections and properties using ALICE at the LHC, Seminar, September 27, 2013, Institute of Physics (IOP), Bhubaneswar (INDIA); (vii) "Measurements of jet properties and cross sections using ALICE, Seminar, September 20, 2013, Bose Institute, Kolkata (INDIA); (viii) Accelerated Computing via GPU, BI-IFCC 2nd workshop, A workshop organized jointly by the Bose Institute and VECC, November 11 – 15, 2013, Bose Institute, Kolkata, (INDIA).

Dr. Mohammed Younus (CAPSS) (i) presented a talk titled 'Heavy Quark Dynamics in Quark Gluon Plasma' at QCD Group Seminar, Dept. of Physics, Bose Institute, CAPSS, on September 27, 2013; (ii) participated in International Conference on Matter Under Extreme Conditions, hosted by Bose Institute, VECC and SINP, at Bose Institute, Kolkata from January 15, 2014 to January 17, 2014; (iii) participated in Compressed Baryonic Matter Workshop held at Darjeeling, by Bose Institute from January 20, 2014 to January 24, 2014; (iv) participated in ECT* Doctoral Training Programme held at Trento, Italy from April 7, 2014 to May 16, 2014 and presented a talk titled 'Charm Quarks and Parton Cascade Model' at its seminar; (v) participated and presented a poster titled 'Energy Loss of Open Charm Produced in Relativistic Heavy Ion Collision' at XXIV International Conference on Quark Matter-QM 2014 held from May 18, 2014 to May 24, 2014 held at Darmstadt, Germany; (vi) presented a overview talk titled 'Overview of Theoretical Talks Presented at Quark Matter-2014' at QCD Group seminar, CAPSS, Bose institute on June 20, 2014.

Dr. Arun Kumar Chakraborty (Librarian) Participated and presented two papers on (i) "Innovations in libraries and information centres for the knowledge society: an overview"; and (ii) "Scientific facets of library and Information Science Discipline" in the 101st Indian Science congress 2014 during February 3rd-7th, 2014 at Jammu. The abstracts of the presented paper published in Proceedings of the 101st Indian Science Congress Part II: Section of Information and Communication Science & Technology (Including Computer Sciences), 3-7 February, 2014 (Jammu) Indian Science Congress Association, Kolkata. (iii) Invited to Chair a Technical session, Paper Presented and Nominated as a member of National Advisory Committee for "The International Seminar on Applications of Communication and Information Technology in Library (SACITIL-2014)" organised by Variable Energy Cyclotron Centre, Department of Atomic Energy, Kolkata during 28-30th January, 2014; (iv) invited to deliver a lecture and also presented a paper on "Web Based Discovery tools versus Disintermediation: the different veracity focused by current end-user" on 10th January, 2014 in the "One Day National Workshop on Web-Scale Discovery Services: Single Window Access to Library e-Resources" organized by Central Library IIT Kharagpur; (v) invited to deliver lecture in the Workshop on "Automation of Library Management System using KOHA-Open Source Software" organized by National Institute of Research on Jute & Allied Fibre Technology, Regent Park, Kolkata on 20th December, 2013; (vi) invited to deliver lecture as an Invited Speaker on "Modern Library Management and Services" held on December 20, 2013 at Netaji Nagar Day College, Kolkata; (vii) invited to attend 4th Library Advisory Committee of University of Kalyani held on December 18, 2013 in the Central University of Kalyani as one of the member; (viii) invited as member of the National Technical Programme Committee (NTPC) of

The 15th International Conference on Asia-Pacific Digital Libraries (ICADL) 2013) organized by the International School of Information Management, University of Mysore held in Bangalore, India during December 9-11, 2013; (ix) invited as a resource person to deliver a lecture on 5th December, 2013 in a 5 (five) day training programme on "Library Automation" from 2-6th December, 2013 organised by Central Library University of Kalyani in collaboration with INFLIBNET Centre, Gandhinagar (an autonomous institution established by UGC as per UGC Act 1956); (x) invited as a panelist "E-Content 2013-Library-Publisher Partnership: Bridging the access gap-integrating Content, Technology and Services" held on 25th October, 2013 at Hotel Park Plaza, Bullygunge in association with Annual Reviews, Maney Publishing, Royal Society Publishing and SPIE Digital Library, J-Gate; (xi) invited to deliver lecture on 3rd September 2013 as a Resource Person for 1-week Programme on "Research Methodology" during September 2-8, 2013 organized by Indian Association of Special Libraries & Information Centres, Kolkata; (xii) invited to "RSC Indian Librarian Advisory Committee Meeting" as a member on 29th August and the RSC Librarian Appreciation Day on 30th August, 2014; (xiii) presided 318th IASLIC Study Circle meeting held on Monday, 26th August, at the seminar room of the Association, Kolkata-700054; (xiv) nominated by Department of Science and Technology (DST), Govt. of India as LPAC (Local Project Advisory Committee) as one of the members for a project on "Measuring Scientific Value of Indian Journals: A Pilot Study on Physics-Chemistry-Biology Journals" under sponsorship of NSTMIS (DST); (xv) nominated as one of the coordinates of NKRC as well as DST Nodal Officer of National Knowledge Resource Consortium, New Delhi; (xvi) nominated as the Governing Body member as well as convener of Serial Division of Indian Association of Special Libraries and Information Centres (IASLIC), Kolkata for the period 2014-2016.

Sri Pradip Kumar Sarkar (Library) (i) participated in "E-Content 2013-Library-Publisher Partnership: Bridging the access gap-integrating Content, Technology and Services" held on 25th October, 2013 at Hotel Park Plaza, Bullygunge in association with Annual Reviews, Maney Publishing, Royal Society Publishing and SPIE Digital Library, J-Gate. (ii) participated in "Web Based Discovery tools versus Disintermediation: the different veracity focused by current end-user" on 10th January, 2013 in the "One Day National Workshop on Web-Scale Discovery Services: Single Window Access to Library e-Resources" organized by Central Library IIT Kharagpur. (iii) participated in International Conference on "Digital Libraries ICDL 2013 on Vision2020: Looking Back 10years and forgoing new frontiers" organized by JERI, New Delhi during 27-29 November, 2013; (iv) participated XXIV All India Conference 2013 on Role of Library Associations in India in Modern age on December 26-29, 2013 organised by National Institute of Virology (ICMR), Microbial Containment Complex (MCC), Pune and IASLIC, Kolkata.

Dr. (Ms.) Banhisikha Chaudhuri (Library) (i) participated in "E-Content 2013-Library-Publisher Partnership: Bridging the access gap-integrating Content, Technology and Services" held on 25th October, 2013 at Hotel Park Plaza, Bullygunge in association with Annual Reviews, Maney Publishing, Royal Society Publishing and SPIE Digital Library, J-Gate; (ii) Participated in "The International Seminar on Applications of Communication and Information Technology in Library (SACITiL-2014)" organised by Variable Energy Cyclotron Centre, Department of Atomic Energy, Kolkata during 28-30th January, 2014.

Ms. Ananya Raha (Library) Participated in "The International Seminar on Applications of Communication and Information Technology in Library (SACITiL-2014)" organised by Variable Energy Cyclotron Centre, Department of Atomic Energy, Kolkata during 28-30th January, 2014.

Ms. Sumita Dey (Library) (i) participated in "E-Content 2013-Library-Publisher Partnership: Bridging the access gap-integrating Content, Technology and Services" held on 25th October, 2013 at Hotel Park Plaza, Bullygunge in association with Annual Reviews, Maney Publishing, Royal Society Publishing and SPIE Digital Library, J-Gate; (ii) participated in "The International Seminar on Applications of Communication and Information Technology in Library (SACITiL-2014)" organised by Variable Energy Cyclotron Centre, Department of Atomic Energy, Kolkata during 28-30th January, 2014.



A seminar on Ethics and Values of Librarianship to celebrate Librarian's Day Programme on the Birth Anniversary of Late Prof. S. R. Ranganathan, National Professor of Library and Information Science on 11th August, 2013 was organized by Bose Institute Library in collaboration with BLA, IASLIC, and WBPLeA at Main Campus, Bose Institute.

Honour Received

Dr. P. Chakrabarti (Biochemistry) (i) Elected the President, Asian Crystallographic Association (2013-16); (ii) Member, Advisory Committee, NIPER-Kolkata (2013-2016); (iii) Member of the Faculty, NIBMG Fellow and YBA Selection Committee of National Institute of Biomedical Genomics (2013-2016).

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

Dr. T. C. Ghosh (Bioinformatics) Member of Editorial board: (i) **BMC Genomics (From 2010 -)** (ii) **Evolutionary Bioinformatics (From 2013-)**; (iii) Elected as a Fellow of West Bengal Academy of Science and Technology in 2013.

Dr. Joyoti Basu (Chemistry) (i) Associate Editor for The Journal of Immunology (July, 2010 to June, 2014); (ii) Member, Editorial Board, PLoS One; (iii) Member of the Scientific Advisory Committee of the Centre for DNA Fingerprinting and Diagnostics, Hyderabad; (iv) Member of the DBT Expert Committee on Tuberculosis; (v) Member of the ICMR Expert on Cellular and Molecular Biology.

Dr. Soumen Roy (Chemistry) invited to serve as Editor of the Special Issue "Perspectives in Systems Biology" for the Springer journal Systems and Synthetic Biology which was published in March 2014.

Dr. Tanya Das (Division of Molecular Medicine) received Raj Kristo Dutta Memorial Award of the Indian Science Congress Association, 2014.

Dr. Kuladip Jana (Division of Molecular Medicine) received Young Scientist Travel Award from ACC&D, Portland Oregon, USA to Deliver Invited Lecture in "5th International Symposium on Non-Surgical Contraceptive methods of Pet Population control" in Portland, Oregon, USA on Jun 20-22, 2013, received Young Scientist Award (\$6200), 2014 from Parsemus Foundation, Berkley, California, U.S.A. for the development of contraceptive drug for male animals and selected as an Expert Consultant of CPCSEA, Ministry of Environment & Forests, Govt. of India and also serving as a Member of the Editorial Board in: Translational Medicine, International Journal of Plant Physiology & Biochemistry, Journal of Diabetes & Endocrinology, International Journal of Clinical Therapeutics and Diagnosis (IJCTD), American Journal of Medical & Biological Research (AJMBR), Journal of Cell and Molecular Biology Research (JCMBR), Signpost Open Access Journal Of Animal Reproduction Studies, Journal of

Translational Medicine and Epidemiology, Journal of Preventive Medicine, Reproductive Biology Insights, Journal of Preventive Medicine, Journal of Cancer Research and Molecular Medicine, Peak Journal of Medicine and Medical Sciences and Peak Journal of Biotechnology etc.

Dr. Subrata Majumdar (Division of Molecular Medicine) Fellow of National Academy of Science (Allahabad) (FNASc) Nov., 2013.

Dr. Gaurisankar Sa (Division of Molecular Medicine) (i) received P.B. Sen Memorial Oration Award from Indian Physiological Society in 2014; (ii) acting as a Task Force Member in Cancer Biology by DBT, Govt. of India.

Dr. P. C. Sen (Division of Molecular Medicine) Nominated Editorial Board member in "American Journal of Experimental Biology" and "International Journal of Biochemistry & Biotechnology Research (IJBBR)"

Dr G. Gangopadhyay (Division of Plant Biology) oral presentation delivered in the 3rd IPPN (International Plant Phenotyping Network) on 19.02.2014 has been selected for publication in the website of IPPN in audio-video mode.

Dr A.N.Lahiri Majumder (Division of Plant Biology) elected a Fellow of the National Academy of Agricultural Sciences (FNAAS).

Dr Sonali Sengupta (Division of Plant Biology) (i) **INSA Young Scientist award, 2013**, Indian National Science Academy, Delhi, India; (ii) **ASPB Travel grant award, 2013**, American Society of Plant Biology, USA.

Dr. Arun Kumar Chakraborty (Librarian) (i) Editorial Board member of IASLIC Bulletin for the year 2014-2016; (ii) One of the editors of 52nd IASLIC seminar volume 2013, seminar held at Pondicherry University during 26th -29th December, 2013.

Patent

Dr. Subhrangsu Chatterjee (PI, Biophysics), Dr. Anirban Bhunia (Co-PI, Biophysics), Dr. Debaprasad Mondal (Co-PI, WBSU), Dr. Shamee Bhattachaya (Co-PI, WBSU) filed two patents (i) Indian and (ii) International PCT on "A cancer Chemotherapeutic agent /Formulation, Manufacture and Use thereof" (Indian Full filing: **1120/KOL/2012** and PCT claim: **PCT/IN2013/000593**).

PCT publication Number: **WO2014049619 A1**

WIPO: <http://patentscope.wipo.int/search/en/WO2014049619>

European Patent Office:

<http://worldwide.espacenet.com/publicationDetails/biblio?CC=WO&NR=2014049619A1&KC=A1&FT=D>



1927 : J.C.Bose, Patrick Geddes, Abala Bose, P.C.Mahalanobis

Symposia and Seminar Organized

Dr. Shubhra Ghosh Dastidar (Bioinformatics) organized "HIGH PERFORMANCE COMPUTING, Accelerating science with Tesla GPU", at Bose Institute, July 26, 2013.

Dr. Shubhra Ghosh Dastidar (Bioinformatics) and **Dr. Pinakpani Chakrabarti** (Biochemistry) organized one day workshop on "Protein dynamics simulation data analysis with R" on Dec 16, 2013. The speakers were Dr. Arumay Pal (A*STAR, Singapore) and Dr. Sucharita Dey (NUS, Singapore) who also conducted hands-on training.

Dr. Subrata Majumdar (Division of Molecular Medicine) Organised Molecular Immunology Forum 2014 Meeting at Bose Institute during 9-11 Jan, 2014

Dr. Swati Sen-Mandi organized a Workshop and Hands-on-Training from 18th February to 4th March, 2014 for young researchers of India under the Bose Institute programme on DNA



Fingerprinting and Diagnostics of Medicinal Potential in Plants. Twenty eight participants consisting of Research Scholars, Assistant Professors, Associate Professors from Universities and Institutes of almost all states of India viz. Jammu and Kashmir, Tripura, Meghalaya, Arunachal Pradesh, Maharashtra, Tamil Nadu, Wild Life Institute, Dehradun etc as well as from corporate sectors viz. Himalaya Drugs, Bangalore attended Technical lectures by subject experts and Hands-on-Training in the laboratory at Main campus of this Institute.

Dr. Supriya Das (Physics) Organised (i) Member, Local Organizing committee for International conference on "Matter at Extreme Conditions: Now & Then", January 15-17, 2014, Bose Institute, Kolkata; (ii) Member, Organizing committee for Workshop on FAIR Physics : Compressed Baryonic Matter at FAIR, January 20-24, 2014 held at Bose Institute, Darjeeling.

Dr. Sanjay Kr. Ghosh (Physics) (i) Coordinator of NESST-BASE 2013, a summer training programme for North-East students in basic sciences held at Bose Institute, Darjeeling; (ii) Chairman, Organizing committee for International conference on "Matter at Extreme Conditions: Now & Then", January 15-17, 2014, Bose Institute, Kolkata; (iii) Coordinator, Workshop on FAIR Physics : Compressed Baryonic Matter at FAIR, January 20-24, 2014 held at Bose Institute, Darjeeling;

Academic Programmes Organised by Bose Institute Library :

1. Bose Institute Library visited by students and faculty of Department of Library and Information Science, North Eastern Hill University, Shilong, Meghalaya the on 27th February, 2014
2. Bose Institute Library organised training programme / awareness programme on 11th February, 2014 on "Endnote-Managing Research Pathways-Searching to Discovery" intended for faculty and scholars of the Institute.
3. Organised seminar on "Ethics and Values of Librarianship" to celebrate "Librarian's Day Programme" on Birth Anniversary of Late Prof. S. R. Ranganathan, National Professor of Library and Information Science on 11th August, 2013 organized by Bose Institute Library in collaboration with BLA, IASLIC, and WBPlea at Main Campus, Bose Institute. More than 650 library / information professionals (faculty/scholars/ students/ librarian and library professionals) from all over West Bengal participated in the programme.

4. Organised a 3-Day workshop on "Content Management using Joomla" during September 23-24, 2013 by Bose Institute Library in collaboration with IASLIC at Centenary Campus, Library.
5. Bose Institute library hosted Internship Programme of "MLIS-5 year Integrated Course" of Department of Library and Information Science, University of Calcutta for two weeks under guidance of Dr. Arun Kumar Chkraborty.
6. Workshop and Hands on Training Programme on IEEE Xplore Digital Library: User Awareness session organized at Bose Institute Library, Centenary Campus on 23rd April, 2013 for faculty scholars and students of Bose Institute.



An IFCC Workshop on "FAIR Computing: Accelerated Computing via GPU" was organized jointly by Bose Institute and Variable Energy Cyclotron (VECC) at Bose Institute, Salt Lake Campus (CAPSS), from 11th to 15th November, 2013. The Workshop was conducted by Prof. Sanjay K. Ghosh of Bose Institute and Mr. Vikas Singhal of VECC.

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.

<i>Name of the Scientists</i>	<i>Name of the crops grown / facility availed by the Scientist</i>
1. Prof. P. K. Saha	Sesame and Morinda
2. Prof. Sampa Das	Mustard, Rice, Pigeon pea, Garlic, Colocassia,
3. Prof. Amita Pal	Vigna mungo,
4. Prof. D. N. Sengupta	Rice
5. Prof. S. R. Sikder	Mustard, Sesame
6. Prof. Debabrata Basu	Mustard, Tomato,
7. Prof. A. N. Lahiri Majumder	Rice
8. Prof. T. K. Ghose	Rice
9. Dr. Pallob Kundu	Tomato

The following scientists utilized the facilities of the Transgenic Green Houses for growing their crops.

<i>Name of the Scientists</i>	<i>Name of the crops grown by the Scientist</i>
1. Prof. A. N. Lahiri Majumder	Rice,
2. Prof. Sampa Das	Mustard, Tobacco, Cotton, Rice, Pigeon pea
3. Prof. Debabrata Basu	Mustard
4. Dr. Pallob Kundu	Tomato
5. Dr. S. R. Sikdar	Porteresia coarctata

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 instrument but also advise research students about how to use them effectively. The most frequently used equipment is the DNA sequencer which handles on an average 8000 samples every year. The MALDI-TOF/TOF spectrophotometer is used extensively for proteomic research. Last year nearly 700 samples were analyzed in this equipment. The Fluorescence assisted Cell Sorter (FACS) which was initially used by specialists in the field of immunology is now being used extensively to investigate the cell biology of eukaryotic as well prokaryotic cells by other groups as well. As a result, the usage of this equipment has increased several fold. In recent times the protein purification systems in the CIF has been revamped. Two HPLCs and an FPLC have been upgraded to meet the demands. Apart from in-house users, a large number of researchers from other Institutes use these systems. The outside users mainly use the HPLC system for separating natural products. As a result of this high demand, the working hours for the HPLCs has increased from about 100 in 2012 to as much as 800 in 2013. The products separated by HPLC are then analyzed by GC-MS. The GC-MS is now fully functional and its demand is also increasing steadily, as more and more researchers are getting engaged in the disciplines of chemical genomics and metagenomics. The increase in users from other Institutes is encouraging, as it shows that the CIF staff has been running the facility efficiently and extending their cooperation to all users, irrespective of the institute or organization to which they belong. Considering that the mandate of the Central Facility is to provide service in a meaningful manner to a broad spectrum of scientists working in diverse fields, the upward trend in external users is highly encouraging.

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.

International Conference on “Matter at Extreme Conditions: Then & Now” held at Bose Institute Kolkata during January 15-17, 2014.

The conference was organized with the aims to discuss the evolution of our understanding of matter at extreme conditions, present status and future directions envisaged. The conference



consisted of invited plenary talks, oral presentation by young researchers and poster presentation. Around 150 scientists and students participated in the conference along with ten invited speakers from abroad.

Matter at Extreme Conditions: FEST-Colloquium:

On January 15, 2014 at 3 PM, a Fest Colloquium was organized in the auditorium of main campus of Bose Institute to felicitate Prof. Sibaji Raha on the occasion of his 60th birthday. Scientists associated with Prof. Sibaji Raha at different periods presented their collaborative works in this occasion.

Workshop on FAIR Physics : Compressed Baryonic Matter at FAIR:

A workshop was organized at Bose Institute, Darjeeling during January 20-24, 2014 to discuss the different theoretical and experimental aspects of forthcoming compressed baryonic matter (CBM) experiment at the Facility for Antiproton – Ion Research (FAIR) at GSI, Germany. The main aim of this workshop was to train the young research scholars on the various aspects of CBM physics. Around 30 research scholars and 20 faculties from all over India participated in this workshop.

Atmospheric Science – Changing airspace environment in eastern Himalayas

- A study on atmospheric fine (less than $2.0\ \mu\text{m}$) particulate matter was performed for the first time over the eastern Himalayas in India in order to investigate the formation and sources in two different seasons, pre-monsoon (Mar–May) and winter (Dec–Feb), for



three consecutive years, 2008, 2009 and 2010. Fine mode aerosols were further segregated into three modes: ultrafine (less than $0.32\ \mu\text{m}$), superfine ($0.32\text{--}1.0\ \mu\text{m}$) and fine ($1.0\text{--}2.0\ \mu\text{m}$). The study was carried out at a high altitude hill station Darjeeling (2200 m asl) in the eastern Himalayas, India, using an aerosol spectrometer (GRIMM) to measure aerosol number concentrations. It was found that the ultrafine and superfine aerosol (less than $1.0\ \mu\text{m}$) concentrations were higher in the pre-monsoon period compared to winter, whereas the concentrations of fine mode aerosols were comparable during these two seasons. Meteorological conditions like sunny/non-cloudy days with higher radiative fluxes and lower humidity favored the formation of ultrafine aerosols from their precursor gases, and the initiation of this formation were observed during 0900–1000 hours LT. Superfine aerosols were mainly found to be aerosols transported from long distances during the pre-monsoon period, and showed peak levels during late morning till late afternoon. In contrast, higher concentrations were seen at night in winter. The fine mode aerosols were mainly locally generated anthropogenic aerosols, mostly emitted from vehicular sources during the pre-monsoon period, and from biomass burning during winter, with sharp diurnal peaks during morning and evening. The long-term study on size segregated aerosol concentrations carried out in this work is of considerable importance, and can be helpful for the validation of several regional and global aerosol models, and for other climate related studies that focus on the Himalayan region.

- The effect of firework activities on air quality was assessed from the ambient concentrations of PM10, water soluble ionic species, metals and SO₂ over Kolkata metropolis, India during Diwali festival in November 2010. PM10 concentrations on Diwali night were found to be ~ 5 times higher than the normal day night-time average concentration. The increase in night-time concentrations of the metals on Diwali spanned over a wide range (Al, Zn, Pb and Cd showed 5–12 times, Cu, Fe and Mn showed 25–40 times and Co and V showed 70–80 times increase in concentrations) compared to night-time concentrations on normal day. The water soluble ionic species showed 1.5–6 times higher concentrations on Diwali night than normal day. The remarkable increases were found for K⁺, Ca²⁺, Mg²⁺ and SO₄²⁻. The diurnal variation of PM10 and SO₂ was also studied in one of the sites which showed their maximum concentrations on Diwali night during 8 P.M.–3 A.M. indicating maximum firework activities during this period. PM10 and SO₂ concentrations increased by ~ 5 times than normal day during this period at this site. The extensive use of firecrackers during Diwali festival was found to have significant effect on the high increase of these air pollutants which could be associated with the serious health impacts and thus use of firecrackers in this kind of festival in a highly populated metro-city like Kolkata, India needs to be controlled where air pollution is an acute problem through-out the year.

Cosmic Ray studies at high altitude

- We have done a detailed study, using accelerator data, to determine the accuracy with which particles can be identified and their energies determined with a commercially available polymer (PET) used as a Nuclear Track Detector (NTD). The achieved charge resolution was ± 1 . The initial energy of stopping particle in PET was determined with an accuracy of 10% for ion energies above the Bragg peak. Our work shows that PET can be effectively used as a charged particle detector with good charge and energy resolution for incident ion energies above the Bragg peak and in the energy regime where the rate of energy loss (dE/dx) falls in the linear portion of the calibration curve, i.e. in $20 < dE/dx < 80 \text{ MeV/mg/cm}^2$ interval.
- We are developing an Air Shower array using active detectors to study the energy spectrum and components of primary cosmic rays. The component(s) of the detectors have been procured. Infra structural facilities like detector tanks and metal frames have been designed and fabricated in-house at the Bose Institute workshop.

Outreach Programme

NESST-BASE 2013: April 29 - May 11, 2013

The North-East Students' Summer Training programme on Basic SciEnces (NESST-BASE) which has now become an annual event of the Institute, was held at Darjeeling during April 29 – May 11, 2013. 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 was also a session with the aim to introduce the students with the fun of mathematics. One day popular lecture was arranged on 2nd May 2013. The school children from Darjeeling were also invited on this occasion. The lectures were delivered by Prof. A. Jayaraman, Director, National Atmospheric Research laboratory, Gadanki, Tirupati on "Our Earth's Atmosphere and Climate Change" and Prof. S. K. Joshi, Honorary Distinguished Scientist, National Physical Laboratory, New Delhi (ex-Director General Council of Scientific and Industrial Research, Govt. of India) on "Satyendra Nath Bose, Albert Einstein and a Dramatic State of Matter".

Manpower development

As a part of our commitment to develop trained manpower, we organize each year, alternatively at Ooty and Darjeeling, a winter workshop followed by a Winter school on AstroParticle Physics (WAPP) during December 17 – 28, 2013. This year school was held at Bose Institute Darjeeling. 24 students (mainly pursuing their masters) from all over India participated in this school. The main objective of this school was to give hands-on training to these students on state-of-art instrumentation used in the present day Astroparticle Physics research and to make them aware of the research challenges in this area. Several eminent physicists from USA as well as Europe participated in this programme as resource persons.

Environmental Sciences Section

Studies on the determination of the purity of Black Carbon particles using optical properties over Eastern Himalaya, India

A two-year long study on the optical properties associated to black carbon (BC) aerosols at eastern part of Himalaya in India has been done in order to investigate the potential sources of BC. The measurement was carried out over a high altitude hill station Darjeeling (27° 01'N,

Outreach Programme

NESST-BASE 2013: April 29 - May 11, 2013

The North-East Students' Summer Training programme on BASic SciEnces (NESST-BASE) which has now become an annual event of the Institute, was held at Darjeeling during April 29 – May 11, 2013. 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 was also a session with the aim to introduce the students with the fun of mathematics. One day popular lecture was arranged on 2nd May 2013. The school children from Darjeeling were also invited on this occasion. The lectures were delivered by Prof. A. Jayaraman, Director, National Atmospheric Research laboratory, Gadanki, Tirupati on "Our Earth's Atmosphere and Climate Change" and Prof. S. K. Joshi, Honorary Distinguished Scientist, National Physical Laboratory, New Delhi (ex-Director General Council of Scientific and Industrial Research, Govt. of India) on "Satyendra Nath Bose, Albert Einstein and a Dramatic State of Matter".

Manpower development

As a part of our commitment to develop trained manpower, we organize each year, alternatively at Ooty and Darjeeling, a winter workshop followed by a Winter school on AstroParticle Physics (WAPP) during December 17 – 28, 2013. This year school was held at Bose Institute Darjeeling. 24 students (mainly pursuing their masters) from all over India participated in this school. The main objective of this school was to give hands-on training to these students on state-of-art instrumentation used in the present day Astroparticle Physics research and to make them aware of the research challenges in this area. Several eminent physicists from USA as well as Europe participated in this programme as resource persons.

Environmental Sciences Section

Studies on the determination of the purity of Black Carbon particles using optical properties over Eastern Himalaya, India

A two-year long study on the optical properties associated to black carbon (BC) aerosols at eastern part of Himalaya in India has been done in order to investigate the potential sources of BC. The measurement was carried out over a high altitude hill station Darjeeling (27° 01'N,

88°15'E; 2200 m asl) using a seven wavelength-based optical instrument called Aethalometer. The absorption coefficient due to BC was determined for different seasons. As the absorption coefficient strongly depends on the wavelength of radiation absorbed by BC, we determined wavelength exponent from the slope of the linear relationship between wavelength and absorption coefficient. Wavelength exponent is the indicator of the nature of Black Carbon particles as emitted from different sources. We observed sharp variabilities in wavelength exponent from season to season. It was found to be high during premonsoon showing impure nature of BC and low during winter showing much purer BC. During premonsoon, BC particles are mostly of transported and thus gets coated with other particles like dust along their pathways from origin. Thus premonsoon BC losses purity during their transport before reaching Darjeeling whereas BC particles during winter retains its purity as BC during winter mainly generates from biomass burning which produces freshly emitted BC particles in to the atmosphere.

Effect of Mountain wind, Local and Long-range transport on Aerosol Loading over Eastern Himalaya, India

A study has been made on the estimation of the contribution of local sources, mountain wind transport and long range transport on the total aerosol loading over eastern Himalayan highaltitude station, Darjeeling. The diurnal variabilities of ultrafine aerosols and its components on normal days were compared with that on several strike days. Normal days were described as the days when all sorts of transport were present but the local sources were almost zero for strike days. During normal days, we observed the effect of mountain wind transport which brings aerosols from low land valley regions. This was much more prominent during strike days where no effect was observed due to local activities as it was zero during strike days. It was observed that aerosols over eastern Himalaya was contributed by around 50 % from local sources, 25-30 % from each of mountain wind and long range transport.

Studies on Volatile Organic Compounds (VOCs) over eastern Himalaya, India

The study on the characterization, temporal variation and source identification of VOCs has been made over a high altitude (2200 m asl) hill station, Darjeeling (27.010N, 88.150E) at eastern Himalaya and the first ever study conducted over Indian Himalaya. The study showed high VOC loading during postmonsoon followed by monsoon, winter and premonsoon. From the point of view of emissions, the VOC loading was very high both in postmonsoon and premonsoon. Both are tourist seasons with high vehicular activities. But the solar radiation during premonsoon was very high which enhanced the production of OH radicals which degraded VOCs. But during postmonsoon VOCs generated do not get degraded due to lower

radiative flux. The present study is thus mainly focused on 1) the identification of the major factors governing seasonal and diurnal (day vs night) variation of VOCs, 2) contribution of long distant source regions in addition to the local sources, 3) source identifications of VOCs using Positive Matrix Factorization (PMF) and 4) comparison of VOCs over Darjeeling with other studies. The PMF results showed that major contributing source of VOCs are gasoline and diesel emissions followed by solvent evaporation.

Acid rain over Eastern Himalaya: chemical characterization of rain

Rain water samples were collected during monsoon 2013 and chemically analyzed for its several ionic components over Darjeeling. Simultaneous studies have been made over Kolkata and Falta near the coast of Bay of Bengal. It was observed that most of the rain events over Darjeeling were acidic whereas that over Kolkata and Falta were alkaline. The dust-rich components were so low in Darjeeling that it could not neutralize the acidity of rains but over Kolkata and Falta, rains were neutralized by alkaline aerosol components. It was found that Calcium and ammonium have the maximum neutralizing potential to neutralize the rain acidity. The most interesting fact is that the local dust particles which are alkaline in nature could not neutralize acidic rains over Darjeeling but when dust particles are transported from western India could neutralize acid rains.

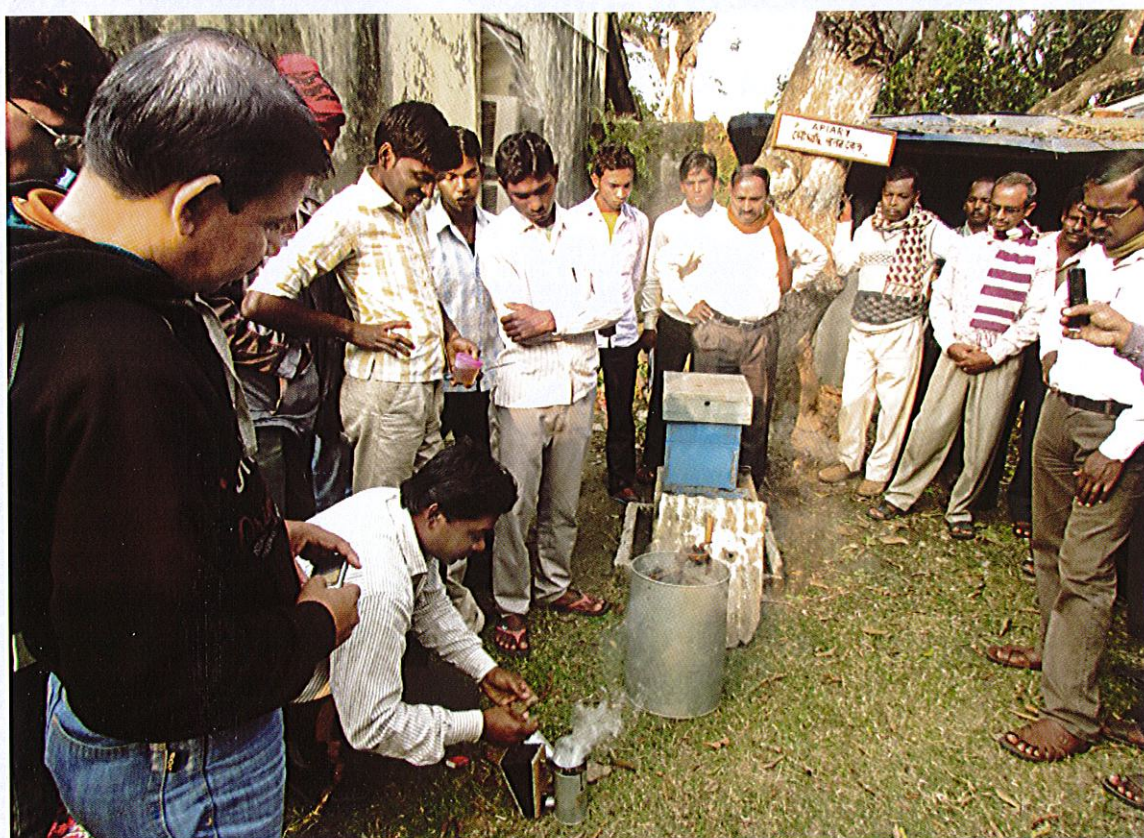
Optical and Physical Properties of Aerosols from Himalaya to Bay of Bengal: A Campaign study during winter, 2014

Ground and satellite based observations of aerosol properties were made in a campaign during December 2013 to February 2014 over Sundarban, Kolkata, Siliguri and Darjeeling. It was observed that aerosol loading gradually decreased from north (Himalaya) to South (BoB) because of continental outflow of anthropogenic aerosols from Indo-Gangetic Plain to BoB. The transport of Black carbon aerosols were found to be very high over Sundarban which is due to its transport from mainland regions. The major source of anthropogenic aerosols over Sundarban was transported in nature whereas the source of anthropogenic aerosols over Darjeeling was biomass burning.

Falta Experimental Farm

Department of Science & Technology, Government of India has entrusted Bose Institute to initiate a "Scheduled Tribe-Specific Rural Biotechnology Programme" for five years. In order to set up guidelines to work under the programme for relevant technological advancement and economic upliftment of the Schedule Tribes community a brain storming meeting was

organized at Bose Institute on 19th November, 2013. Forty-two participants from different NGOs and Academic Institutions attended the meeting. As a part of the programme several visits were done in different tribal villages of West Bengal and finally five areas were selected to initiate the activity. The areas were Chhachanpur Village in Bankura District, Bhutadih village of Purulia District, Amlasole and adjoining five villages of Pashchim Medinipur District, Satyadaspur village of G-Plot, Pathar Pratima Block, Sunderban, South 24-Parganas District and several tribal villages adjoining to Santiniketan, Bolepur, Birbhum District. Initial training was given to 34 selected people, mostly from tribal community from some of the above mentioned areas during 19-25 February, 2014 at Falta Experimental Farm, the Centre for Rural Biotechnology Programme of Bose Institute. These people will serve as the onsite trainer for implementation of the programme.



One of our Master Trainers demonstrating handling of bee box to the trainees during the training programme on "Scheduled Tribe-Specific Rural Biotechnology Programme" held during 19-25 February, 2014.



Trainees were collecting earthworms under the guidance of Mr. L.C. Porel, resource person for vermicompost programme during the training programme on "Scheduled Tribe-Specific Rural Biotechnology Programme" held during 19-25 February, 2014.



One trainee was injecting hormone to a fish, a part of the fish breeding programme under the guidance of Dr. A.K. Datta, resource person for fishery programme during the training programme on "Scheduled Tribe-Specific Rural Biotechnology Programme" held during 19-25 February, 2014.



Initial meeting held in December 2013 with the people of the tribal (Sabar) community at Satyadaspur village, G-Plot, Pathar Pratima Block, Sunderban, District: South 24-Parganas to appraise them about the "Scheduled Tribe-Specific Rural Biotechnology Programme".



Prof. D.K. Chakraborty, resource person for the mushroom programme was distributing certificate to Mr. Santimay Murmu, the trainee from Chhachanpur village, Bankura District during the training programme on "Scheduled Tribe-Specific Rural Biotechnology Programme" held during 19-25 February, 2014. The other members on the dais were Prof. S.R. Sikdar, Coordinator Rural Biotechnology Programme, Bose Institute and Dr. K.C. Mandal, resource person for Sericulture programme.

J C Bose Centre (*Publication and Museum*)

J C Bose Centre comprising the Museum and the Publication unit. From the very beginning of the establishment of the Museum, people take a lot of interest to visit it. The museum has been visited by many renowned scientist and also social dignitaries. Beside that it has also been visited by school children from many famous schools, Institutions of India and also from abroad. The main object of this museum to project in every walks of the society for highlighting about the invaluable works of Sir J C Bose and people can easily understood how the scientific works of Sir J C Bose give a useful effect to the society. Further development of our museum, the progressive work is going on with the help of many scientist and renowned members of the society.

Since its inception in 1980 the Publication Section has been doing all sorts of publication, i.e. Annual Report (both English & Hindi Versions); BI News; Memorial Lecture, Director's folders; Posters and leaflets of different Symposia, Seminars and Training Programmes and works of Sir J.C. Bose. The following publications are now available for sale : J. C. Bose and Microwaves – A collection : Rs.200.00; Science and Society – Reflections : Rs.1050.00; J.C. Bose A Scientist and A dreamer – Vol. 1 : Rs.1250.00; Vol. II : Rs.1250.00; Vol. III : Rs.600.00; Vol. IV : 1500.00 ; Vol. V : Rs.550.00; Patrabali (Bengali) Rs.150.00; Acharya Jagadis Chandra Bose (Bengali) Rs.12.00; Abyakta (Bengali book written by Sir J.C. Bose) Rs.50.00; Acharya Jagadis Chandra Bose (Bengali Combined) Rs.325.00; 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.

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 Jagadish Chandra Bose and a wing at the 'Centenary Building' was opened in 1983. In the year 2007 a small library was set-up in the Salt Lake Campus of the Institute. Library provides latest information to the BI faculty, researchers, staff members and students of Integrated M.Sc.-Ph.D. programme on Life Sciences and Physical Sciences. Library extends its physical Library facilities as well as online resources access to other Institutions /Universities /R&D 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.

Bose Institute Library Activities:

Collection Development:

Collection	Total as on 31 March 2014
Books	14287
Theses	512
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 of Bose Institute Library

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)
- (2) Public Library of Science (PLOS).

D. New Addition(s) in 2013-2014:

During the year 2013-2014 Library subscribed new Database(s) such as:

- a) 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).
- b) Book(s) added in 2013-2014 : 260 nos.
- c) Thesis added : 16 nos.
- d) Bound Volumes of Journal added : 194 nos.

E. New journals available :

Journal Title	Journal Title
Acta Tropica	Infectious Disorders - Drug Targets(Online Only) (ISSN: 1871-5265)
Biochemical Pharmacology	International Journal of Andrology
Biology Reproduction	International Journal of Parasitology
Biomarkers in Medicine	Journal of biomedical nanotechnology
Blood	Journal of Infectious Diseases
Clinical Infectious Diseases	Journal of nanoscience and nanotechnology
Clinical Lipidology	Journal of Organic Chemistry
Diabetes Management	Journal of Theoretical Biology
Down to Earth Magazine	Molecular Cellular Endocrinology
Endocrinology	Molecular Plant
Epigenomics	Nanomedicine
Evolutionary Bioinformatics	Nanoscale
Experimental Parasitology	Organic and Biomolecular Chemistry
Fertility and Sterility	OUP Life Science Collection (47 Journals)
Free Radical Biology & Medicine	Parasitology International
Future Medicinal Chemistry	Personalized Medicine
Future Microbiology	Reproductive Toxicology
Future Virology	RNA Biology
Helicobacter	Science Signaling
Heterocycles (OL)	The Journal of Parasitology
Human Reproduction	The Lancet
Indian Journal of Theoretical Physics Print only (ISSN:0019-5693)	

F. 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

G. e-Books added from 2013-2014 :**E-Books**

Oxford Scholarship Online Physics Titles

- OSO Con Framework Quantum Field
- OSO Conductor Insulator Phase Transitions
- OSO Luminescence Spectroscopy Of Semiconductors
- OSO Many-Body Physics With Ultracold Gases
- OSO Nicolas-Louis De La Chapelle Astronomical Geology
- OSO Niels Bohr & The Quantum Atom
- OSO Non-Equilibrium Thermodynamics & Statistical Mechanics
- OSO Quantum Theory Small To Large Scales
- OSO Stellar Magnetism 2e
- OSO Story Of Semiconductors

H. 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.

I. 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	162
Bound Volume Journal Issued	253
Loose Journal Issued	109
No. of Readers	4129
Internet Accessed (in hours)	9403
Scans	92504
Photocopies	290607
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.

Workshop

The Workshop of Bose Institute has been functioning independently as fully fledged Section, catering the various job requirements of different departments as well as different campuses of Bose Institute. The Workshop of Bose Institute consists of following units for maintenance, repair and fabrication of different equipments.

Units	Requisition	Job executed	Continuing job
Electrical	943(M.C. & C.B.)	100%	Nil
Mechanical	65	100%	Nil
Carpentry	55	100%	Nil

Apart from the above, the electrical unit of workshop has operated the Audiovisual & Public address systems throughout the year for 141 nos. of different types of seminar & lectures held at both campuses.

The Mechanical Section has fabricated various types of Volumetric spore trap, Burkard Volumetric machine Key of Anderson sampler, Display stands, DNA gel apparatus comb, dice of thermal evaporator, rain water collector, pipette stand etc. Various projects have been endured such as design and fabrication of air sampler for Visva Bharati, Two stage air sampler for Rabindra Bharati University and Air Petri sampler for Tripura University.

Electrical renovation work and new power line arrangements have been carried out in various campuses of Institute viz., Main Campus, Falta Experimental Farm, Shyamnagar Experimental Farm etc. 1 no. 30 KVA new DG set been installed and commissioned at Shyamnagar

Experimental Farm with 1no. 5 KVA UPS and 1no. 10 KVA UPS. Installation and commissioning of 5 KVA UPS has been done at Falta Experimental Farm for enhancement of existing power required for new Animal House at Madhyamgram experimental farm. One no. 3panel HTVCB including the old HTVCB for existing 315 KVA transformer with 300 m HT cable laying has been commissioned there and due to that several lakhs of rupees of the Institute have been saved.

The transport system of the Institute including the allotment of Institute vehicles and their maintenance and processing of bills related to transportation are also under the direct supervision of Workshop.

The Carpentry unit is a very essential unit of Institute. This unit, having one carpenter and one helper has completed various types of wooden jobs during the period ,such as Laboratory working table of different sizes, sophisticated furniture repairing and photo binding of Dr. D.M.Bose house etc. Wooden partition work of new lab of Chemistry and Physics dept., packing arrangement of Cosmic Ray Detector machine boxes and rain guard of Darjeeling campus, locking arrangement of door, door closures fitting and other repairing works of furniture of various laboratories etc as and when required.

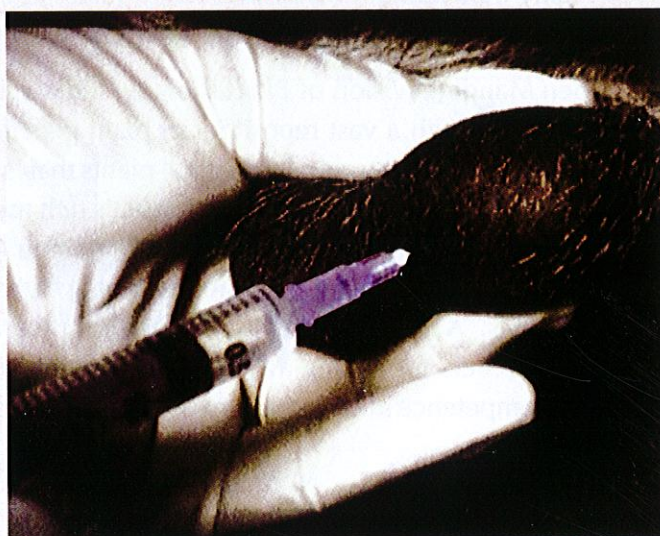
The Store unit purchased building, electric and carpentry materials against departmental requisitions and issued various materials which are recorded in MS excel sheet system and also processed the requisite bills of all purchased items as well as AMC bills etc pertaining to Workshop.

Socially Relevant

Dr. Kuladip Jana (Division of Molecular Medicine) Chemisterisol, Non-surgical Contraceptive of Male: Clinical Evaluation and its Mechanism of Action.

Sterilization has long been recognized as the most effective means of controlling pet populations. However, with the enormous number of owned and un-owned dogs and cats in India, the sterilization programs currently available are not enough. Mostly the population control for male dogs and cats have been accomplished through surgical sterilization, i.e. orchidectomy. However, it carries the risks that inherent in any surgical procedures. Furthermore, many people are unwilling to subject their pets to what they perceive to be a painful and invasive procedure. In addition, when considering dog/cat populations where permanent sterilization is desired, surgical methods can be expensive to be performed on a large scale. Presently a viable alternative to surgical sterilization is being intensively investigated. Although, a variety of compounds have been tested, some of which were either safe but not effective or vice versa. Moreover, we have evolved a new sterilizing

preparation where calcium chloride (dehydrate) dissolved in alcohol with lignocaine hydrochloride; local anesthetic, a preservative, and several minor ingredients (Chemisterisol),



to sterilize dogs and cats. Now we have already been established that Chemisterisol is the potential drug for androgenesis-eliminating nonsurgical contraception of male dogs/cats in addition to its proven efficacy in cats and ther domestic mammals.

Dr. Nripendranath Mandal (Division of Molecular Medicine) The two major thematic fields of research in Dr. N. Mandal's laboratory, viz., **Marine** and **Medical Biotechnology** has played a major role to address the basic socio-economic problems in the field of disease management in shrimp as well as human systems.

For the first time, various DNA markers have been developed to identify disease resistant population of shrimp, *Penaeus monodon* that will help to solve the disease related problem in shrimp aquaculture industry. So, this technology will be beneficial to the socio-economic aspect by revival from this devastating problem.

From the prevention point of view, early prediction of Coronary Heart Disease (CHD) in the field of **Medical Biotechnology** will be very important to control the disease. Research outcome from this arena will be useful to develop biometric chip for screening the risk of CHD among Asian Indians that will be beneficial to the society.

Again from therapeutic standpoint, screening of copious Indian medicinal plants in another **medical biotechnology** research program has revealed that most of them are potential sources of natural antioxidants and orally administrable iron chelators. Moreover, illustration of specificity between the malignant and normal cells; and selective killing of the former not only by the crude extracts of plants, but also isolated pure compounds of *Spondias pinnata* have been highly motivating. In short, research outcome in this field will provide the impetus to search for better, safer and cost effective natural antioxidants; and in course an anticancer drug.

Dr. S. Sen Mandi (Division of Plant Biology) India's rich heritage in knowledge of medicinal plant use along with a vast repository of plant genetic resource positions our country as an important player in the trade of medicinal plants that is expected to reach US\$ 5 Trillion by the year 2050. Authentic documentation of India's rich medicinal Plant Genetic Resource and for developing national competence in the programme initiated by Swati Sen Mandi conducts state of art Research in plant genomes involving Biotechnology, Biochemistry, Statistics and Bioinformatics. Additional activity under this programme involves Hands-on-Training to young researchers for raising awareness for preventing loss of biodiversity and developing technical competence in this area of national importance.

List of Personnel

Administration

Dr. Sibaji Raha,	<i>Sr. Professor & Director</i>
Shri Surajit Panigrahi,	<i>Registrar</i>
Smt. Noreen Bhattacharjee,	<i>Deputy Registrar (from 01.10.2013)</i>

Centenary Campus: Parimal Ch. Das (Retd. on 31.1.2014), Tapan Datta, Subir Sen, Ashis Chakraborty, Sougata Banerjee, Umesh (resigned on 20.08.2013), Achintya Mukherjee, Sisir Chakraborty, Bidyut Kr. Mandal, Manick Ch. Das, Nikhilesh Roy Ghatak (transferred to Chemistry Dept. on 08.4.2013), Amit Kr. Ghosh, Baladeb Goswami, Rina Roy, Susanta Kr. Das, Shyamal Kr. Ghosh, Amitabha Bhattacharjee, Elizabeth Pal, Dhrubajyoti Sen, Mantu Bhattacharjee, Vineet Tandon, Nilanjana Bhattacharya, Kamal Singh, Debdas Nandi, Gopa Dasgupta, Supriya Das, Nitin Sharma, Satya Swarup Behera, Ananya Malgope, Rubi Sarkar, Sudam Jana, Bably Marick, Rina Das, Somnath Das, Mahendra Nath Shee, Prodip Kr. Mullick (retired on 30.06.2013), Sanjoy Krishna Chaki, Debasis Kaley, Angshuman Bhowmik, Sanjib Kr. Das, Biplab Malakar, Shaubhik Ghosh, Arpita Bose, Hemanta Kumar Sahoo, Goutam Behera, Animesh Jana, Ratan Saha, Sumanta Ghosh, Satyabrata Chatterjee, Dipak Dutta, Gouranga Paramanik, Chotelal Rangwa, Tapan Kr. Banerjee (Retd. on 28.2.2014), Kisun Turi, Sudhir Turi, Khoirul Basar Malla, Nagnarayan Yadav, Kanai Hazra, Prafulla Bhunya, Kanak Baran Hazra, Duryodhan Nayak, Bablu Mandal, Sukanta Chakraborty, Subrata Banerjee, Ranjit Das, Sarada Devi, Sukumar Mandal, Bulaki Das, Jagabandhu Nayak, Jagannath Das.

Main Campus: Tarun Kumar Maji, 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 (Consultant Scientist & Executive Chairman)

Staff Members: (Lab.): Mr. Asis Kumar Dalal, Mr. Atanu Deb, Dr. Saurav Bhattacharya, Dr. Subhendu Bandyopadhyay, Ms. Debopriya Chattopadhyay, Mr. Bapi Dey;

Staff Members : (Field): Mr. Pulak Kumar Roy, Mr. Raj Kishore Lenka, Mr. Rabin Talukdar, Mr. Laxmi Kanta Pradhan, Sk. Inal Ali, Mr. Bhanu Kisku, Mr. Mahesh Dasgupta, Mr. Subhas Senapati (Joined on 15.03.2013 as a contractual staff).

Biochemistry Department

Faculty : Dr. B. Bhattacharyya (Raja Ramanna Fellow), Dr. Pinakpani Chakrabarti, Sr. Professor, Dr. Rajagopal Chattopadhyaya, Professor, Dr. Ajit Bikram Datta, Assistant Professor and Wellcome Trust-DBT India Alliance Intermediate Fellow, Dr. Pradip Kumar Parrack, Professor, Dr. Anuradha Lohia, Sr. Professor & Chairperson, Dr. Srimonti Sarkar, Associate Professor, Dr. Subrata Sau, Associate Professor, Dr. Pratima Sinha, Sr. Professor (Retd. on 30.11.2012), Dr. Abhrajyoti Ghosh (Ramanujan Fellow).

Students/RA/Project Assistant : Dr. Tanaya Chatterjee, Dr. Snehasish Basu, Shri Soumyananda Chakraborty, Shri Himadri Biswas, Shri Jaspreet Singh Grewal, Shri Sandeepan Sengupta, Shri Amritanshu Chakraborty, Shri Abhishek Sinha, Shri Biswanath Jana, Shri Abinit Saha, Shri Abhishek Mondal, Ms. Aditi Ghosh, Ms. Aritrika Pal, Ms. Gopa Dhar, Ms. Sumana Banerjee (upto 31.10.12), Shri Somnath Datta, Ms. Sayani Sarkar, Shri Aditya Prasad Behera, Shri Sukhendu Mondal, Ms. Prerana Agarwal, Ms. Indrani Kar, Ms. Devlina Chakraborty, Shri Anindya Biswas, Shri Biswanath Jana (upto 28.02.13), Dr. Arumay Pal (upto 30.06.12), Ms. Sayantani Chowdhury (from 01.06.12), Shri Shankari Prasad Datta, Shri Soumitra Polley (from 07.08.12), Ms. Nabanita Saha (from 02.07.12), Ms. Atrayee Ray (from 15.11.12), Ms. Shamila Sarwar (from 02.07.12).

Supporting Staff : Shri Durga Charan Das (Retd. on 30.09.2012), Shri Ashim Kumar Banerjee, Shri Subhash Chakraborty, Shri Asim Kumar Poddar, Ms. Debarati Kanjilal, Md. Asrafali Molla, Shri Basudev Ghorui, Shri Dulal Chandra Mondal, Ms. Ranubala Das, Shri Atanu Pramanik, Shri Tuhin Saha (from 11.01.2013).

Bioinformatics Centre

Faculty: Dr. Pinakpani Chakrabarti, Sr. Professor & Scientist-In-Charge, Dr. Tapash Chandra Ghosh, Professor, Deputy Co-coordinator, DBT, BIC, Dr. Shubhra Ghosh Dastidar, Asstt. Professor, Dr. Zhumur Ghosh, Faculty Fellow, Dr. Sudipto Saha, Scientist.

Students /RA /Project Assistant : Sucharita Dey, (Upto May, 2013), Debarati Mukherjee, Arup Panda, Deeya Saha, Jyotirmoy Das, Kakoli Biswas, Kamalika Sen, Soumita Poddar, Tina Begum, Debarun Acharya, Sandip Chakraborty, Sarmistha Majumdar, Atanu Maity, Prerna Priya, Ranjan Kr. Maji, Arijita Sarkar, Sohini Chakraborty, Jesmita Dhar, Debashree Sarkar, Tonmoy Jana.

Staff Members : Tushar Kanti Bhattacharya, Sujata Roy, Sanjib Gupta, Jibananda Mondal.

Biophysics Department

Faculty : Dr. Gautam Basu, Professor, Dr. Anirban Bhunia, Assistant Professor, Dr. Subhrangsu Chatterjee, Ramanujan Fellow, Dr. Debjani Roy, Assistant Professor, Dr. Manju Roy, CSIR-Emeritus Scientist.

Students/RA/Project Assistant : Dr. Saumya Dasgupta, Dr. Tulika Chakraborty, Dr. Aparajita Pal, Himal Kanti Ganguly, Madhurima Das, Sarbani Chattopadhyay, Nipa Chongdar, Paulami Chatterjee, Anirban Ghosh, Jagannath Jana, Rajib Kumer Kar, Aritreyee Datta, Soma Mondal.

Staff Members : Basudeb Marick, Barun Majumder, Tanmay Debnath, Swapan Joghsharma, Sudhir Turi.

Chemistry Department

Faculty : Dr. Joyoti Basu, Sr. Professor & Chairperson (upto 28.02.14), Dr. Suman Kr. Banik, Asstt. Professor, Dr. K. P. Das, Sr. Professor, Dr. Pradip Das, Professor, Dr. Mmanikuntala Kundu, Sr. Professor & Chairperson (upto 01.03.14), Dr. Jayanta Mukhopadhyay, Asstt. Professor, Dr. Soumen Roy, Asstt. Professor

Students/RA/Project Assistant : Mr. Joyes De, Mrs. Priyanka Halder (upto 04.04.13), Mrs. Shreya Sengupta, Mr. Srijon Kaushik Banerjee, Mr. Saurav Sanyal (upto 18.04.13), Mr. Shamba Gupta, Miss Chandrayee Datta, Mr. Kallol Paul (Transferred to Physics), Mr. Victor Banerjee, Mr. Ranjeet Kr. Prajapati, Mr. Ranjeet Kumar, Mrs. Paulami Rudra, Mr. Arnab Bandopadhyay, Mr. Soumyajyoti Banerjee, Mr. Manish Kumar, Mr. Sanjoy Kr. Sahoo, Mr. Siddhartha Mukherjee (upto November, 2013), Miss Rajdeep Kaur Grewal, Mr. Saptarshi Sinha, Dr. Sangita Majumder (upto 17.06.2013), Dr. Mandavi Kumari (upto July, 2013), Mr. Abhijit Nagar (upto 4.04.2013), Miss Arijita Subuddhi, Mr. Ayan Chatterjee, Mr. Arun Kr. Sharma, Dr. Sujit Roy, Dr. Subhalakshmi Ganguly (upto November, 2013), Mrs. Amrita Mukherjee (upto 22.12.13), Miss Benajir Alam (upto 31.07.2013), Mr. Amit Kr. Rai (upto May, 2013), Mr. U. Bharat Kr. Pattanaik, Mr. Prasun Sarkar, Mr. Amit Kr. Chatterjee (upto 28.02.14), Mr. Arkajyoti Datta, Mr. Biswabir Chatterjee.

Staff Members : Dr. Aniruddha Aich, Nikhilesh Roy Ghatak (joined w.e.f. 08.04.2013), Pranab Kr. Dey, Shyamal Kr. Ghosh (transferred to Accounts Section on 09.04.2014) Tapas Ghosh, Dipak Chandra Konar, Rama Chatterjee, Amarnath Bhatta (Retd. on 30.11.2013), Gaurab Kr. Roy, Mrityunjoy Kundu, Subhas Chandra 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), Dr. Banabihari Giri (Ramanujan Fellow),

Staff Members (Cent. Campus) : Jaganmay Guin (Up to 30-11-2014), Jaideb Chattopadhyay, Ranjan Kumar Dutta, Smriti Ranjan Maji, Mrinal Das, Swaroop Biswas, Sheolee Ghosh Chakraborty, Amarendra Nath Biswas, Pallab Chakraborty, Alpana Bhattacharya.

Staff Members (Main Campus): Arup Kumar Sen, Samir Mukherjee, Prodip Karmakar, Tanima Modak Dhar, Debabrata Polley (Up to 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, Professor, Dr. Subrata Majumdar, Senior Professor, Dr. Anup Kumar Misra, Associate Professor, Dr. Mahadeb Pal, Associate Professor, Dr. Gaurisankar Sa, Senior Professor, Dr. Parimal C. Sen, Senior Professor & Head, Dr. Parames Ch. Sil, Senior Professor.

tudents/RA/Project Assistant : SMs. Swatilekha Ghosh, Argha Manna, Ritajit Sarkar, Abhijit Sarkar, Joydeep Roy, Supriya Chakraborty, Joyita Hazra, Manjuri Kundu, Kirti Kajal, Nikhil Bhaban Ghate, Sankhadeep Pal, Sourav Datta, Bidisha Pal Chowdhury, Saikat Majumdar, Pabitra Bikash Pal, Sayantan Banerjee, Monoranjan Ghosh, Shilpi Saha, Kuntal Halder, Abhijit Sau, Poulami Khan, Shibali Das, Soumyadip Paul, Barun Mahata, Sudip Bhattacharya, Manas Jana, Tamashree Ghosh, Dipankar Chowdhury, Nilanjan Gayan, Debashis Dhara, Pravat Kumar Parida, Asif Ali, Junaid Jibran Jawad, Abir Kumar Panda, Sreeparna Chakraborty, Deblina Guha, Taniya Saha, Sahana Mitra, Amrita Bhattacharjee, Ajoy Mallick, Kahkashan Rashid, Pooja Mukherjee, Usri Chakraborty (upto 16.02.14), Krishnendu Sinha, Bhaswati Banerjee, Shatadal Ghosh, Sukanya Saha, Debabrata Mandal, Sourav Panja, Minakshi Majumdar, Aparajita Ghosh, Nivedita Roy, Pushpak Bhattacharjee, Anamika Bose (upto 07.3.14), Suman Bhandary, Abhishek Das, Satabdi Biswas, Sayantan Bose (from 01.8.13), Shrutarshi Paul (from 01.8.13), Pritam Sadhukhan (from 01.8.13), Baijayanti Ghosh (from 01.8.13), Anshupriya Si (from 30.7.13), Avisek Banerjee, Anupam Adhikari (upto 31.5.13), Bibhabasu Hazra (upto 17.5.13), Devina Mitra (upto 06.5.13), Shilpa Guta (upto 8.7.13), Nivedita Roy (from 01.7.13), Samik Chakraborty (14.8.13) Anirban Roy (upto 21.8.13), Abhishek Santra (upto 06.12.13), Nihar Ranjan Biswal (upto 20.12.13), Shabina Parveen (upto 20.12.13), Malavika Bhattacharya (upto 15.01.14), Abhishek Das (from 01.01.14), Ishani Bhaumik (from 21.02.14), Sharmistha Banerjee (from 06.3.14), Shibjyoti Debnath (from 25.3.14)

Staff Members : Indrajit Ray, Sukumar Maitra (Upto September 2013), Barindra Nath Mandal, Prabal Gupta, Uttam Kumar Ghosh, Arindam Basu, Debasish Majumdar, Shanghamitra Das (Sau), Sourav Samanta, Kalyan Das, Amartya Sen, Ranjit Das, Purnendu Manna, Shankar Prasad Bari, Bijoy Munshi, Kanan Singh, Pradip Kumar Mallick (MOES Project Staff), Satabdi Biswas (DBT Project) (from 16.7.13), Naibedya Dutta (DST Project) (from 15.01.14),

Priyanjana Chaudhuri (DBT Project) (upto 11.02.14), Deepak Bharadwaj PVP (DBT Project) (from 12.3.14).

Division of Plant Biology

Faculty (Cent. Campus) : Dr. Debabrata Basu, Assoc. Professor, Dr. Shubho Chowdhuri, Asstt. Professor, Dr. Sampa Das, Sr. Professor & Head, Dr. Pallob Kundu, Asstt. Professor, Dr. A.N. Lahiri Majumder, Raja Ramanna Fellow, DAE, Dr. Amita Pal, Sr. Professor (CSIR Emiretus), Dr. S.R. Sikdar, Professor, Dr. Anupama Ghosh (Inspire Faculty).

Faculty (Main Campus) : Dr. Gaurab Gangopadhyay, Assoc. Professor, Dr. T.K. Ghose, Assoc. Professor, Dr. P. K. Saha, Consultant Scientist, Dr. D.N. Sengupta, Sr. Professor, Dr. Swati Sen-Mandi, Emeritus Medical Scientist, ICMR, Dr. Swati Gupta-Bhattacharya, Professor

Staff Scientist : Dr. Sonali Sengupta (DBT Project)

Students/RA/Project Assistant (Cent. Campus) : Dr. Sumanti Gupta, Dr. Rajeswari Mukherjee, Dr. Santosh Kumar, Dr. Shubhendu Bandopadhyay, Dr. Sourav Bhattacharya, Dr. Srirupa Das, Dr. Mitali Chatterjee, Dr. Arpita Bala, Dr. Sritama Mukherjee, Dr. Lekha Bandopadhyay, Dr. Rumdeep Kaur Grewal, Dr. Amit Roy, Mr. Anirban Jyoti Debnath, 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. Dipannita Mitra, Ms. Adrita Roy, Ms. Banani Mondal, Ms. Sanghamitra Adak, Mr. Sayantan Ghosh, Ms. Shruti Chattaraj

Students/RA/Project Assistant (Main Campus) : Dr. Himadri Shekhar Chakraborty, Dr. Basabdat Das, Ms. Niti Yashvardini, Shankar Bakshi (Resigned 01-05-2013), Mrs Marufa Sultana, Mr. Bodhisattwa Saha, Mr. Vivek Arora, Ms. Debarati Dey, Mrs Sayantini Sihi, Ms. Sangita Roy (Joined on 11-11-2013), Mr. Debmalaya Dasgupta (Upto 30-09-2013), Dr. Subhabrata Ghosh, Dr. Sangita Dey (Upto 30-04-2013), Ms. Ranjana Prasad, Ms. Nandini Ghosh, Mrs. Kavita Ghosal, Mrs. Bipasha Roy, Mr. Gaurab Sircar, Mr. Tathagata Nath, Mr. Anubhab Laha, Ms. Koyel Sengupta.

Staff Members (Cent. Campus) : Mrs. Puspita Mukherjee, Mr. Subal Basak, Mr. Ashim Kumar Nath, Mr. Binoy Krishna Modak, Mr. Jayasish Ghosh, Mr. Motilal Singh, Mr. Arup Kumar Dey, Mr. Nadiram Kayal, Mr. Birendra Kumar Bari, Mr. Uttam Das, Mr. Swarnava Das, Mr. Surajit Maity, Mr. Sudipta Basu, Mr. Avhishek Mukherjee, Ms. Srabani Sen, Mr. Bapi Dey, Ms. Debopriya Chattopadhyay, Ms. Kakoli Mondal, Mr. Ranajit Ghorui, Mr. Nasiruddin Molla.

Staff members (Main Campus) : Dr. Ramit Poddar (Upto 30-04-2013), Shri Sukumar Majumdar (Upto 30-11-2013) , Shri Chanchal Chakraborty , Shri Jadab Kr. Ghosh , Mrs. Kaberi Ghosh , Dr. Chaitali Roy, Shri Bipul Kumar Nag, Shri Siddhartha Roy , Mrs. Sarama Pradhan , Mrs. Moumita Mondal , Shri Amitava Bhattacharya(since 09-01-2014) , Shri Sanjib Das(since 15-01-2014)

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 (IRHPA), Ms Debolina Seal (IRHPA)

Students/RA/Project Assistant : Mr Chirantan Sarkar (SRF), Mr Arindam Roy (JRF)

Falta Experimental Farm

Faculty : Dr. S.R. Sikdar (Division of Plant Biology) *Sr. Professor & Coordinator Rural Biotechnology Programme.*

Staff Members : Shri Sobhan Roy Choudhury (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 and Shri Sijarul Hoque (all five are Master Trainers in the "Scheduled Tribe-Specific Rural Biotechnology Programme"), Sk. Ansar Ali (Helper-G).

Microbiology Department

Faculty : Dr. Sujoy K. Dasgupta, *Professor*, Dr. Tapan K. Dutta, *Professor*, Dr. Wriddhiman Ghosh, *Associate Professor*, Dr. Sibaji Raha, *Director & Chairman*

Students : Sri Debajyoti Ghosal (terminated on 09/06/13), Sm. Priyanka Bhowmick (terminated on 31/08/13), Pratick Khara (terminated on 24/10/13), Sri Prithwiraj Kirtania (terminated on 31/12/13), Sm. Piyali Pal Chowdhury (terminated on 31/03/14), Sm. Soumita Dutta (terminated on 31/12/13), Masrura Alam , Sm. Shreya Ghosh, Sri Soumik Basu, Sri Arindam Dutta, Sri Prasenjit Pyne, Sri Sourav Samaddar, Sm. Soniya Chatterjee, Dr. Joydeep Chakrabarty (terminated on 15/03/14), Sri Chayan Roy, Sm. Niketa Bhawinghka, Sm. Neha Gupta, Sm. Rimi Roy (from 11/06/13), Shrestha Ghosh (from 01/08/13), Satamita Deb (from 03/01/14), Rameez M.J. (from 18/02/14).

Staff Members : Biswanath De Sarkar (reited on 31/01/14, Provat K. Chattopadhyay, Saifullah Gazi, Debasishs 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 (Retd.), Dr. Dipankar Home, Sr. Professor, Dr. Barun Kumar Chatterjee, Sr. Professor & Chairman, w.e.f. 01.02.2014, Dr. Tripurari Prasad Sinha, Sr. Professor, Dr. Swapan Kumar Saha, Professor, Dr. Sanjay Kumar Ghosh, Professor, Dr. Somshubhro Bandyopadhyay, Associate Professor, Dr. Amitabha Mitra, Associate Professor, Dr. Dhruva Gupta, Associate Professor, Dr. Rajarshi Ray, Associate Professor, Dr. Supriya Das, Asstt. Professor, Dr. Achintya Singha, Asstt. Professor, Dr. Partha Sarathi Joarder, Associate Professor.

Students/RA/Project Assistant : Dr. Alo Dutta, Dr. Sumana Chakraborty, Dr. Anindita Banerjee, Dr. Binita Ghosh, Dr. Sidharth Kumar Prasad, Dr. Atanu Maulik, Mr. Mohammed Younus, Mr. Amit kumar Pal, Ms. Sayantari Ghosh, 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, Ms. Dyutima Das, Mr. Saswata Haldar, Mr. Shib Shankar Singha, 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.

Staff Members : Mr. Sankar Prasad Singha, Mr. Shyamsundar Mallick, Dr. Subhasis Banerjee, Mr. Manas Dutta, 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": Vineet Surana, Ayona Chakraborty, Consultant (Administration): Arun K. Dasgupta, Technical Assistant: Mrs. Sarmistha Saha, Bikram Mahatha.

IRHPA – ASTROPHYSICS : Research Scientist: Dr. Ajay Kumar Singh, Dr. Sandhya Dey (Mandal), Technical Assistant: Mrs. Sumana Singh, Mr. Bhaskar Roy, Mr. Bivek Gurung, Mr. Sabyasachi Majee, Ms. Debolina Seal.

Project Scientists/Technical Assistant : NASI Senior Scientist Fellow: Prof. Partha Sarathy Ghosh, INSA Senior Scientist Fellow: Prof. Probir Roy, Technical Assistant (ALICE Project): Mr. Sanjoy Mukherjee.

J. C. Bose Centre

(Publication and Museum)

Faculty : Dr. Sibaji Raha, Director & Chairman, Dr. K K Mukherjee (Consultant/Advisor)

Staff Members : Tarun Kumar Maji, Ishani Chatterjee, Chandra Kanta Sasmal

Library

Dr. Arun Kumar Chakraborty (**Librarian**)

Staff Members (Main Campus): Dr. (Ms.) Banhisikha Chaudhuri, Mr. Anshuman Bhowmick, Mr. Gautam Mukherjee, Mr. Arun Kr. Nandi, Mr. Dinanath Das.

Staff Members (Centenary Campus): Mr. Pradip Kumar Sarkar, Ms. Ananya Raha, Ms. Sumita Dey, Mr. Sarat Chandra Bhuiyan, Ms. Tanusri Bhattacharya, Mr. Mrityunjay Jogsharma.

Workshop

Mr. Raju Chandra Paul, Electrical Engineer, Workshop Supdt

Main Campus : Sri Ashutosh Sarkar retired on 30/04/2013, Sri Samar Dutta expired on 25/12/2013, Sk.Md. Eha Hossain retired on 31/01/2014, Sri Basanta kr. Shit, Bholanath Saren, Abdul Rahaman Molla, Panchanan Santra, Panchugopal Karak, Sk. Md. Farruck, W.D. Rozario, Rajkumar Das, Pranab Banerjee, Brahmdeo Prasad, Subrata Basak, Sanjoy Santra, Nageswar Das, Fullchand Sardar, Kissan Das, Bidyut Mondal (Transferred to Workshop on 01/01/2014 as per order no. R/4632/13 dt. 30/12/2013), Jyotimoy Sarkar (joined on 01/05/2013 as contractual purely temporary basis)

Centenary Campus : Mr. Ramprasad Ray (Consultant Electrical Engineer), Ashit Banerjee, MurariMohan Shee, Baidya Nath Murmu, Sk. Md. Raffick