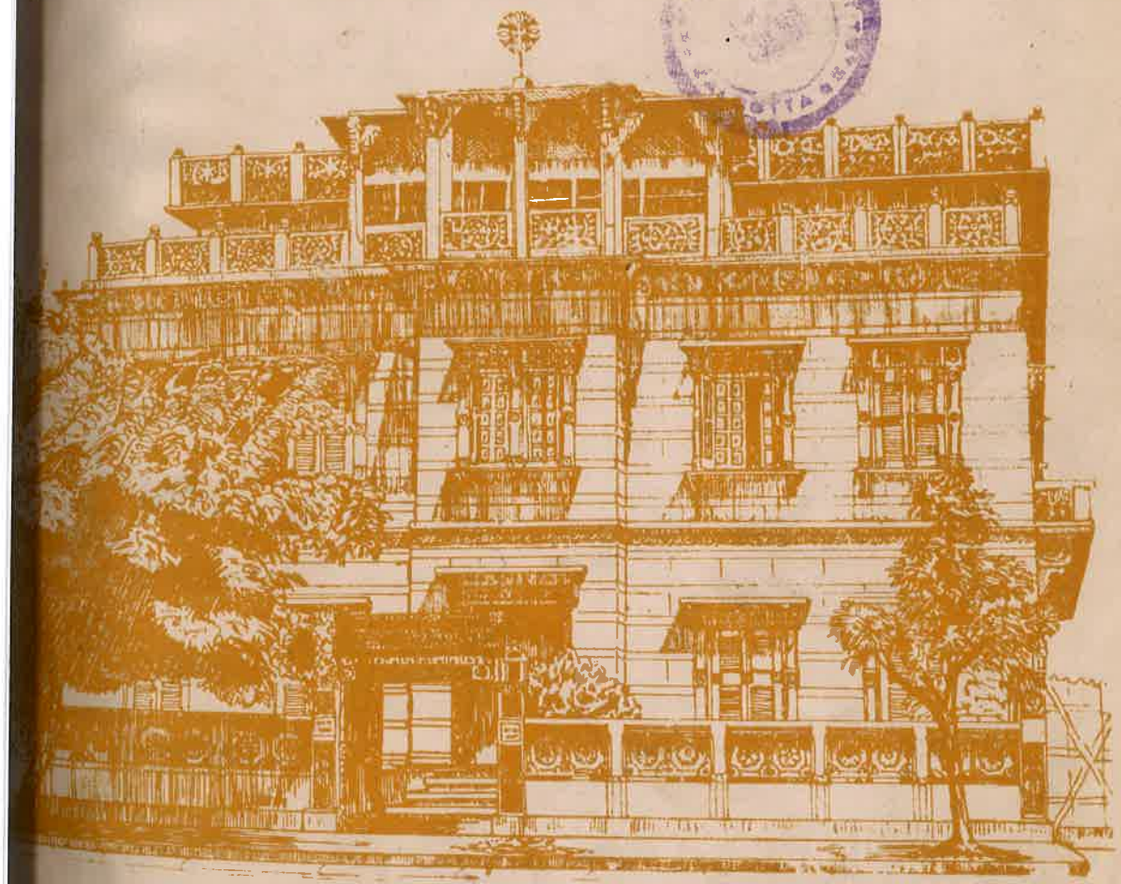
ANNUAL REPORT

OF

THE BOSE INSTITUTE

FOR

1989-90



BOSE INSTITUTE

93/1, ACHARYA PRAFULLA CHANDRA ROAD

CALCUTTA-700 009

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Bose Institute

ANNUAL REPORT

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CONTENTS

DIRECTOR'S REPORT

Dr. Ramachandran, members of the Bose Institute Governing Body and Council, our scientist colleagues, ladies and gentlemen,

Today is the birth anniversary of Acharya Jagadis Chandra Bose, a venerable son of this soil and a doyen of the scientific world. We very sincerely cherish the desire to maintain the heights of academic excellence set by Acharya J. C. Bose and in this pursuit the scientists of this Institute within the span of the last one year have done remarkbly well. Dr. B. Bhattacharyya received the Santi Swarup Bhatnagar Award ; Dr. Joyoti Bose was awarded the INSA Young Scientist Award ; Dr. Dipankar Home has been made a Member of the New York Academy of Sciences.

One hundred and twenty one scientific publications have been made in international and national journals of standing.

Fifty two scientists participated in conferences and scientific meetings both in the country as well as in foreign lands. One International Seminar and four Technical Workshops were conducted by the scientists of this Institute. A brief account of performance in seven identified areas of research activities of the Institute is indicated in the following.

On problems in Condensed Matter, Intermediate Energy Physics and Related Interdisciplinary Areas :

Possibilities of interesting quantum mechanical non-local effects have been explored and experimental refinements are proposed to unambiguously resolve the Einstein-Podolsky-Rosen paradox and to investigate electron interferance effects so as to discriminate between the particle and the ensemble interpretations in quantum mechanics. Experimental results of Einstein's two slit experiment done recently have been analysed to understand the implications of complementary principle in contast to the de Broglie-Bohm casual interpretations of quantum mechanics.

An exact formalism of the two state system has yielded corrections to the adiabatic limit for transition rates and phases. Geometric phases were seen to affect transition rates. Implications of the geometric phase for one dimensional superconductivity and for conduction in polyacetylene were studied.

Rydberg atoms in strong magnetic fields have been studied using singular perturbation theory. The problem has also been studied using action-angle variables when the motion of the guiding centre gets isolated.

The effect of rotational constraint on the critical behaviour of lattice animals, a lattice model of polymers and the percolation model, a model of disordered systems, has been studied. A full analysis of scaling theory in the critical region has been carried out.

Some spin models have been constructed for which the ground and excited states can be written down exactly. Puzzling characteristic of the experimental spectrum on CeAs has been explained using one of the models. The other models are the first examples in the literature for which the resonating-valence-bond states (the starting states for a well known theory of high T_C super conductivity) are the exact ground state. Some exact results have been derived for the dynamics of a single hole in a spin background. This problem is of relevance in the context of charge transport in high T_C superconductors.

Using the Lie analysis technique the dynamical equations involving two phase flow of fluids in a permeable rock has been solved exactly for an infinite set of capillary pressures and relative permeability.

Radiation induced damage in polymeric liquids has been studied by observing the change in viscosity using a differential viscometer developed in the laboratory.

Facilities to build the novel Superheated Drop Neutron Detector has been established for the first time in India.

Instabilities of fluid-fluid interfaces towards the formation of backward propagating soliton like pulses were studied in acoustically pumped systems.

Diffusion in binary systems under different physical conditions has been studied experimentally and irreversible thermo-dynamic principles have been employed to explain the results.

α, xn reactions have been studied using 70 MeV alpha particle obtained from Variable Energy Cyclotron Centre and the experimental results thus obtained were analysed using pre-compound nucleus formalism.

Compton profile of CuO has been studied using 59 keV photons and Fermi momentum of the sample has also been determined. The study of this compound is important in the understanding of high T_C superconductors.

Photon-atom interaction probability has been computed in collaboration with the University of Pittsburgh for neutral atoms and ions for energies near and above K-edges. It has been realized that some structures predicted near threshold are nonphysical in origin and may be due to the limitation of the independent particle approximation.

Anomalous scattering factors for neon atoms and ions have been calculated using a dispersion relation integration method. Such studies indicate a much larger contribution of the bound-bound transitions in ions to the scattering factors and the results were found to agree well with the S-matrix calculation.

Experiments on elastic scattering of photons in a selected region of interest as demanded by theory are in progress.

Irradiation of certain compounds with gamma rays create free radicals which may subsequently react when dissolved in a suitable solvent emitting visible radiation—known as the lyoluminescence. Experimental investigations have been carried out to investigate the spin-lattice interaction of the created radicals.

On Structure, Function and Dynamics of Biomolecules :

Studies on structure and function of the DNA binding protein involved in transcription regulation revealed that a high affinity mutant repressor of bacteriophage lambda has been cloned, and the ha-repressor has been shown to follow first order kinetics in operator binding compared to the second order kinetics by the wild type repressor. By genetic analysis, the high affinity mutation has been shown to be located between the 66th codon and 117th codon of *c*I gene. In order to understand the dynamic nature of the specific operator repressor interaction, a fluorescent probe has been found that binds to the C-terminal part of the lambda repressor, far away from the DNA binding site. With the help of this probe it has been shown that the conformation change of the protein occurs upon its binding to DNA which is then transmitted to the C-terminal part of the repressor. It has also been observed that the hinge region is flexible which make the above transmission possible.

Tubulin substructure and identification of its functional domains indicated the following.

Controlled proteolysis of goat brain tubulin by subtilisin was carried out to investigate regulatory aspect of the binding of colchicine to tubulin. Tubulin S, obtained by the cleavage of the carboxytermini of both the alpha and beta-

subunits of tubulin by subtilisin, exhibited the following differences compared to native tubulin : (a) Reaction with colchicine, which has an optimum *p*H of 6.8 becomes independent of *p*H. (b) The colchicine binding site which is labile at 37°C (tl/2=4—5 h) becomes highly stable (tl/2=12 h). (c) The affinity for colchicine is lowered. (d) This lowering affinity arises from a faster dissociation of the complex. The above characteristics of tubulin S were not shown by a partially digested hybrid in which the C-teminus of the beta-subunit alone was cleaved. The hybrid behaved very much like the undigested native protein. These results strongly suggest that the regulatory switch for colchicine tubulin interaction is located in a small region (about 15 residues) of the C-terminies of the—subunit of tubulin.

Identification of factors needed for initiating DNA replication at yeast replication origins revealed that unlike the prokaryotes, eukaryotic genomes are organised into multiple chromosomes, with each chromosome carrying multiple replication origins. A genetic approach has been taken to study the nature of the initiation complex(es) required to initiate replication at multiple replication origins using the yeast *S. cerevisiae* as a model systems. Minichromosomes were constructed, each of which carried a cloned replication origin, a centromere and a selectable marker for propagation in yeast. Mutants which failed to replicate these minichromosomes were reported earlier. One of these mutants, M46 (mcm2), affected the maintenance of minichromosomes depending upon the replication origin cloned on them. This mutation also caused the loss of some small native chromosomes and also caused hyperrecombinogenenicity in the genome of the mutant strain. It was conjectured that mcm2 might code for a protein involved in the initiation of DNA replication at yeast chromosomal replication origins.

Physical, chemical and structural studies were conducted on Calotropins DI and DII, the two cysteine proteases isolated in homogeneous state from the latex of "Akanda" (*Calotropis gigantea*). They consist of a single polypeptide chain of 210-215 amino acid residues. The partial amino acid sequence of Calotropin DI has been determined. The essentiality of cysteine residue and the involvement of a histidine residue in their catalytic action have been demonstrated. Both Calotropins are two distinct proteins and they are not produced by autodigestion of a single precursor. This has been shown by their autodigestion studies, end group analyses and peptide mapping. They share a high proportion of common regions in their amino acid sequences. Both Calotropins have been crystallized and X-ray crystallographic analysis of Calotropin DI has been conducted.

Structural and conformational studies on nucleosides and β-lactam analogues are in progress.

Attempts to characterise various polymorphic forms (B=Z) and their transition pathway through computer simulated model building approach. The effect of base pairs, sequence and composition have been kept in view.

Structural and conformational features of a typical series of nucleoside and β-lactam analogs have been defined and a correlation is attempted in order to find out the activity and inactivity of these analogs in terms of their conformations.

On Biomembrene the objectives are (1) to gain an understanding of the relationship between the lipid composition and the physical properries of membranes and membrane-associared functions ; and (2) to delineate mechanisms underlying altered membrane structure and functions in pathology. Membrane lipid manipulation was found to effect amino acid transport in several eukaryotic microorganisms. Liposome-trapped nystatin, an antifungal antibiotic was used effectively for growth inhibition of *Aspergillus niger* demonstrating the superior efficacy of liposome technology in fungal diseases.

Defects in membrane cytoskeletal protein organization were identified in chronic myelogenous leukemia and acute lymphoid leukemia in the red blood cells. Defects were also identified in the anchorage of the cytoskeleton to the membrane bilayer through the anion transport protein. Enhanced binding of autologous immunoglobulin G to CML erythrocytes, possibly due to the ienhanced clustering of band 3, may lead to premature or early removal of CML erythrocytes accounting in part, for the anemia associated with chronic myelogenous leukemia. The finding may be useful in the prognosis of the disease.

Plasma membranes of maturning goat caput, corpus and cauda epididymal spermatozoa were isolated and lipids were studied in details. Different classes of lipids were found to change during various stages of development of goat sperms.

Microsome of the goat seminal vesicle was found to contain maximum prostaglandin synthetase activity compared to that of sheep and bull. Ca^{++} has a profound effect on the goat enzyme. Methods are being developed for the large scale production of PGs by immobilizing the goat enzyme on solid matrix.

To amphiphilic drugs chloroquine (anti-malarial) and chloropromazine

(anti-emetic and anti-hypertensive) have been found to inhibit Na^+, K^+-ATPase and Ca^{+2}-ATPase in different organs of rat both *in vivo* and *in vitro*. A Ca^{+2}-ATPase which does not require mg^{+2} for its activation has been identified characterized in the reproductive organ of the male rat.

The cytochrome P450 family of enzymes are involved in the detoxification reactions in all living systems. These are ubiquitous in nature and this ubiquity is paralled by their avidity for organic substrates ranging from simple aliphatic hydrocarbon to macrocyclic molecules. With a view to understand the structure function of this protein in fungi a strain of *Aspergillus ochraceus* TS has been developed in the laboratory. This has got dual capacity to metabolize endogenous (steroids) and xenobiotic '[benzo (a) pyrene] both under *in vivo* and *in vitro* conditions. The structure, function and multiplicity of this enzyme vis-a-vis drug and enobiotic metabolism are highlights of future activity.

On Immunological and Genetic Approaches to Human Diseases :

Vibrio cholerae and enteropathogenic *E. coil* strains have been studied to evaluate the role of bacterial "adhesin" / "hemagglutinin'' in the intestinal colonisation process. Antibodies to several cell surface proteins of *V. cholerae* 01 and non-01 strains are shown to induce passive protection against vibrio challenge, presumably through anti-adhering mechanisms. In certain strains of enteropathogenic *E. coil*, plasmid-mediated cell surface proteins of 18 and 14 KD sizes have been identified and shown to be responsible for their cellular adherence properties.

Molecular biologic studies carried out with *Entamoeba histolytica*, the the causative agent of amoebiasis in human, have revealed the existence of several repetitive DNA families in the organism. One of these showed the presence of multiple copies of autonomously replicating sequence (ARS) core consensus sequences of yeast (*Saccharomyces cerevisiae*). The *E. histolytica* ARS consensus sequences have allowed a eyeast integrating plasmid to replicate autonomously in *S. cereviseae*. A "bent DNA" fragment has been located in one member of these repetitive DNA family.

Immunobiologic studies on *Leishmania donovani*, the causative agent of visceral leishmaniasis or Kala-azar, are aimed at identification and characterisation of leishmanial antigens. The promastigote form of the parasite has been found to release "excretory-secretory" antigens in liquid cultures which should be of considerable importance in the immunodiagnosis of the disease.

A study has been undertaken to determine the molecular basis of certain biochemical properties of *Mycobacterium smegmatis* with a view to extend the information to other pathogenic mycobacteria that cause human diseases. A "lectin-like" protein, showing binding specificities towards arabinogalactan and yeast mannan, has been purified from *M. Smegmatis* and its partial amino acid sequence determined. The role of this bacterial lectin in mycobacterial growth and host-pathogen interaction is being evaluated. A penicillin sensitive, mycolic acid deficient mutant of *M. smegmatis* has been isolated and is being utilized in the studies on the biosynthesis of mycolic acid and its role in bacterial physiology and transport.

Studies on allergens derived from various locally isolated pollen grains and fungal spores have been carried out to evaluate their role in respiratory allergy and related disorders. A skin test survey has shown the involvement of pollen allergens of various types in the induction of allergic responses in the local population. Attempts have been made to correlate some of these results with total as well as allergen specific serum IgE levels in atopic individuals. Biochemical composition of different types of pollen grains has been determined. The prevalence and seasonal periodicity of fungal aeroallergens have also been studied.

On microbial technology for bioleaching and production of microbial metabolites and enzymes of commercial importances :

Bioleaching is the science of metal extraction or removol of impurities from metal through the action of microbes. Benification of magnesite ore by removing silica microbiolagically is being done. A strain of *Bacillus licheniformis* has been isolated which removes silica from magnesite ores. Using a stainless steel laboratory fermentor, 80% of the silica was removed from Salem magnesite ores. With the financial assistance from DBT and Burn Standard Co., a five metric ton pilot plant has been set up at Salem, Tamil Nadu, which is being standardised for commercial exploitation.

Cellulase complex of a new thermophilic fungal strain of *Myceliophthora thermophila* D14 (now deposited at ATCC as No. 48104) isolated in this laboratory has been characterized and employed for saccharification of different easily available cellulosic wastes like straw, waste paper, rice husk, leafy and vegetable wastes, sugarcane bagasse, etc. About 40 to 60% saccharification was achieved depending on the substrates. The liberated sugars are fermended with yeast. Large scale production of ethanol and immobilization of yeast for repeated use are now being investigated.

Proteolytic soil Streptomycetes capable of degrading waste leather into soluble nitrogenous compounds which chould be used for agricultural purposes have been isolated. Some Streptomycetes strains produced collagenase and keratinase. Collagenases are clinically useful and keratinases are used as depilatory agents and for unhairing of skins and hides in leather industry. Applications of these enzymes in leather wastes and hide powder are now being investigated.

A high yielding glucoamylase producing mutant strain or *Aspergillus terreus* NA170 was isolated through mutation and optimum enzyme production standardized. It has a promising prospect for commercial use in strarch indutries. Also, a strong xylanase producing mutant strain of *Aspergillus ochraceus* was isolated and characterized for optimum enzyme production for commercial exploitation using agricultural residues like wheat bran which seems to be the most suitable substrate.

A "Lichen" strain capable of growth in culture medum and having the capability of producing litmus dye was isolated. The isolated strain can possibly be exploited commercially for litmus production was well as a food and beverage colouring agent.

A strain of *Aspergillus ochraceus* TS has been developed for 11-oxygenation of steroid. Purification of steroid transformiog enzymes and studies on their biochemical properties, immobilization of spores and development of a practical method for continuous production of 11-oxygenated and 17-keto steroid have been successfully carried out. It can transforom progesterone exclusively to its 11-hydroxy derivative both under *in vivo* and *in vitro* conditions.

A new siderophore (Fe^{3+} chelator) named 'Spirilobactin" has been isolated from *Asospirillum brasilense* and its structure determined. Its potential as a plant growth enhancing substance due to its antimicrobial activity is now being investigated.

On improvement of crop productivity using techniques of plant biotechnology :

Application of the full potentiality of new genetics through genetic manipulation of crop plants at the molecular and cellular levels based on r-DNA and plant cell culture techniques has been the hallmark of this programme. Following is a brief account of our present status of the progress that has been achieved.

Organisation of the nuclear genome in mustard, jute and mungbean have been studied. Repetitive DNA has been cloned, sequenced and organisation studied or compared with several other related speciees. Genomic library of large fragment DNA of mustard generated.

Storage seed proteins of mungbean and mustard ; endotoxin protein from *Bacillus thuringiensis* ; and a serine protease inhibitor from cowpea have been isolated, antibody raised. Genes for these proteins have been cloned and mapped.

Two molecular constructs for seed specific expression of any gene as well as a vector for transfer of foreign gene to Mungbean have been completed.

A well conserved repetitive DNA sequence of 177 bp has been identified in the nuclear genome of *B. campestris* which seems to have homology in the other members of *Brassica* complex. Organisation of a few seed storage protein genes are being studied with a view to identify the seed specific promoters in *B. campestris*.

Amplification of the genomic library of nuclear DNA of *Brassica campestris* has been carried out.

Several *Agrobacterium* plasmid based vectors have been constructed. Interaction between T-DNA border sequences and *vir* function contained in the helper plasmid that influence T strand production and plant transformation has been monitored.

Several plant development genes (*rol* A, *rol* B and *rol* C) have isolated, cloned, promoters identified.

Considering *Arabidopsis thaliano* as the model system for seed oil improvement programme in mustard, a systematic survey of ten different ecotypes of *Arabidopsis* analysed. The oil content varied from 22-38% of the seed.

Wide cross hybridisation in rice, mustard, jute and sugarbeat yielded interesting results. In case of mustard and jute protoplast fusion techniques were adopted to achieve our goals. Somatic hybrids and cybrids have been produced and they are in the advanced field trials.

Analysis of mitochondrial DNA for cytoplasmic male sterility (cms) in rice and mustard is being pursued. RFLP studies are in progress in case of mungbean to locate the genes conferring resistance to yellow mosaic virus.

Suitable plant cell culture techniques have beed developed in order to induce somatic embryogenesis in jute, chickpea, tea. Thus the plant cell culture techniques have been found to be suitable for adoption for gene transfer techniques.

Genetic transformation has been achieved in rice and mustard with *Bt* endotoxin gene. Development of elite cultivars of Jute and chickpea with *Bt* gene are in active state of fulfilment. Plant transformants with *rol* genes have also been raised in case of mustard.

Mechanism of salt tolerance in rice and mungbean is being studied. High levels of polyamines or polyamine systhesis have been implicated in the salt tolerance.

Micropropagation technique for elite genotypes of Teak, papaya and Costos has been evolved.

The capacity of influencing chloroplast protein synthesis by spermine, a polyamine, in pea leaf was monitored. The results indicated that senescence may be mediated by polyamines in plant system. Such a role seems to influence the biology of nitrogen fixation in the domain of nodules formed after Rhizobium infection.

The loss of viability and vigour of seeds (wheat) during storage can be salvaged partly through cultural treatments. Preliminary results indicate that this could possibly be achieved by cultural treatment before sowing. Induction of artificial aeging in order to mimic the natural process is being pursued. In case of success this should possibly form a model system for future experimentation.

Loss of germinating ability of seeds of Sal, an important forestry crop, appears to be associated with endogenous level of IAA, Research works to sustain the capacity of germination for a longer period of time by Sal seeds is under progress.

A systematic collection of gene pool from wild and distantly related source in case of genus, *Trichosanthes* sp and *Bassella* sp, vegetable crops, have generated interesting observations.

The leaf hairs on the under-surface of tea leaf is considered very likely the seat of flavour generating chemical compounds. Richness of tea variety is dependent upon the nature of pubescence and the presence of such hairs in the processed tea. This is an important information for the tea technologists.

Acrylamide used in the industry is a synthetic product. For the first time, rich source of natural acryamide has been found from plants of the family Convolvulaceae. This seems to be the first record of natural occurance of acrylamide and the same may be looked upon for commercial utilisation.

Significant progress has been made in developing micropropagation techniques for Teak trees as well as Papaya, a horticultural crop. The technique developed has been made available to the Forest Department and the Horticulture Department of the local Government.

Protoplast derived plant production in indica rice has been achieved. Following uptake of plasmid DNA by the protoplasts, genetic transformation could also be effected.

On Chemical and Biological Studies on Marine Organisms :

Search for useful compounds from marine source generated interesting results. A soft coral turned out to be a rich source for marine sterols and terpenoids ; a sea worm and a sea animon have been found to have spectacular hipotensive activity ; a marine squid turned out to be a rich source for prostaglandin and useful eichosanoids ; gastropod mollusc, *D. telescopium* contains lipids of pharmacological significance.

Having recounted the long list of achievements, in the same breath it should be mentioned that we can cope up with still more challenges in the arena of our research activities. We welcome any interaction from private as well as public institutions to tackle their research challenges which fall within our competency. The competency of Bose Institute has hardly been explored to its fullest. I strongly feel that the management of research institutes of the stature of Bose Institute, merits a closer looking at.

I have great pleasure in informing you that a large number of bright and competent academic members have joined the Faculty in recent times. Some more are expected to join in the near future.

The services and facilities rendered by my colleagues from the Library, Workshop, Regional Sophisticated Instrumentation Centre, Distributive Information Centre and the Experimental Farm have been of high standard considering the limitations in which they all work. The day-to-day administrative machinery that has sustained the academic activities through out the year deserves my special thanks. A large number of my colleagues in various capacities who, with smiling faces, are helping the scientists carry out their responsibilities has always been the hall mark of the Bose Institute culture and that's a lifetime's experience. Those who miss this must be missing a golden experience in their life.

During the year some of our senior scientist colleagues retired and we offer our sincere gratitude to them for helping this Institute grow. Others who retired from the Bose Institute service earlier also deserve our thanks. To our ex-colleagues, who expired during the year, we pray that their souls may rest in peace.

Prof. S. K. Sen

Acharya Jagadis Chandra Bose Memorial Lecture

The 51st Acharya Jagadis Chandra Bose Memorial Lecture was delivered by Prof. O. Siddiqi, F. R. S., of Tata Institute of Fundamental Research, Bombay on "Neural Darwinism—The selectionist theories of the formation of the nerve connections".

Lectures

1. Dr. F. Scoot McDermott of Saha Institute of Nuclear Physics, Calcutta, gave a talk on "Tokamak as a total in Plasma Physics".
2. Dr. Ravi V. Gomatam, Bombay, delivered a lecture on "Chance, Causality and Consciousness in Modern Science".
3. Dr. Kamales Kar, Saha Institute of Nuclear Physics, Calcutta, delivered a lecture on "Neutrinos and Super novaexplosions".
4. Dr. Pratip Mukhopadhyay, Indian Institute of Science, Bangalore gave a talk on "Dynamic Elastic property of Spin Glass and Reentrant Spin Glass System across their transition region".
5. Dr. Satyajit Saha, USA gave a talk on "Parity Non-conservation in heavy nuclei".
6. Dr. Arghya Taraphder, Indian Institute of Science, Bangalore, delivered a lecture on "Superconductivity in Ba-Bi Systam."
7. Prof. J. M. Ghuysen delivered a lecture on "Bacterial DD-peptidases and beta-lactamases : mechanism, structure and evolution."

Obituary

The Bose Institute was deeply grieved at the passing away of the following members of the Bose Institute. Condolence resolntion, duly adopted in the general meeting of the staff, were sent to members of the bereaved families :

1. Sri Chandra Nath Ganguli—Ex. Office Asst., 11.4.89
2. Sri S. K. Gupta—Council Member, 22.6.89
3. Sri Ananda Gopal Mukherjee—Council Member, 19.8.89
4. Sri Rambahadur Chowlagay—Ex. Watchman, March, 1990.

Acknowledgement

The Council takes the opportunity to express its grateful thanks to the Government of India in the Department of Science and Technology for generous funds in the form of Grants-in-aid, and in the support of research projects, and for construction of buildings and also to other external agencies such as the Government of West Bengal, Department of Atomic Energy, Council of Scientific and Industrial Research, Indian Council of Agricultural Research, Indian council of Medical Research, etc. The Council also records its thanks to the British Council, Federal Republic of Germany, PL-480 Authorities and others for their support in several forms, such as gift of equipments, books, travel grants, collaborative project, etc. The Council further records its thanks to the Governing Body, Bose Institute, and to the members of the various Selection Committees.

Members of the Council

1. Prof. Sivtosh Mukherjee
2. Dr. K. N. Mitra
3. Prof. B. K. Bachhawat
4. Prof. S. Bose
5. Sri Sanjoy Sen
6. Sri Debabrata Bose

} Nominees of the Governing Body

7. Secretary to the Government of India, Department of Science and Technology or his nominee
8. Director General C. S. I. R. or his nominee
9. Joint Secretary and Financial Adviser, Department of Science and Technology or his nominee
10. Representative of the Lok Sabha
11. Principal Accountant General (A & E) West Bengal
12. Dr. A. K. Chatterjee (Nominee of the Govt. of West Bengal)
13. Shri R. K. Prasannan, Representative of the Calcutta Municipal Corporation
14. Director, Bose Institute—ex-officio
15. Deputy Director, Bose Institute
16. Dr. K. K. Sundaran
17. Prof. D. Balasubramanian

} Two Scientists from outside West Bengal

Registrar, Bose Institute—Secretary

Invities :
1. Senior most Professor on rotational basis
2. Representative of Bose Institute Employees Association

Members of the Governing Body

1. Prof. Sivatosh Mukherjee
2. Dr. K. N. Mitra
3. Shri Sanjoy Sen
4. Prof. Sunando Bose
5. Shri Debabrata Bose
6. Prof. B. K. Bachhawat
7. Prof. S. D. Chatterjee
8. Dr. (Mrs) Debi Chakraborty
9. Prof. R. N. Chakraborty
10. Director, Bose Institute—ex-officio — Secretary

Members of the Finance Committee

1. Prof. Sivatosh Mukherjee (Representative of the Council)—Chairman
2. Director, Bose Institute—ex-officio
3. Joint Secretary and Financial Adviser to the Govt. of India, Department of Science and Technology or his nominee
4. Shri Sanjay Sen (Representative of the Governing Body)
5. Principal Accountant General (A & E), West Bengal
   Registrar, Bose Institute—Secretary

Members of the Advisory Committee of the RSIC, Calcutta

1. Director, Bose Institute—Chairman
2. Scientist-in-Charge, RSIC—Member-Secretary
3. Secretary, Govt. of India, Dept. of Science and Technology or his nominee
4. Financial Adviser, Govt. of India, Dept. of Science and Technology or his nominee
5. Dr. A. Ghosh, USIC, Kalyani University, W. B.
6. Prof. U. R. Ghatak, IACS, Calcutta
7. Dr. J. Das, IICB, Calcutta
8. Dr. D. N. Bose, IIT, Kharagpur, W. B.
9. Dr. Amit Chatterjee, Tata Iron & Steel Co. Ltd., Jamshedpur

Members of Research Staff and Scholar

Director : Professor B. B. Biswas, M.Sc., Ph.D., F.N.A. F.A. Sc. (upto 28.2.90.)
Professor S. K. Sen, Ph.D., D.Sc., F.N.A. (Acting from 1.3.90)

Dy. Director : Professor A. K. Mishra, M.Sc., Ph.D, (upto 31.12.89)
Professor S. K. Sen, (from 1.1.90)

Department of Physics

Chairman : Prof. M. H. Engineer, M. Tech., Ph.D.

Professors : Prof. S. C. Roy, M.Sc., Ph.D.

Readers : Dr. A. K. Chatterjee, M.Sc., Ph.D.
Dr. S. N. Changder, M.Sc., Ph.D.
Dr. D. Bhaumik, M.Sc., Ph.D.

Department of Physics (Contd.)

Lecturers : Dr. Indrani Bose, M.Sc., Ph.D.
Dr. Dipankar Home, M.Sc., Ph.D.
Dr. (Mrs.) B. Roy, M.Sc., Ph.D.
Dr. B. K. Chatterjee, M.Sc.

Research Scholars : Smt. Lipika Santra, M.Sc.
Smt. Tuktuk Sur, M.Sc.
Smt. Kumkum Bhattacharya, M.Sc.
Sri Krishnandu Chakrabarty, M.Sc.
Mrs. Aparna Das (Sen) M.Sc.
Smt. Santana Bandopadhyay, M.Sc.
Smt. Samita Seal, M.Sc.
Sri Sitangshu Bikas Santra, M.Sc.

Department of Chemistry

Chairman : Prof. N. K. Sinha, M.Sc., Ph.D.

Professors : Dr. A. K. Barua, M.Sc., Ph.D.
Dr. D. P. Chakraborty, Ph.D., D.Sc.
Mr. J. Dutta, M.Sc.
Dr. P. Chakrabarti, M.Sc., Ph.D.

Readers : Dr. A. Ghosh, M.Sc., Ph.D.
Dr. P. Bhattacharyya, M.Sc., Ph.D.
Dr. Dolly Ghosh, M.Sc., Ph.D.

Lecturers : Dr. P. C. Sen, M.Sc., Ph.D.
Dr. M. Chakrabarty, M.Sc., Ph.D.

Research Scholars (Senior) : Shri Alok K. Hazra
Sm. Eli Mukherjee

Research Scholars (Junior) : Shri Subhansu Roy

Department of Botany

Chairman : Prof. A. K. Roychoudhury, M.Sc, Ph.D. (upto 30.11.89.)
Prof. Sunirmal Chanda, M.Sc, Dr.rer.nat (Gottingen) (from 1.12.89)

Readers : Dr. B. Majumder, M.Sc., Ph.D.
Dr. S. Gupta, M.Sc., Ph.D.
Dr. S. N. Ganguly, Ph.D., D.Sc.
Dr. B. B. Mukherjee, M.Sc., Ph.D.
Dr. (Mrs) B. Ghosh, M.Sc., Ph.D.

Department of Botany (Contd.)

Lecturers : Dr. K. Mukherjee, M.Sc., Ph.D.
Dr. (Mrs.) S. Sen-Mandi, M.Sc., Ph.D. (Cantab).
Dr. P. K. Saha, M.Sc., Ph.D.

Research Scholars : Sm. Amita Bhattacharya, M.Sc. (upto 28.2.90)
Shri Biswajit Bera, M.Sc., (upto January '90)
Smt. Malabika Ray, M.Sc. (upto 16. 10.89)
Smt. Aditi Chattopadhyay, M.Sc
Smt. Swapna Banik, M.Sc. (upto 10.3.90)
Smt. Sikha Manna, M.Sc. (From May '89 to 15.2.90)
Smt. Rina Basu, M.Sc. (From May '89)
Smt. Kajari Lahiri, M.Sc. (From June '89)
Smt. Y. Sunitibala Devi, M.Sc. (From June '89 to 11.1.90)
Smt. Mousumi Das, M.Sc. (From June '89)

Department of Microbiology

Chairman : Prof. S. L. Chakrabarty, M.Sc., Ph.D. (from 1.12.89)

Professors : Dr. A. K. Mishra, M.Sc., Ph.D.
Dr. A. C. Ghose, M.Sc., Ph.D.

Readers : Dr. (Mrs.) A. L. Chandra, M.Sc., Ph.D.
Dr. (Mrs.) A. Das, M.Sc., Ph.D.
Dr. T. B. Samanta, M.Sc., Ph.D.
Dr. (Mrs.) Geeta Nanda, M.Sc., Ph.D.
Dr. (Mrs.) Kalyani Sen, M.Sc., Ph.D.
Dr. Pran K. Chakrabartty, M.Sc., Ph.D.

Lecturers : Dr. (Mrs.) Roma Chakrabarty, M.A., Ph.D.
Dr. Pradosh Roy, M.Sc., Ph.D.

Research Scholars : Sri Subhas Ch. Jana, M.Sc. (upto 30.4.89)
Sm. Anuradha Ghosh, M.Sc. (upto 16.12.89)
Sri Ramprosad Mukherjee, M.Sc. (upto 13.12.89)
Sri Swadesh Ranjan Biswas, M.Sc. (upto 30.4.89)
Sri Bijoy Kumar Mohanty, M.Sc. (upto 20.12.89)
Sri Anup Kumar Halder, M.Sc. (31.1.90)
Sm. Sumuna Das, M.Sc. (upto 30.6.89)
Sm. Jharna Datta, M.Sc.

Department of Microbiology (Contd.)

Sri Aloke Dhar, M.Sc.
Sm. Ruby Dash, M.Sc. (upto 3.4.89)
Sri Ram Krishna Sadhukhan, M.Sc.
Sri Amitabha Chaudhuri, M.Sc. (upto 14.7.89)

Research Scholars : Sri Amaresh Sinha, M.Sc.
Sri Tilak Banerjee, M.Sc. (from 16.6.89 to 30.6.89)
Sm. Mousumi Ghosh, M.Sc. (from 11.12.89)
Sri Pranab Kumar Sadhukhan, M.Sc. (from 11.12.89)
Sri Bijoy Kumar Jaiswal, M.Sc. (from 15.1.90)
Sm. Nupur Roy, M.Sc. (from 1.3.90)

Department of Biochemistry

Chairmen : Prof. R. K. Mandal, M.Sc., Ph.D. (Upto 01.05.1989)
Prof. N. C. Mandal, M.Sc., Ph.D. (From 02.05.1989)

Professors : Prof. S. Ghosh, M.Sc., Ph.D.
Prof. R. K. Mandal, M.Sc., Ph.D.

Readers : Dr. (Mrs.) S. Biswas, M.Sc., Ph.D.
Dr. B. Bhattacharyya, M.Sc., Ph.D.

Lecturers : Dr. (Mrs.) P. Sinha, M.Sc., Ph.D.
Dr. P. Gupta, M.Sc., Ph.D.
Dr. (Mrs.) A. Lohia, M.Sc., Ph.D.

C.S.I.R. Emeritus Scientist : Prof. B. B. Biswas, M.Sc., Ph.D., F.N.A., F.A.Sc. (From 01.03.1990).

Research Scholars : Sri Sibaprasad Bhattacharyya (Upto 16.10.1989)
Sri Niranjan Das
Sm. Rina Saha
Sm. Sarbani Maity
Sri Asish Roychaudhuri
Sri Debaprasad Saha (Upto 28.08.1989)
Md. Golam Farook
Sri Utpal Ghosh
Sri Sudip Chatterjee
Sri Santanu Dasgupta
Md. Nizam Haider
Sm. Karabi Chatterjee (Upto 19.07.1989)

Department of Biochemistry (Contd.)

Sm. Mau Mukhopadhyay (Upto 07.06.1989)
Sm. Ambalika Roy (From 01.01.1990)
Sri Basudev Dalal (From 11.12.1989)

Animal Physiology Section

Reader-in-Charge	:	Dr. A. K. Ray, Sc., Ph.D.
Professor	:	Dr. A. K. Medda, M.Sc., D.Phil, F.N.A.Sc.
Lecturer	:	Dr. Rama Ghosh, M.Sc., Ph.D.
Research Scholars	:	Sm. Srabani De (upto 7.7.89)
		Sm. Debjani Ghosh
		Sri Santanu Das
		Sm. Sudipta Chatterjee (From 18.12.89)

Plant Molecular & Cellular Genetics Section

Professor-in-Charge	:	Dr. S. K. Sen, Ph.D., D.Sc., FNA.
Lecturer	:	Dr. (Miss) A. Pal, Ph.D.
Research Scholars	:	Mrs. A. Mitra (Bhattacharya), M.Sc.
	:	Mrs. A. Roy (Paul), M.Sc.
	:	Mrs. S. Sen Gupta, M.Sc.
	:	Shri T. Johnson, M.Sc.

Regional Sophisticated Instrumentation Centre

Scientist-in-Charge	:	Dr. A. Chatterjee, M.Sc., Ph.D.
Technical Officers	:	Dr. D. K. Mukherjee, M.Sc., Ph.D.
		Dr. S. Chaudhuri, M.Sc., Ph.D.
		Shri A. Biswas, M.Sc.
		Shri T. Datta, B.E. (E & T.C.E.)

Administration

Registrar	:	Shri A. J. Datta, B.Sc., L.L.B.
Dy. Registrar	:	Shri T. K. Ghorui, M.Com., I.C.W.A. (Inter)
Audit & Finance Officer	:	Shri M. L. Datta, B.Com., L.L.B. (upto 31.12.89)
Workshop Superintendent	:	Shri Alok Mukherjee, B.E. (Mech.)
Librarian	:	Mrs Ila Biswas, M.Lib (Sc.)

Department of Biophysics

Reader-in-Charge	:	Dr. Asok Banerjee, M.Sc.,Ph.D.,M.Ny.A.Sc.(USA)
Lecturer	:	Dr. Siddhartha Roy, M.Sc., Ph.D.
Research Scholars	:	Shri Goutam Biswas
	:	Shri Utpal Banik
	:	Ms. Anusree Bhattacharya
	:	Ms. Tista Bhattacharya
	:	Ms. Sumita Bandopadhya
	:	Shri Bankim Das
	:	Ms. Sampa Pain
	:	Ms. Indrani Dey
Pool Officer	:	Dr. Manick Das

Institutional Projects

Institutional Project No. I : "Improvement of plant productivity nitrogen fixation and photosynthesis using modern biotechnology and plant breeding".

A. *Studies with Cruciferae seeds for the improvement of oil quality and quantity* : Manas Pathak and Dolly Ghosh (Supervisor) (A part of UNDP programme on oil seeds improvement).

(a) Lipid composition of *Brassica species* : Among the *Cruciferae* family, the most important cultivated species for oil seed production are *Brassica campestris*, *Brassica juncea* and *Brassica napus*. In our Institute's current oil seed improvement programme, seed lipid analysis of high yielding varieties was necessary. We analysed lipid composition of five *Brassica campestris* var-(Agrani, Sita, B-9, Selec-I and Selec-II), *Brassica juncen*, var (varuna) and *Brassica napus* cultivated in our Madhyamgram field. The seeds contain 30-45% oil of which 90-95% is glyceride, 1.5-4. 5% phospholipids, 10-20 μmoles glycolipid (in respect to glactose) and 60.140 μmoles glueosinolate (in respect to allyl-isothiocyanate). *Ver-Selec*-I (grown and selected in in our field) contains highest percentage of oil. Fatty acid comopsitions : Erucic acid (22 : 1) 45-55% highest in Selec-II and and lowest in Selec-I, eicosaenoic acid (20 : 1) 4-10%, (Agrani), oleic acid 10-61% (var-napus), linoleic acid and linolenic acid average 10% and 15% and saturated fatta acids about 6%. Of these seeds Brassica napus is unique in the sense it contains 61% aleic acid 1·4% erucic acid and 5% eicosaenoic acid and only 61 μmoles of glucosinolate.

(i) *Lipid composition of Arabidopsis thaliana.*

In this oil seed improvement programme, of our Institute it became clear that routine experiments on plant cell transformation and construction of transgenic plants with *Brassica* cultivers would be extremly difficult. However, among the *Cruciferae*, *Arabidopsis thaliana* has been widely recognised as a plant of choice for studies of plant genetic engineering. It was not clear previously whether *Arabidopsis thaliana* like *Brassica* species, produces oil seeds. To settle this issue we investigated 6 varieties of *A thaliana* Var [Co-4], [Be-0], [AG-0], [Bus-0], [Ms-0] and [Kas-1] for the lipid composition. These seeds were found to be rich in oil (21-38%) and could be considered as oil seeds. The oil contains, glyceride 90-95% ; phospholipid, 1.5-4% glycolipid, 20-50 μmoles and glucosinolate 80-400 μmoles.

Var *Kas-1* (grown in Kashmir) contains maximum oil (38%). Fatty acid composition of *A. thaliana* seed oils are quite different than *Brassica species* though both of them belong to *Cruciferae group*, surprisingly unlike *Brassica* spp. Very little or no erucic acid (22 : 1) could be detected in these seeds but contains considerable amount of eicosaenoic acid (20 : 1) 20-28%. [Kas-1] Var contains highest erucic acid 4% and in [Bus-0] and [Co-4] erucic acid could not be detected. Average percent fatty acids, oleic, linoleic and linoleic are 20, 25 and 15 respectively.

B. *Performance of Meghna-1 with respect to photoperiod sensitivity :* A. K. Roy-Choudhury and R. Poddar.

Meghna-1, a selection of *aman* paddy was isolated by Prof. S. Bose, the ex-Chairman of the Department of Botany from a cross between *IR-8* and *Badshabhog*. The selection is claimed to be photoperiod non-sensitive. To testify the claim of photoperiod non-sensitiveness of *Meghna-1* an experiment was conducted last year but the results based on small number plants were not satisfactory.

In the current year, aman time of flowering of *Meghna-1* and two established varieties, *viz. IR-8* and *Rupsail* were studied on four dates of sowing at an interval of 15 days, *i.e.*, May 15, June 1, June 15 July 1, 1989 at Madhyamgram Farm. Mean time of flowering based on 100 plant varies from 91 to 107 days (*i.e.*, August 30 to September 30) in *Meghna-1*, from 94 to 107 days (*i,e.*, August 30 to October 4) in *IR-8* and from 111 to 156 days (*i.e.*, October 18 to October 20) in *Rupsail*. These results indicate that *Meghna-1* like *IR-8* is photoperiod non-sensitive as claimed by Prof. S. Bose. The other variety *Rupsail* is photoperied sensitive ; its mean date of flowering is confined to a range of three days of October irrespective of dates of sowing.

(i) *Performance of grain yield of two selection of paddy :* A. K. Roychoudhury and R. Poddar.

To study the relative performance of grain yields of two selections of paddy, viz., *Maghna-1* and *Meghna-2* and three established varieties, viz., *IR-8*, *Rupsail* and *Mohini*, an experiment was conducted in a RB design with four replications at Madhyamgram Farm. Though mean grain yields per plot for *Meghna-1* (3.0 kg.) and *Meghna-2* (3.2 kg.) are higher than those of *IR-8* (2.6 kg.), *Rupsail* (2.3 kg.) and *Mohini* (2.9 kg.), the differences are not statistically significant.

(ii) *Study on crose-pollination of aman paddy :* A. K. Roychoudhury and R. Poddar.

To study the percentage of cross pollination in *aman* paddy for different spacings, i.e., 9″, 1½′, 3′ and 6′, two varieties viz, *Crossa* with purple stem colour and Meghna with green stem colour were selected. For each spacing three rows of 50 plants each with *Crossa* in the middle and Meghna in both sides were used. All the seeds of each plant in the side rows for each spacing experiment have been collected. These seeds will be sown in the following generation to ascertain the percentage of cross pollination.

C. *Clusiered mutnnts in rice* : B. Majumder.

A number of mutants in the panicle characters of rice have been isolated. Some of them were reported earlier. Here only the clustered Mutants of rice have been mentioned. Clustered mutants are those where grains are closely attached to the panicleas. There are a number of such mutants with the name CRM/1 CRM/2 etc. Most of them were induced by the physical mutagens, like X-rays, β-rays and gamma rays.

(i) *Agronomic behaviour of the clustered mutants* :

Number of (11) such clustered mutants were put in a yield trial along with a standard rice cultivar namely IR-8. They were put in a yield trial with six replications. The grain yield of the mutants indicate that most of them were lower in grain yield than the standard rice variety IR-8. But with one exception viz., CRM/1, which was higher in grain yield than the IR-8 variety.

(ii) *Inheritance of ihe clustered panicle mutant* :

The selection S.417 is a clustered panicle mutant. The spikeletes are attached to the panicle in a clustered form. The number of flowers in a panicle is reduced than the parent Dular variety. This low density grain mutant with clustered nature was crossed with the parent Dular variety with normal panicle. The inheritance studies of the F_1 and F_2 generation indicate that the present form of low density clustering of grain in a panicle was monogenic recessive in nature.

(iii) *Changed Flag leaf character in rice* : B. Majumder.

The hybrid CM5-DF and a mutant S.268, where flag leaf characters were

changed. The mutant S.268, had an extra flag leaf whereas CM-5DF had abnormal mid vein in the flag leaf. These two peculiar plants were sown in the field along with the other morphological mutants to understand the role of changed flag leaf on the quantitative characters of the rice.

The studies on the agronomical characters showed that the hybrid (CM-5DF) and the mutant (S 268) with negative exergence in character of the panicle. But the exergence character of the parent was positive. The yield of grains per plot was better in the hybird and lower in the mutant S 268, when compared to their parents.

(iv) *Induced photosensitive mutants in rice* : B. Majumder.

The mutants S 285 was induced in the rice variety Jhanjee, after the treatment of radioactive phosphorus (p^{32}). This mutant was pure for the character for which it was selected. Later it was grown along with its parent and another mutant S 265A, in a micro plot analysis. This mutant had higher number of florets than the parent Jhanjee, but less than the mutant S 265A. The mutant S 285, had a higher positive exergence value than its parent. The yield of grains per plant was higher than the parent Jhanjee. This mutant S.285 was 25 days late in flowering than the parent Jhanjee. It was both late flowering and photosensitive mutant, whereas the parent was early and photoinsensitive rice variety.

(v) *Systematic mutation in rice* : B. Majumder.

Many macro mutants have been induced in rice with the treatment of different physical mutagens. The mutants are S 221, S 12, S 417 wihch are of significant importance taxonomically. Such transgressive mutants have been induced in few laboratories of the world. On a recent survey of literature on rice and other crop mutants revealed that there are five such reports in rice and barley.

On calculation it was observed that the rate of induction of mutation of multiple carpel character in rice is in the rate of $1x10^{-9}$.

(vi) *Studies on rice hybrids* : B. Majumder.

There are a number of hybrids in the cross between the mutant S.410 and the cultivated rice varieties TN—1 and CB—1. The grains of the mutant S.410 was bigger than the parent Marichbati variety. Therefore, attempt was made to transfer this bigger grain size of the mutant to the cultivated rice varieties. From the above

mentioned crosses, number of hybrids were selected and maintained. After they attain homozygous in the character for which they were selected, attempt was made to put them in a trial to assess their grain yield ability of the hybrids. It was observed that a hybrid between the cross S 410x TN-1 was with better in grain yield than their parents. The difference was significant. Therefore, it seems that induced changed grain character of the mutants can be utilised for better grain yield by transferring its grain character to the cultivated rice variety.

D. *Role of spermine on chloroplastic protein synthesis in pea leaves* : Soumen Chattopadhyay and Bharati Ghosh.

Polyamines (PAs), the universal polycations, are known to prevent the senescence syndrome in developing *Pisum sativum* cv. Early wonder by retarding the senescence induced loss of chlorophyll, protein and hydrolases, especially peptidases and proteases. Simultaneously, these amines inhibit all major components of photosynthesis. Among them, tetra amine, spermine (Spm) is the most effective modulator of senescence in pea. In search of the resultant effect of this polycations on chloroplastic protein during senescence, we therefore, investigated the role of Spm on protein synthesis by isolated chloroplast, using (^{35}S)-methionine during senescence of pea. It appears that Spm at a concentration of 0.5 mM and 0.1mM inhibite the rate of labelled methionine incorporation by 2.8 fold and 2.0 fold respectively. SDS-PAGE and subsequent detection of the (^{35}S)-methionine incorporated polypeptides by fluorography also indicates this inhibitory role of Spm, particularly the synthesis of high molecular weight protein synthesis. The sensitivity of Spm on the capacity of chloroplastic protein synthesis indicates that PAs role on senescence may result from effects on protein synthesis. More detail work is undertaken to elucidate the role of PAs on Rubisco, the most important source of N_2, for sink organ in senescent plant.

(i) *Putrescine translocation in higher plants* : Soumen Chattopadhyay and Bharati Ghosh.

If PAs function as growth regulator, its transport and distribution in plant is essentially important. But very little information is available regarding the uptake and translocation of PAs in higher plants. To enlighten this problem, we performed autoradiographic experiment using (^{14}C)-putrescine (put) in rice and pea. It is evident that put was translocated very effectively (distributed within 3 hrs.) by vascular tissues of stem, petiole, major veins of leaflets (in pea), leaf lamina (in rice) whereas, there

was little transportation to interveinal region of pod wall in pea and glumes in rice. From this autoradiographic study it appears that along with the vascular supply, putrescine accumulated more in the non-vascular region of the source organ than that of the sink one. However, completely defining the mechanism of transport in intact plants needs further studies.

(ii) *Nodule senescence in leguminous plants* : Kajari Lahiri and Bharati Ghosh.

In previous year we have reported that the changes in polyamine titre as well as leghaemoglobin content and nigrogenase activity was related during senescence of nodules and thus to nitrogen fixation. Amongst the aliphatic amines, Spm significantly modulated the major synthetic and degradative enzyme activity of the nodules. Nodule senescence includes general loss in soluble cytosolic proteins especially leghaemoglobin. In the reported year, major emphasis had been given to leghaemoglobin. Partial purification of leghaemoglobin was done according to the conventional method, Non denaturing PAGE showed a single senescence. SDS-PAGE showed the disappearance of major components of leghaemoglobin during the nodule senescence. Treatment with law concentration of Spm increased the level of leghaemoglobin. Further delailed study is going on to ascertain whether polyamine may modulate the quantity and synthesis of leghaemoglobin components.

(iii) *Genotypic variation of nodule senescence in V. mungo* : Kajari Lahiri and Bharati Ghosh.

The biochemical parameters e.g. leghaemoglobin level, polyamine titre and nitrogen fixing activity was measured in the various genotypes of *Vigna mungo*.

It was observed that genotypes having shorter life span (55-70 days) possessed lower level of leghaemoglobine, polyamine and nitrogenase, the reverse was occurred in genotypes having longer life span (90-95 days). However, more detailed experiments are carrying on to eorrelate the yield and the titre of above biochemical parameters in various genotypes in respect to nodule senescence.

(iv) *Effect of putrescine on rice (Oryza sativa) seedling salinity* : Rina Basu and Bharati Ghosh.

Exogenous putrescine protects the membrane permeability of early rice seedling against salt (NaCl) stress. Putrescine at 10^{-4}M promoted rice seed germination and after salt stress putrescine treated seedlings showed lesser leakage of

electrolyes. Putrescine at above concentration could also protect the membrane from leakage and reverse the ionic disbalances by NaCl stress. Using (^{14}C) put, it was observed that putrescine binds strongly to the microsomal membrance of coleoptile and root.

(v) *Effects af NaCl stress on protein synthesis and mRNA levels in rice seedling* : Rina Basu and Bharati Ghosh.

As salinity is an important limitation to crop production in many agricultural areas, investigations on its molecular effect are scant. We first tried to see the salt induced changes in protein synthesis in rice seedlings. Various concentrations of NaCl was applied to 72 hr germinated seedlings for 6 hr and protein pattern of microsomal membranes and cytosolic fractions was analysed by SDS-PAGE electrophoresis. Some new proteins of MW 26 kDa and 32 kDa have been induced during salt stress. Further work is in progress.

(vi) *Thermal regulation of Ribolose-1, 5-biphosphate carboxylase in rice* : Anindita Bose and Bharati Ghosh.

High temperature stress in the natural environment can severely reduce photosynthetic efficiency and thereby limit the yield of crop plants. We are proposed to see whether thermostability of the carboxylating enzymes and/or the synthetic machinery which produces them may be important components of plant resistance to heat stress. The quantitation and activity of RuBpcase protein were measured after various regime of heat stress for different time intervals in excised rice leaves of various ages. The quantity of enzyme was analysed by 6% native PAGE. At 45°C, the quantity of RuBpcase protein increases and maximum amount of fraction-1-protein noticed after 2 hr heat stress, then gradually declined. Stress effect on individual subunit of RuBpcase was measured using 12% SDS-PAGE. On the other hand, RuBpcasc activity was maximum after 1 hr heat stress at 45°C, then gradually become less active. However, more detailed experiments are going on to find out the changes in subunits of RuBpcase in several heat sensitive and resistant cultivars of rice.

(vii) *Thermal regulation of metabolism in cultured rice cells* : Malabika Roy and Bharati Ghosh.

Plant responses to superoptimal temperature include inhibition of photosynthesis, protein synthesis and other metabolic processes. This diversity of responses complicate efforts to study specific mechanism and to identify meaningful

markers of improved heat tolerance. So, we have begun a study of heat hardening and injury in suspension cultureed rice plant cells. The absence of chloroplasts in in culture cells may further facilitate close examination of other metabolic responses. Moreover, information on cultured cells is important because it may be possible to select for heat tolerance *in vitro*. After trials with different media, it was observed that R_2 inorganic salts and B_5 organic ingredients were most suitable for callus initiation in ES_8/N_{22}, heat tolerant cultivars, whereas in IR8, profuse callus initiation was obtained in L.S. medium. After heat stress, suspension cell cultures have been assessed for the validity of viability tests, percent of injury, electrolyte leakage etc.

(viii) *Salinity induces cellular events in Brassica sps.* : Sankar Das and Bharati Ghosh.

The germination percentage and seedling performance of genotypes of *Brassica* sps. was done during salinity stress. It was observed that retardation of seedling growth as well as germination percentage was obtained by 75 mM NaCl ; attempts are going on to characterise the stress proteins. Field experiment are being conducted to grow plants under various saline stress and studies on stress tolerant metabolism are in progress.

E. *Performance of naturally deteriorated embryos on agar supplemented media* : Smritimala Ganguly and Swati Sen-Mandi.

Rejuvenation of naturally deteriorated wheat embryos, in simple media like agar plus sucrose, has an applied importance. While the badly deteriorated embryos have a very low ability to utilize sucrose for rejuvenation, the less deteriorated embryos have an appreciable rejuvenation potentiality. Stand establishment of such seeds/ embryos is now being studied.

(i) *Hot-water-dip treatment and its effect on certain agronomic traits* : Smritimala Ganguly and Swati Sen-Mandi.

Pre-sowing hot-water-dip treatment of wheat seeds has shown to some beneficial effects (earlier report). Attempts are now being made, to study the effect of this (hot-water-dip) treatment of certain agronomic traits of economie importance.

(ii) *Response of scutellar amylase activity to GA in aged wheat seeds* : Gitali Das and Swati Sen-Mandi.

GA induced scutellar α-amylase has been observed both in naturally and artificially deteriorated wheat seeds. However, the ability of β-amylase to respond to GA differ in both these aged stocks. Starch-gel electrophoresis of scutellar amylase enzyme is being studied to understand the isozyme patterns of amylase in differently deteriorated seeds.

(iii) *Establishment of plants from embryos of apprecinbly deteriorated (artificially aged) seeds after transplantation from in vitro laboratory conditlon to the fidld* : Gitali Das and Swati Sen-Mondi.

Non-germinating embryos of appreciably deteriorated seeds can be made to germinate and eatablish in the field provided they are incubated on agar supplemented sucrose medium. Further, seeds raised from such plants are viable and show crop yield in the next generation. Attempts are being made to see whether plants raised from such seeds could show some beneficial economic traits in the field.

(iv) *Study of potentiality of cells in deteriorated embryos* : Gitali Das and Swati Sen-Mandi.

In order to understand whether the cells in deteriorated (naturally and artificially aged) embryos, responding to Triphenyl Tetrazolium Chloride test have similar Chloride test have similar potentiality necessary for initiation of germination, serial sections of embryos are being studied.

(v) *Studies on multiple isozymes of Acid phosphatase in unaged and aged embryos* : Selva Meena Dass and Swati Sen-Mandi.

Isozyme studies of acid phosphatase in unaged (99% V) and aged (artificially 0%V, naturally 0%V) embryos exhibit striking difference in banding patterns. Five distinct isozyme bands were observed in artificially aged embryos while only three diffuse bands were seen in naturally aged embryos. In unaged (99%V) embryos however four isozymes bands were detected. This indicates that the method of ageing, plays a crucial role in determining the pattern of enzymes inactivation/ activation.

(vi) *Invigoration of rice seeds/embryos : Certain biochemical aspects* : Selva Meena Dass and Swati Sen-Mandi.

Aged rice seeds were invigorated by hydration-dehydration pre-treatments. Invigorated embryos exhibited higher acid phosphatase, dehydrogenase and isocitrate

lyase activity, when compared with aged embryos. Invigoration treatment brings about repair of cellular lesions that occour during storage.

(vii) *DNA lesions occur with loss of viability in ageing embryos of rice seeds* : Selva Meena Dass and Swati Sen Mandi.

Artificially aged (0%V) and naturally aged (0%V) embryos exhibit remarkable fragmentation of nuclear DNA. Unaged low vigour (99%V) embryos also exhibit a few DNA nicks whereas unaged high vigour (99%V) embryos do not exhibit any DNA strand breaks.

(viii) *Metabolic mechanisms that occur during the hydration dehyeration treatments* : Selva Meena Dass and Swati Sen Mandi.

Aged low vigour embryos whose DNA exhibits certain amount of fragmentation breaks, show no DNA breaks after invigoration pre-treatment. Hydration-dehydration treatment therefore brings about repair of DNA nicks/breaks. This suggest that metabolic repair mechanisms are activated during hydration which counteract the effects of seed ageing which leads to reduced seed quality.

(ix) *Seed invigoration in rice* : *Its assessment and impact on crop performance* : Selva Meena Dass and Swati Sen Mandi.

Improvement in the rate and uniformity of germination and in storage potential of rice seeds has been achieved by hydration-dehydration pre-treatment. This improvement is due to the fact that the early stages of germination are initiated and the treated seeds are therefore at a more advanced stage of germination. Thus, to realise the full genetic potential of a variety both germination and seeds vigour is maintained high at the time of sowing. Preliminary field studies of invigorated seeds have given interesting results, further studies are underway.

F. *Quantitative estimation of free and bound IAA in different stages of maturation in Shorea robusta seeds* : Amita Bhattacharya, P. K. Saha (Supervisor) and S. N. Ganguly.

In mature germinating seeds both free and bound IAA content were less in comparison to those immature seeds. Free IAA again was absent in non-viable seeds but a minute quantity of bound IAA was still retained. Results of IAA content in the seeds of sal indicated that until a seed was mature the bound IAA content was

higher. Germinating mature seeds showed the rapid depletion of IAA and seeds without free IAA were non-viable.

(i) *Germination studies on seeds of Cassia tora* : Amita Bhattacharya and P. K. Saha (Supervisor).

Studies on water uptake pattern showed that a group of seeds previously identified within a seed lot capable of germination (100%) absorved 137% and 117% at the end of Phase A and Phase B respectively. The other group of seeds of the same lot absorbed 32% of water at the end of imbition stage (Phase A) which increased upto 55% at the end of activation stage (Phase B) but no germination was observed.

(ii) *Chemical treatment to break the dormancy in the seeds of Cassis fistula* : Amita Bhattacharya and P. K. Saha (Supervisor).

Both the hilum and micropyle in the seeds of *C. fistula* are plugged. The storophiole is also plugged. Treatement with concentration sulphuric acid and subsequent germination test showed the water absorption was increased and seeds germinated. This may be due to the disintegration of the seed coat material as well as micropylar plug.

G. *Cytogenetical and chemical inrestigations of naturally occurring diploid and hexaploid Chenopodium album* : B. Bera S. N. Ganguly and K. K. Mukherjee.

In continuation of our chemical investigations on different ploidy levels of naturally occurring *C. album.*, five compounds were isolated from the seed of broad leaf diploid cytotype. On the basis of the physical and chemical evidences the compounds were identified as dimeric tetracesane, tetracos-1-one, Octadec-1-one, pentratriacontane and penta triacontane-1-ene.

(i) *Cytogenetical investigations on Beta spp.* : K. K. Mukherjee.

Hybrids between *Beta palonga* and *B. vulgaris* were advanced from F_2 to F_4 generation. Both mass selection and random bulk selection methods were applied. Evaluation of F_4 data shows that in all populations, excepting in one hybrid line mass selection yielded higher means compared to bulk selection with respect to certain character like leaf area and dry weight.

(ii) *Cytogenetical investigations in Trichosanthes spp.* : A. K. Sardar and K. K. Mukherjee.

Leaf isozyme profile of two monoecious species of *Trichosanthes*, namely, *T. anguina* and *T. cucumerina* and two dioecious species, namely, *T. dioeca* and *T. palmata* revealed that with respect to amylase, catalase, GOT, LAP, peroxidase and phosphatase, the monoecious species are more closely similar to each other compared to the dioecious ones. Within the dioecious species however, the male plants of both *T. dioica* and *T. palmata* showed distinct differences with their respective female plants with respect to most of the isozymes. Morphological characters of the plants were also recorded to study the relationship between isozymic and morphological variations.

(iii) *Investigations on wild gene pool of Quamoclit spp. and Basella spp.*: K. K. Mukherjee.

Two wild plants of the genus Basellaceae and Convolvulaceae have been isolated. Phenotypic and genotypic characterisation of the wild plants are in progress.

(iv) *Investigation on Camellia sineneis*: Malabika Roy, S. N. Ganguly and K. K. Mukherjee.

In an attempt so study the pubescence i.e. hairs on undersurface of tea leaves, which is one of the major selection criteria, cuticular morphology of both plucking and maintenance leaves of both Assam and Darjeeling varieties were studied through both light and SEM. Samples from only two localities have been studied. Further survey is in progress.

(v) *Pollen phenolics in understanding plant affinity*: K. K. Mukherjee and S. Chanda.

Phenolic compounds present in the pollen grains of *Areca caechu*, *Phoenix sylvestris*, *Trema orientalis* and *shorea robusta* showed wide diversity in their chromatograms with respect to both colour and hRf values. This diversity has also been observed in pollen morphology. Potentialities of utilizing pollen phenolies in understanding phylogenetic relationships has been demonstrated.

H. *Studies on in vitro grown culture of Nigella sativa*: Aditi Chatterjee and B. B. Mukherjee.

Some biochemical parameters like total phenolies, total starch and soluble sugars, the enzymes like peroxidase, acid phosphatase, and amylase, and their

isoenzyme patterns were studied in morphogenetically competent tissues at different stages of development of longterm culture. Developmental stages in tissues prior to initiation of shoot buds were also studied histologically. Morphogentic changes were observed in such tissues after 810 days of culture in MS medium with $\frac{1}{2}$ strenth of major and monor salts supplemented with growth regulators ; and this change was initially indicated by the appearance of yellow coloration in otherwise white tissue. Once those tissues became yellow, within 20 days in a culture passage, other changes in histological characters also appeared. It was possible to identify 4 different stages of development, each with different biochemical parameters. Tissue in the stage prior to that showing shoot initiation, showed maximum metabolic activity.

Studies on similar biochemical parameters with calli derived from different sources (leaf, stem and root) were also studied. Prelimary results indicated that calli derived from 3 different sources were with some persistant differences even when cultured in similar cultural conditions.

(i) *Micropropagation of Teak and Papaya*: Sunitibala Debi, Mousumi Das (Mandal), B. B. Mukherjee and Sukumar Gupta.

Papaya: Rooting media of the multiplied shoots were further standardized. It was observed that a pretreatment for 5 days in $\frac{1}{2}$ MS (modified MS) with 2 mg/L IBA before transferring these to a hormone-free liquid MS was necessary for development of healthy roots.

Rooted plantlets were transferred from culture medium to soil, and 75% of those survived in the field. These plants are growing now.

Pattern of some of isozymes-Peroxidase, Esterase, Glutamate Oxaloacetate transaminase (GOT), Acid phosphatase and Leucine amino peptidase (LAP) were studied using gel Chromatography in leaves of (1) *in vitro* grown plantlets (2) the elite mother plant, and (3) *in vitro* raised plants growing in the field, observe whether the conservative characters of the elite mother plant were retained in the cloned plants, or lost during prolonged culture. (i) In case of peroxidase, 6-7 bands appeared only in upper part ; (ii) esterase, 3 bands appeared in the lower part (iii) GOT, three bands were found in the upper half ; (iv) acid phosphatase, total 4 bands appeared and two were in the upper part of gel, one in the middle, and one in the lower part of gel ; and v) LAP, four bands appeared. The banding pattern was similar in all three samples, excepting that the 4th band of LAP was present in only elite mother plant.

Teak : Distribution pattern of different phenols in TIC plate were studied with samples taken from leaves of (i) the elite mother plant, and (ii) of those derived through clonel propagation. It was observed that pattern was similar in all the cases.

Banding pattern of the two isoenzymes (peroxidase and estease) were also studies in the leaves samples stated above in gel chremotography, and it was observed that the patterns of these two isozymes in the mother plant and in cloned plants were similar indicating that the basic characters of the mother plants were retained in the cloned plants.

Rate of growth of cloned plants are more than those in plants raised from seeds. All the cloned plants grown in field showed similar type of growth and grew up to 4 m in first two years.

I. *Nicotine content of field grown plants cloned from Nicotiana tabacum (var Jaysri) in vitro culture* : Sujata Saha and Sukumar Gupta.

The nicotine content of the leaves of the field grown plants cloned *in vitro* were studied. The powdered dry sample of leaf (800-1000 mg.) was mixed with Mgo (0.5 g) and the mixture was steam-distilled in a specially designed distilling apparetus. The distillate (90 ml.) was collected in a 100 ml. volumetric flask containing 10 ml. of 0.5 N HCL, and UV absorbance was studied at 236, 259 and 282 nm, and nicotine content was calculated following stand are procedure. It was observed thau the nicotine content of the leaf FO and FI plants varied between 2.04-2.24 percent respectively.

J. *Expression of nitrate reductase in root-nodule bacteria* : Pranab Kumar Sadhukhan and P. K. Chakrabartty (Supervisor).

Expression of assimilatory nitrate reductase was studed in two strains of *Rhizobium meliloti*, SU 47 and CC 169 and four strains of *Bradyrhizobium*, *B.* sp. (*Cicer arietinum*) 27A8, and 27A15 and *B.* sp. (*Vigna radiata* var *mungo*) U8. The enzyme was induced in GTS-glutamate medium in the presence of nitrate in the *R. meliloti* cultures, whereas, no detectable activity of the enzyme, as revealed from the measurement of nitrite in the medium, could be ascertained in the cultures of *Bradyrhizobium* under similar conditions.

i) *Solubilization of phosphatic compounds by root nodule bacteria* : A. K. Halder, A. K. Mishra and P. K. Chakrabartty (Supervisors).

In condition of our study of solubilization of phosphate from insoluble phosphatic compounds including rock phosphates, strains of *Rhizobium* were tested *in vitro*. Phosphate solubilization was observed to be related to pH-drop of the media. Ammonium salts as the sole nitrogen source caused higher solubilization of phosphate as compared to nitrate, salts, indicating the involvement of different mechanisms for phosphate solubilization. In the presence of NH_4^+, production of inorganic acid by an NH_4^+/H^+ exchange mechanism is thought to be operative. However, another mechanism involving organic acids produced is also identified. 2-Ketogluconic acid was found to be the prime agent for rock phosphate solubilization by *Rhizobium* sp. BICC 635.

Calcium as $CaCl_2$ reduced the extent of phosphate solubilization while EDTA increased the level indicating a role of calcium actively in the dissolution of phosphate rocks.

R. meliloii SU 47 and *Rhizobium* sp. BICC 635 solubilized Purulia rock phosphate-P_6 applied at 2 mg./gm. of soil to the extent of 17 and 35%, respectively after 45 days of incubation.

(ii) *Iron-transport in Bradyrhizobium sp.* (*Cicer arietinum*) : Nupur Roy and P. K. Chakrabartty (Supervisor).

To characterize iron-transport system in root-nodule bacteria of chickpea (*Cicer arietinum*), production of a Hathway reagent-positive compound has been detected and quantitated in three *Bradyrhizobium* strains of *C. arietinum*, Ca_2, 27A15 and Tal 622. Quantity of the compound in the medium parallels the growth curve and its highest level is achieved during the late stationary phase of growth.

K. *Storage protein from Vigna radiata* : S. Bhattacharyya and B. B. Biswas (Supervisor).

The major storage protein (7S) of *Vigna radiata* contains 52k polypeptide along with other small subunits of 31k and 23k. 52k subunit of vicilin (7S) disappears gradually with the accumulation of other two polypeptides i.e. 31k and 23k when incubated with mung bean seed extract, suggesting that 31k and 23k are derived from 52k polypeptide. Amino acid sequences derived from cDNA sequences of 7S storage proteins thus far reported also reveals the possibility of proteolytic cleavage at a site to produce two smaller polypeptides. By western analysis homology of 52k with 23k polypeptide has also been shown antigenically.

(i) *Genetic transformation and regeneration in Vigna radiata* : Mahadeb Pal, Utpal Ghosh, Amita Pal and B. B. Biswas (Supervisor) (Supported by UNDP and CSIR Grants) (With technical assistance of Asim Podder).

As described in the last years reports adapting the same procedure GUS gene along with NPTII gene was introduced to mung bean cells. However, the procedure relied on a protocol in which shoot organogenesis was induced on cotyledons of mung bean genotypes selected for susceptibility to Agrobacterium. Approximately 4-5% of the shoots produced on the Kanamycin selected cotyledons are transgenic based on assays for Kanamycin resistance as well as GUS activity. Thus demonstrated that transformation and regeneration in mung bean are partly possible so that introduction of 2S gene into mung bean can be attempted. (see report under PCMG section regarding regeneration of mung bean).

(ii) *Construction of Binary vectors for mung bear transformation* : Mahadeb Pal and B. B. Biswas (Supervisor) (Supported by UNDP grant).

The widely used promoter CaMV-35S is strong enough but not seed specific. Three promoters from 2S albumin gene of *Arabidopsis thaliana* (AT 2S) have been isolated and cloned by others and named as *Arabidopsis thaliana* albumin gene 1, 2 and 3. One of these promoters AT 2SPl was shown to give seed specific expression in tobacco. It was expected that the promoters from other genes of the same family will also give similar results. To confirm that two vectors were constructed with AT2S gene 3 promoter (AT2S3P).

(a) Vector 1 : It has complete AT2S albumin gene 3 inserted into a binary plant expression vector. The 1·5 Kb promoter of AT2SP3 was isolated from pAT2S2l as NcoI/EcoRl fragment. The 5' overhanging of NcoI site was filled in by Klenow fragment. The 2 Kb coding sequence of AT2S3 was isolated as EcoRl/Pstl fragment from pAT2S3. Those fragments were ligated and cloned in pUC19 at HincII/Pstl site. 3.5 kb fragment isolated and cloned in pGS1703A to get the putative vector.

(b) Vector 2 : This construct contains coding sequence of selectable bar gene under the control of AT2S3P to fuse bar coding sequence with AT2S3P it was essential to produce a NcoI site at the 3' end of AT2S3P as the translation start site of bar contains a NcoI site. This was done by site-specific synthetic oligonucleotide directed mutagenesis by the gapped duplex DNA method using T4 DNA polymerase and T4 DNA ligase. It was cloned in *E. coli* strain WK6 mutS and selected on chloramphenicol plates. From *E. coli* this is to be mobilized to the disarmed recipient *Agrobacterium tumefaciens*.

(iii) *RFLP mapping bean genomes* : Susweta Biswas and B. B. Biswas (Supported by UNDP grant).

We have certain varieties of *Vigna radiata* which are resistant to either virus/insects. It is expected that RFLP mapping of those varieties with respect to certain mung bean genes such as tubulin and vicilin as well as some genomic clones might yield different restriction pattern. Restriction of nuclear and chloroplast DNA from mung bean is being attempted. DNA from nuclei and chloroplast has been isolated and purified for restriction analysis.

L. *Characterization of 2S storage protein and its gene in mustard* : S. Dasgupta, J. Dasgupta and R. K. Mandal (Supervisor).

With a view to improve storage protein quality of mustard, work on the isolation and characterization of major storage proteins of one variety of yellow mustard *Brassica campestris* var. B-9 was initiated last year. Two types of saltsoluble globulins preteins (12S and 2S) are present in mustard as major components. The amino acid composition analysis of purified 2S protein showed the presence of all amino acids, but the amount of methionine, tyrosine and tryptopham indicate the need for improvement of the seed protein quality for use as an animal feed. Antibody against the purified 2S protein has been raised in rabbit and the accumulation of the storage protein during mustard grain filling will be quantitatively followed using this antibody. The crossreactivity of this antibody with 2S proteins of other *Cruciferae* will be studied.

Quantitative dot blot hybridization was used to estimate the copy number and transcript accumulation of 2S protein genes in diploid *B. compestris* var. B-9 and tetraploid *B. juncea*, var. 'Sita', using 2S napin cDNA as a probe. Southern blot hybridization reveated a 0·7 Kb fragment in HindIII digest of *B. cameptris* DNA. This fragment has been cloned and will be sequenced for comparison of the amino acid sequence with other *Cruciferae* storage proteins. Once characterized, this clone can be used for fishing out the genomic clone from *B. campestris* gene library. (This work is supported by UNDP).

(i) *Regeneration and transformation of mustard and tobacco plants* : Sudip Ghosh and R. K. Mandal (Supervisor).

Successful plant regeneration from somatic tissues cell is the prerequisite for producing transgenic plants with introduced foreign genes. With a view to transformation of mustard plants, *Brassica campestris*, variety B-9 has been established in tissue culture. Rapidly growing calli could be obtained from leaf, petiol, hypocotyl, stem and root explants in Murashige and Skoog medium supplimented with cytokinins and auxins. However, multiple shoots could be regenerated only from apical meristem and nodal explants. The shoots can easily be rooted and transplanted to soil. Transformation of *B. campestris* by cocultivation of nodal explants with genetically engineered *Agrobacterium* has not so far been successful. Successful tranformation and regeneration from leaf discs have been standardised with tobacco (*Nicotiana tabacum*, variety Petit Havana) as a model system. Conditions for regeneration and transformation are being optimised using some other varieties of *Brassica* (Supported in part by UNDP and CSIR).

(ii) *A conserved repeated DNA sequence in Cruciferae* : J. Dasgupta and R. K. Mandal (Supervisor).

The cloning and sequencing of a highly repetitive 177 bp DNA element from Indian mustard *Brassica campestris* and *B. juncea* were reported last year. These sequences showed 88% homology between them and are present to the extent of 18% of the genome. They possess a few direct and inverse repeats and can be folded to secondary structures with extensive stems and loops. Although some short open reading frames were found by computer analysis, no RNA transcript could be detected by Northern blot hybridizaion. These repeated DNAs have regular nucleosomal organization in native chromatin as revealed by micrococcal nuclease digestion. Some protein(s) have been found in mustard nuclei, which specifically binds to the homologous repeated DNA only. Computer search revealed extensive homology of this DNA with similar sequences present in other *Cruciferae*. Thus, unulike other *types* of repeated DNA which diverge more rapidly even within a genus, this repeated DNA is highly conserved in the family *Cruciferae* thus pointing towards its important role, which is a matter of conjecture yet.

M. *The motility of Mimosa pudica plants regenerated from pulvinus* : Ambalika Roy, Amita Pal (Co-supervisor) and Susweta Biswas (Supervisor).

Regenerated calli from *M. pudica* pulvini were maintained in suitable medium for subsequent passages each consisting of 21 days. These transferred to shoot generating medium and maintained till the shootlets became atleast 4 cm. long. After 4-5 weeks, regenerants with a sharp cut at the basal end were transferred to an

appropriate rooting medium. The small plantlets with well developed roots were removed from aseptic condition, washed thoroughly and transferred to earthen pots containing garden soil compost and ultimately to field at Madhyamgram Research Station.

The response curve of primary leaf of the regenerated plant was compared with that of normal one with the help of an instrument known as "Oscillating plate Phytograph" fabricated by J. C. Bose. It has been found that the curve in case of regenerated plant showed delay in the response as well as in its recovery whereas in normal plant the response was almost instantaneous and also recovered within a shorter period.

The specific activity of NTPase enzymes previously charactreized from the motile parts of *M. pudica* plant, was found to be lesser (about 1/3rd) in case regenerated plant in comparison to normal one. Effect of several contractile proteins like actin, myosin, heavy meromyosin and microtubule on the NTPase purified from the normal *M. pudica* plants were studied. The result showed that the specific activity of NTPase enzyme was increased 4-5 fold with the addition of microtubule purified from goat brain. Other contractile proteins were found to be ineffective. Attempts are now being taken to study the interaction of NTPase with microtubule in greater detail.

N. *Characterization of a pleiotropic Nif mutant of Azospirillum brasilense that also failed to utilize inorganic nitrate for growth* : Ashim K. Mandal and Sudhamoy Ghosh (Supervisor).

We previously reported the isolation of one *A. brasilense* mutant, strain no. RG747, that could grow on ammonia or organic nitrogenous compounds normally as only source of N but could not utilize dinitrogen and nitrate. Therefore, like some *Klebsiella pneumoniae* mutants with the same phenotypic defects that are complementable by *ntrA* gene, we suspected RG747 to be also defective in the nitrogen assimilation regulatory gene (*ntrA*) of *A. brasilense*. However, we failed to complement the bactrerium's phenotypic defect after conjugul transfer of broad host-range plasmids containining *ntr* genes like pLV72 (*A. vinelandii ntr*A like gene), pLV50 (*A. vinelandii* ntrC like gene) and pGE10 (*K. pneumoniae glnA ntrB ntrC*). We, therefore assumed that the phenotypic defect of *A. brasilense*RG747 was not due to any known nitrogen regulatory genes (i.e. *ntr* genes). Since the mutant failed to utilize nitrate, we analyzed nitrate reductase and nitrite uptake activities of the mutant. These experiments

revealed that the mutant is not defective in nitrate reductase, but the mutation only altered the enzyme expression to constitutive level. In addition, unlike the wild type, the mutant showed no ability to utilize nitrite presumably due to a defect in the induction of nitrite reductase.

Nif$^{(-)}$ pleiotropic mutants showing altered expression of nitrate reductase and non-inducibility of nitrite reductase were not described before. Therefore, RG747 is an unique strain for investigation of the possible existance of any regulatory genes that control specifically the expression of inorganic N utilization systems in soil bacteria. (Supported by CSIR, New Delhi).

(i) *Amplification of genomic library of Brassica campestris var. Agrani in EMBL-3 phage (Lambda replacement vector) and testing of genomic inserts by restriction enzyme analysis of some randomly selected recombinant EMBL-3 clones* : Niranjan Das and Sudhamoy Ghosh (Supervisor).

For long term storage and use of the genomic library it was essential to amplify the entire genomic clones in EMBL-3 vector. About 2×10^5 recombiant clones of the library, previously prepared by us, were amplified following the protocol described in "Molecular cloning" by Maniatis *et al.*, (1982). Host used for amplification was an *E. coli* P2 lysogen. The amplified genomic clones were stored in phage storage buffer (100mM NaCl, 50mM Tris, HCl, pH 7·5, 10mM, $MgSO_4$, 0.01% gelatin) at 4°C with a few drops of chloroform.

Fifteen recombinant phage plaques were selected from the library after plating (pure strain plaques) and each of them were amplified using host strain *E. coli* p2392 (P2 lysogen) in liquid culture by lytic infection procedure. From each purified and amplified recombinant phage clones, DNA was isolated following standard method for miniscale preparation. Restriction analysis of these purified phage DNA with EcoRI and BamHI showed that each donor insert was different from the others with respect to restricted DNA band patterns. This clearly indicated that recombinant clones contained different insert sequences.

(ii) *Experiments on enhancing siderophore productivity by Azospirillum brasilense* : Ashitava Basu and Sudhamoy Ghosh (Supervisor).

Spirilobactin, a new siderophore produced by *A. brasilense* RG was previously identified ; its structure was also determined, and it was shown to have three resedues, 2, 3 dihydroxypenzoic acid, ornithine and serine in equimolar amount. To enhance the productivity of *A. brasilense* for spirilobactin, we tested the effect of

addition of ornithine, serine and 2, 3-dihydroxybenzoic acid in Fe^{+++}-free growth medium. No noticable increase in spirilobactin content in the cultural supernatant was observed due to above additions. Moreover, 2, 3-dihydroxybenzoic acid above 0.01% concentration was found to be growth inhibitory ; it also failed to support growth of *A brasilense* as source of C. However, 2, 4-dihydroxybenzoic acid (an isomer of the 2,3-dehydroxybenzoic acid) is well-utilized by *A. brasilense* for growth as C-source ; it enhanced (at 0·01% conc.) the production of spirilobactin at least three fold. In addition, we also observed that glutamine when supplied as N-source (but not ornithine or serine) not only stimulated better growth under Fe^{+++}-free condition, but also increased spirilobactin production about two-fold (compared to NH_4-grown cells). Large-scale isolation of spirilobactin is necessary for studies of the effect of this siderophore on plant productivity under natural condition. (Supported by an ICAR project).

(iii) *Cloning of regulatory and structural genes of fru operon of Azospirillum brasilense* : Sudip Chattopadhyay and S. Ghosh (Supervisor).

The plant-associative, nitrogen fixing *A. brasilense* is known to enhance plant productivity by supplying fixed-N to plants in exchange of photosynthates (mainly fructose and not glucose for this bacterium). Since *fru* operon is inducible and normally remains repressed by succinate, we wanted to reconstruct *fru* operon of *A. brasilense* to make it constitutive and to increase the ability of this plant associative bacterium to supply fixed-N to plants more efficiently.

A number of fru$^-$ mutants were already isolated in our laboratory, and only three of these mutants were utilized in our cloning experiments : RG C2 (enzI$^-$, enzII$^-$, enz PFK$^-$), RG C17 (Fru$^-$, Ara$^-$, Gly$^-$, Gln$^-$, Gal$^-$) and RG C7 (enzII$^-$). Previously we reported the construction of a genomic library of *A. brasilense* RG using the broad host-range cosmid pLAFRI (inserts at EcoRI site) and isolation of a clone from the library (clone no. 93) that complemented *fru* defect of RG C2 and RG C17 (when pLAFRI-93 was transferred by conjugation from *E. coli* S17.1 to the *A. brasilense* mutants). We have now observed that pLAFRI-93 also complements RGC7 for its *fru* defect. We also isolated another clone from our library by mass conjugation of clones 301-400 (in *E. coli* S17. 1) to mutant RG C2. One of the Fru$^+$ transconjugants, RG C2 fru$^+$ (pLAFR1-CG1), was used for the isolation of the reccmbinant cosmid and re-transformation of *E. coli* S17.1 and also large scale isolation of the plasmid DNA. *E. coli* S17.1 (pLAFRI-CGl) was tested for its ability to complement RG C2, RG C17. pLAFR1-CG1 only complemented RG C2.

Moreover, RG C2 (pLAFR1-CG1) grew more slowly than RG C2 (pLAFR1-93) in fructose containing selection plates.

Further physical characterization of the inserts of the recombinant clones was done by restriction analysis, plasmid pLAFR1-93 on digestion with EcoRI yielded discrete DNA fragments, as found by agarose gel electrophoresis analysis, of sizes 22 kb (pLAFR1), and 10 kb, 9 kb and 5 kb (insert fragments). Only two DNA fragments of sizes 22 kb (pLAFR1) and 25 kb were found when pLAFR1-CG1 was digested with EcoRI. Therefore the insert CG1 has no EcoRI site whereas the insert 93 has two EcoRI sites. BamHI and EcoRI double digestion of pLAFR1-CG1 however yielded DNA fragments 22 kb (pLAFR1) and 12 kb, 7 kb, 3 kb and 1.5 kb (insert fragments). As pLAFR1 has no BamHI site, the CG1 contains at least 3 BamHI restrictions ites. The 9 kb fragment of pLAFR1-93 was subcloned in EcoRI site of pLAFR1 and the subclone pLAFR1-SC93 was found to complement RG C17. The above results suggests that the locus of *fru* (or *pts*) operon of *A. brasilense* is closely linked with the regulatory gene that controls the induction of carbohydrate operons.

O. (i) *Construction of plant vectors for transfer of genes to plants* : S. Das, D. Basu and S. K. Sen.

A series of vectors for plant transformation has been constructed. They have been assayed with regard to their efficacy for plant transformation. Since the border sequences of the nopaline, octopine and agropine type of virulent strains of agropine differ in their organisational pattern, it was considered worthwhile to judge their potentiality to interact with plasmid borne *vir* functions in a binary vector system. To do that four different types of helper plasmids were utilised with each of the vectors representing a particular type of border sequences. It was revealed that the interaction of the border sequences with a particular set of *vir* functions contained in a helper plasmid resulted differential level of T strand production and plant transformation. The plasmid dependent functional factors for T-DNA transfer, contain variabilities to secure sufficiently high plant transformation rate in case the appropriate combination of the *vir* functions are allowed to interact with the right type of the border sequences. All border segments contained the overdrive sequences in our vector constructs.

(ii) *Genetic analysis of the T DNA transfer process* : S. Das, D. Basu and S. K. Sen.

The Agrobacterium based T-DNA transfer from the bacterium to the plant cells as a process, bears resemblance with the bacterial conjugative mode of DNA transfer. The *mob* and *ori T* loci of RF 1010 can replace the necessity of the T-DNA border segment in a plant vector. Additionally, it was revealed that acctosyringone can induce the ss-DNA production in the same manner as in case of T-DNA production. The different types of helper plasmids used in a binary vector system of plant transformation with vectors containing the *mob* and *ori T* loci in place of T-DNA borders resulted differential level of plant transformation. The influence of the *vir* functions to the vectors, minus the border seguences, appeared as intriguing. It was speculated that the T-DNA transfer process bears similarities infact in a larger scale than we figured out to be.

(iii) *Cloning of plant development rol genes* : N. S. Banerjee, C. Ganguly, D. Basu, S. Das and S. K. Sen.

The *rol* genes contained in T-DNA of A. rhizogenes formed our experimental system. The *rol* genes contained in a contiguous manner in a series, as rol A, rol B, rol C were cloned and sequenced. All the genes contain eukaryotic promoters. Different sets of gene combinations have been constructed for their ultimate transfer to plants. Some of these genes have been refashioned to raise chimaeric constructs for studying the nature of the genetic elements and their influence on plant development. Transposon insertions into these genes have also been carried out to functionally map these genes.

(iv) *Cloning of iusect resistance genes* : D. Basu, S. Das, A. S. Rishi, T. Johnson, D. Banerjee and S. K. Sen.

Cloning of *Bacillus thuringiensis* toxin genes from a number of strains is underway. The endotoxin gene contained in Btk, HD-73', Berliner are fast reaching completion. The structural gene was subjected to certain tailoring before the same is used with plant promoters. The tailored gene has already been tested for its expression in E. coli. Antibody against the endotoxin has been raised. The progress already attained seems to ensure that the gene can be used to transfer to plants shortly.

The second gene that has attracted our interest is the Cowpea Trypsin Inhibitor. The protein has been isolated from the legume grain. Antibody against this protein has also been raised. The developmental stage when the protein appears in the grain, has been indentified. Poly A m RNA are being isolated from the developing seed to generate a c DNA genomic library.

(v) *Plant transformation studies* : S. R. Sikdar, T. Saha, P. Nayak, S. Kar, P. Mukherjee, S. Das, and S. K. Sen.

Agrobacterium transformation techniques through infeciion in case of mustard, jute have been perfected. Transformation through electroporation and uptake of DNA by the protoplasts in case of rice, jute and mustard has been achieved in a routine manner. Similar techniques are being developed for chickpea and tea.

(vi) *Studies on genomic organisation of jute* : S. Majumdar, S. K. Sen.

The nuclear genomic organisational differences are being worked out in case of two cultivated species of jute. Restriction fragment analysis of nuclear DNA is being employed to monitor the organisational diversity that exists between the two species.

(vii) *Genetic manipulation at protoplast level in crop plants* : S. R. Sikdar, P. Nayak, S. Das and S. K. Sen.

The advanced generations of Erussica, a somatic hybrid between *Eruca juncea* are beinng studied for evolution of novel genetic recombinants. The somatic hybrid between *Diplotoxis muraiis+Bbassica juncea* turned out to be sterile. Attempts to restore fertility are being made through backcrossing with either of the parents.

Transmission of mitochondria borne cms principles is being attempted through protoplast fusion technique. A number of fusion products has been raised into plants. The sources for the cms trait were *Pollima* and *ogu* cms cptoplasm.

A number of cms lines of rice have been collected and are being maintained through plant cell culture techniques. The lines are being raised *in vitro* conditions for their ultimate use for cell manipulation studies.

The mitochondrial DNA of the cms lines are being analysed for characterising the cms principle.

P. *In vitro produetion of diosgenin* :

(i) *Genotypic effect on diosgenin production from callus cultures fo C. speciosus* : Archana Roy and Amita Pal.

Comparative estimation of diosgenin contents from embryo calli of three *C. speciosus* revealed that diosgenin content highest in one of the tetraploid clone, the rhizome of this particular clone also contain more diosgenin *in vivo* than two

other experimental clones. The lowest diosgenin content was recorded from the embryo-calli of the triploid clone. This also contains comparatively lower diosgenin content *in vivo*. This result clearly suggests that the regulatory mechanism of gene or genes which govern diosgenin synthesis and accumulation under *in vivo* condition also remain equally effective under cultural condition.

(ii) *Estimation of diosgenin at different phases of callus growth of C. speciosus* : Archana Ray and Amita Pal.

Diosgenin contents were estimated from the lag, exponential and stationary phases of callus growth. The result indicates that diosgenin synthesis starts at the linear growth phase and the accumulation of diosggenin reaches to a maximum at the stationary phase when other metabolic activities of the cell decline.

(iii) *Estimation of diosgenin from unorganized and organized calli of C. speciosus* : Archana Roy and Amita Pal.

The growth index (GI) of the organized and unorganized calli showed that root callus grew rapidly than the unorganized callus and callus showing shoot differentiation. GI value was lowest in shoot regenerating calli where the diosgenin content was highest. Diosgenin accumulation was found to be lowest in the unorganized calli.

(iv) *Regeneration of shoots from callus cultures of Costus speciosus* : Archana Roy and Amita Pal.

Three different types of calli were induced *in vitro* on embryos of *C. speciosus* of which only hard type of calli were found to be amenable to morphegenetic responses. *De novo* formation of both shoot-buds and embryoid-like structures were recorded. Histological studies ensured two different modes of regeneration. Embryoids or bi-poler structures were formed either from epidermal or from sub-epidermal layers and later these discrete units or embryoids were separated from the mother tissue. In most of the cases the root primordia developed after some time. Shoot buds with shoot meristems enclosed in a coleoptile sheath were present within the same callus mass where embryoid-like structures were found.

Callus regenereted plants were transferred to the field condition and rhizeme growth, diosgenin contents and karyomorphological studies were conducted from individual plants. The result indicates production of somaclonal variants.

(v) *Improvement of diosgenin in Costus speciosus following unconventional technigne* : Amita Pal and Archana Roy.

Based on our previous hypothesis it has, been experimentally shown that elite clones of *Costus speciosus* could be raised through embryo culture. It has been estimated that 36 percent embryo clones contained higher diosgenin than that of the donor plant. We have shown that by the established techniques diosgenin content can be improved upto 600 mg per 100 gm dry tissue. The results further demonstrated that the diosgenin yield of plants within any embryo clone are more or less uniform unlike natural populations.

Development and improvement of regeneration system of Vigna radiata : Monalisa Chandra and Amita Pal.

The absence of standarized regeneration methods of *Vigna radiata* is a major obstacle in the application of genetic engineering technology. Additionally the potential for somaclonal variations arise when plants are regenerated adventitiously *in vitro* or via callus phase. Hence it is expected that regeneration of plants from tissues after vector mediated gene transfer may be resulted in altered genotypes. This is undesirable especially when original genetic integrity of the crop is desired.

In the ongoing programme on 'genetic improvement of mung-bean' we have selected three genotypes of *V. radiata.* The regeneration ability of embryo, decapitated embryo, cotyledon, apical meristem, leaf and hypocotyl explants of these three genotypes is being studied. Calli were initiated from most of these explants of all the genotypes. However, only rhizogenesis was obtained so far. Dedifferentiation of callus tissue to form adventitious shoots is underway.

Since genetic uniformity in the culture regenerants is essential hence direct regeneration or brief interruption by a callus phase is desired. We have regenerated entire plantlets from the apical meristem, excised embryos and cotyledonary explants. Lab. to field transfer of these regenerants is underway.

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2. Spontaneous and induced mutants in rice : A review : B. Majumder, *J. Nat. Bot. Soc.* **44** : (1) : 47-58, 1990.

3. Growth regulating compounds in the seeds of diploid cytotype of *Chenopodium album.* B. Bera, K. K. Mukherjee and S. N. Ganguly. *Physiol & Biochem.*, **16** ; 49-51, 1989.
4. Role of hormones on propagation of Indian variety of Tobacco (*Nicotiana tubucum* var Jayasri) Sujata Saha and S. Gupta *Phytomorphology*, **39** : 203-208, 1989.
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6. Effect of spermine on chloroplastic metal ion efflux of source and sink organs. Soumen Chattopadhyay and Bharati Ghosh, *Phytochemistry* **29** : 45-48, 1990.
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14. Plant regeneration through somatic embryogenesis from suspension cultures of a minor millet, *Paspalum scrchiculatum.* P. Nayak & S. K. Sen ; *Plant. Cell. Rep.* **8** : 296-299, 1989.

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16. "Erussica" the intergeneric fertile somatic hybrid developed through protoplast fusion between *Eruca sative* Lam and *Brassica juncea* (L) Czern. S. R. Sikdar, G. Chatterjee, S. Das and S. K. Sen, *Theor. Appl. Genet.* **79** : 561-567, 1990.

17. Meiotic development features relevant to prophase specific chromosomal characteristics in Saccharomyces cerevisevae. S. K. Sen, S. Das, A. Banerjee, N. Jasani-Gupta, M. Shah and S. Ghosh. In : Trends in Chromosome Research pp. 141-164. Springer Verlag Public.

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Institutional Project No. II : Chemical and Biological Studies on Marine Organisms

A. *Chemical investigation of a marine animal :* Anup Kumar Ray, Pran Krishna Datta, Prantosh Bhattacharyya, Kalyan Basu and A. K. Barua (Supervisor)

Chemical investigation of a marine animal collected from Digha has led to the isolation of three aramatic nitragenous compounds. Further work is in progress.

B. *Chemical investigation of a soft coral* : Prantosh Bhattacharyya, Kalyan Basu and A. K. Barua (Supervisor) and B. B. Mukherjee (Department of Botany)

Chemical investigation of a soft coral has furnished a number of marine sterols and some terpenoids.

The crude extract of the above coral has been found to be toxic in the brine shrimp test, performed in the laboratory by Dr. Debasis Ghoshal. Further work is in progress.

C. *Chemical examination of a marine squid :* Anup Kumar Ray, Pran Krishna Datta and A. K. Barua (Supervisor)

Earlier the isolation of two new amides from a marine squid was reported. It It has now been possible to isolate another compound. Its NMR, IR and mass spectra indicated it to be an interesting compound. Further work is in progress.

D. *Chemical investigation af some marine molluscs :* Pran Krishna Datta, Anup Kumar Ray, and A. K. Barua (Supervisor)

Five molluscs have been collected from Digha. Preliminary chemical examination of two of these has been carried out and a compound has been isolated in a pure state and is betng further examined. Brine shrimp test of the extracts of two molluscs, however, showed no toxicity.

E. *Biological screening of the extract of marine plants and animals :* A. K. Barua

Sixteen extracts of marine algae and animals were sent to CDRI, Lucknow for biological screening. The extract of a sea worm has been found to have

hypotensive activity at an extremely low dose. The extract of a sea anemone also showed hypotensive activity. One of the extracts showed spermicidal activity at 1% concentration.

The extracts showing the above activities are being investigated for the isolation of the active constituents.

F. *Studies on a marine squid, Loligo duvacelli :* T. Anoopkumar and Parul Chakrabarty (Supervisor)

It is been reported earlier that the above marine organism is a rich source of prostaglandins and some other useful eicosanoids. Further investigation revealed the presence of peptido leukotriene in the organism. The reproducitivily mature organism contains cysteine-containing leukotrienes which could not be detected in the immature ones. Further work is in progress to evaluate the role of these biologically important compounds in the life cycle of this marine squid.

G. *Seasonal variation of lipidis of the marine bivalve mollusc* **Macoma birmanica** : Suniti Misra (Calcutta University) and Amitabha Ghosh (Supervisor)

Elaborate studies have been made on the edible bivalve, **M. birmanica** abundantly available in the coastal areas of Bay of Bengal, regarding seasonal varition of lipidis with particular reference to biologically active components.

H. *Studies on biochemical ecology and Food chains of the marine bivalve* **M. birmanica** : Suniti Mishra (Calcutta University) and Amitabha Ghosh (Supervisor)

Lipid composition of plankons and detritus on which the bivalve *M. birmanica* feeds have been determined along with the lipids of various organs of the mollusc. Intake of primary lipid molecules through food and their biotransformation by *M. birmanica*, with special reference to polyunsaturates and ether linked lipids have been investigated in details.

I. *Lipids of the gastrood marine mollusc T. telescopium* : Aloke K. Hazra, Amalesh Choudhury (Calcutta University) and Amitabha Ghosh (Supervisor)

Detailed investigation on lipids of the gastroopod mollusc *T. telescopium* have been made with special reference to certain pharmacologically active lipids.

Publications

1. Lipids and fatty acids of the horesehoe crabs *Tachypleus gigas* and *Carcinoscorpius rotundicauda* : S. C. Pakrashi, P. K. Dutta, B. Achari, S. Misra, A. Choudhury, S. Chattopadhyay and A. Ghosh ; *Lipids*, **24**, 443-447, 1989.

2. Fatty acids and sterols in the sediments of Hoogly estuary, north-east cost of India : P. B. Ghosh, S. Misra, A. Choudhury and A. Ghosh. *Indian J. Marine Science*, **19**, 22-25, 1990.

3. Possible sources of aliphatic hydrocarbon in sediments of Hooghly, P. B. Ghosh, S. Misra, A. Choudhury and A. Ghosh, *Indian J. Marine Sci.* **19**, 1990, 145-147.

4. Lipid composition of some mangrove plant leaves of Sunderban ecosystem, S. Chattopadhyay, P. K. Pal, A. Ghosh, S. Misra and A. Choudhury, "Proceedings of the National Symposium on Marine Resources, Techniques, Evaluation and Management", held at Andhra University Geology Department, from May 14-16, 1987. Editor, A. V. R. Sastry, Andhra University Press & Publications, Visakhapatnam 530 003, May 1990, pp 5-7.

5. Hydrocarbons and fatty acids of the gut contents of the mullet *Liza parsia* of Sunderbans mangrove estuary, G. Chattopadhyay, S. Misra, A. Choudhury, P. K. Pal, S. Chattopadhyay and A. Ghosh, "Proceedings of the National Symposium on Marine Resources, Techniques, Evaluation and Management", held at Andhra University Geology Department, from May 14-16, 1987. Editor, A. V. R. Sastry, Andhra University Press & Publications, Visakhapatnam-530 003, May 1990, pp 9-11.

6. Cymbinodin-A, a phenanthraquinone from *Cymbidium aloifolium*, A. K. Barua, B. B. Ghosh, S. Ray and A. Patra, *Phytochem.*, **29**, 3046, 1990.

Institutional Project No. III : Investigations on the interaction of nuclear and other radiations with matter and studies in structure, functions and dynamics of biomolecule.

A. Physical Acoustics, Microwave and Solid State Physics

(i) *Investigation using Emisonic 4200 ultrasound Scanner :* B. Roy

Output power and voltage measurements of the ultrasound scanner were attempted at various frequencies and with different probes to test the feasibility of investigating the ultrasonic luminescence of certain biological fluids, like blood plasma.

(ii) *Experiments on Photoacoustic Spectroscopy :* B. Roy, S. C. Roy, M. H. Engineer

Due to total involvement in alternative projects no progress has been made in this area.

(iii) *Tagential Instabilities at the Interface of flowing liquids :* Pradip Roy (Guest Worker), B. Roy, M. H. Engineer and B. K. Chatterjee

The question of tangential instabilities at the interface of (acoustically driven) comoving liquids, propagating tangential to a separating interface, has been experimentally investigated. When the relative velocity of the two fluids is small the flow is always laminar independent of the geometry. However, at a certain critical relative speed interfacial distortions (ripples) appear superimposed on the laminar flow. These ripples are phase incoherent when the relative speed slightly exceeds the critical speed. However, far beyond the critical speed phase coherence seems to set in and giant pulses regularly propagate along the interface *against* the steady motion. The qualitative aspects of the pulse and the pulse-shape appear to be independent of the fluids being used.

An experimental rig for the accurate measurement of the interfacial tension and independent measurements of fluid and pulse propagation velocities and pulse height distribution have been set up. Attempts were made for *in situ* measurements

of viscosity (later supplemented by a routine viscometer) and pulse shape / pulse-pulse correlation, but in these aspects more development work need to be done.

B. Nuclear Physics

(i) *Measurement and calulation of Compton profile :* A. K. Chatterjee and Santa Bandyopadhyay.

The measurement of Compton Profile of CuO is vital as it plays an important role in high T_C materials. This study on the compound (CuO) can also give the electron correlation effects on the structure of transition metal compounds. CuO is an anti-ferromagnetic semiconductor with a monoclinic structure. An admixture of $3d^9$ and $3d^{10}$ electrons contribute to the valence band.

This investigation in being continued to study the electron correlation of CuO and its possible contribution to the properties of high T_C materials.

(ii) *Electron momentum density and Compton profile Calculation :* A. Chatterjee, I.A.C.S., Jadavpur, A. K. Chatterjee.

The Compton profile J (q) defined as the ground state electron momentum is then proportional to the projection of the electron momentum density (EMD), $\gamma(\vec{p})$ on the scattering vector $\vec{K}$ taken in the z-direction i. e. $J(q)=\iint \gamma(\vec{p})\, dp_x\, dp_y$.

The EMD, $\gamma(\vec{p})$ can be written in terms of the single particle momentum space wave function.

By Fourier transformation one can get single particle position space wave function. If now any ground state electron charge distribution (ECD), $\rho(r)$ is given, it should be possible in principle to obtain corresponding $\gamma(\vec{p})$. One method to obtain EMD, $\gamma(\vec{p})$ from ECD, $\rho(\vec{r})$ is quasiclassical phase-space consideration. This approach is based on rigorous phase-space formalism described in detail in literature. The phase-space function, $f(\vec{r}, \vec{p})$ defined in joint position and momentum space is also known as Wigner function.

We thus have $\int f(\vec{r}, \vec{p})\, dr = \gamma(\vec{p})$

Parr et al combined maximum-entropy principle with the above approch to determine $f(\vec{\gamma}, \vec{p})$ in atoms and molecules. Following a similar approach Wingner's function in metal is obtained as $f(\vec{r}, \vec{p}) = \left(\frac{3\rho}{4\pi t}\right)^{\frac{3}{2}} \rho(\vec{r}) \exp\left(-\frac{3\rho p^2}{4t}\right)$

where $t = t(\gamma)$ is the kinetic energy density in space.

Calculation is being continued to determine electron momentum density and Compton profile from electron charge distribution of a metal atom.

A report was presented at the 8th National Radiation Physics Symposium held at BARC, Bombay in January, 1990

(iii) *(a, xn) reaction and precompound effect using alpha beam from Variable Energy Cyclotron Centre :* B. Mitra, A. K. Chatterjee, S. N. Changdar, A Chatterjee, and collaborator B. B. Baliga of S. I. N. P.

In the energy region 40 to 70 MeV the neutron emission in the (∝, xn) reaction take place in the following way. The first two neutrons are emitted by pre-compound process and the third and other multiple emission of neutron occur by compound nuclear mechanism. The calculation of scattering kinematics from semiclassical model assumes that either the target nucleon motion are completely neglected or only the ground state Fermi motion described by a zero temperature Fermi distribution is considered. In actual practice the target nucleus is initially in the ground state, a zero temperature Fermi distribution can be used to approximate the nucleon momentum distribution only at the time of the first interaction. After the first collision the composite nucleus is excited. In our present approach in calculating the pre-compound emission of neutrons we are considering the motion of the target nucleons.

(iv) *'Cold Fusion' Experiment to detect Neutron and Tritium :* M. Bose and S. Sanyal, A. K. Chatterjee, S. Banerjee and S. Sarkar.

In the electrolysis of a solution of O. 1 M LiO^2H in ^2H_2O with titanium disk cathode and platinum foil anode surrounding the cathode, neutron and tritium were detected. The conventional pulse-shape discrimination technique was used to detect neutrons in presence of gamma rays. Tritium was detected by a sensitive Beckman LS1800 Liquid Scintillator. The counting device showed that neutron detection rose to a value of 5.2±1 counts per 100 sec at 10786 sec and then gradually decreased

to steady value of nearly 3±1 counts per 100 sec. Tritium count detected was 43 counts / minute.

This experiment showed that some processes are acting which might be a d-d ρ fusion process to produce neutron and tritium.

C. Radiation and Tracer Technique

(i) *Liquid Dynamics / Applied Radioactivity :* S. N. Changdar (Supervisor), Aparna Das (Sen).

The equation of state and the transport properties of gases and liquids are intimately related to the forces between the molecules. From measurements of any of these macroscopic properties it is in principle possible to determine the law of force between the molecules. With this aim in view the sliding cell technique developed in our laboratory has been utitized for the measurement of diffiusion coefficients (both self and mutual) in aqueous electrolyte solutions. The isotopes used were ^{134}CS and ^{137}CS. No isotope effect has been found so far. It has also been found that over a wide range, diffusion coefficient can be taken as a constant which does not depend on the concentration of the radio-isotopes present. Attempts are now being made to correlate these experimentally found diffusion coefficients with the phenomenological coefficients of Onsager.

D. Radiation Physics, Conduced Matter (Experiment)

(i) *Change of Viscosities of polymers on gamma irradiation :* Random Resistor Network Model. L. Santra, B. K. Chatterje, D. Bhaumik and S. C. Roy (Supervisor).

The change in viscosity of polymeric silicone fluids due to gamma irradiation have been studied below the gelpoint using a sensitive differential yiscometer. Using the correspondences between resistivity and viscosity of fluids, the random resistor network model was used to explain the increase in viscosity due to irradiation.

(ii) *Cold Nuclear Fusion :* Pradip Roy (Guest Worker), B. K. Chatterjee.

Investigations on the "Cold Nuclear Fusion" of deuterons adsorbed/absorbed on/in to palladium foil cathode were carried out by the use of a nonstir-calorimetric

technique and coincident detection of produced neutrons. From our experiment no evidence of the evasive "Cold Fusion" was observed.

(iii) *Studies of radiation-induced free radicals by the Lyoluminescence and ESR spectroscopy :* Tuktut Sur and S. C. Roy (Supervisor)

With the objective of understanding the mechanism of lyoluminescece (LL), a free-radical process, involving increase in (LL) response in spite of large radical loss during annealing, the absolute radical concentration of those annealed samples are determined by using dpph as standard. The effect of microwave power also has been investigated to confirm the reduction in spin-lattice interaction.

Attempts have been made to predict $(\dot{R}+\dot{O}_2)$ and $(\dot{R}+\dot{R})$ reaction rates relative to a value obtained by direct measurement of O_2—consumption through the LL dose-response studies for a large number of materials upto higher doses.

(iv) *Calculation of anomalous scattering for ions and atoms* : S. C. Roy

The anomalous scattering factors g′ and g″ for forward scattering are generated for neutral Ne and for Ne 2^+, 4^+, 6^+ and 7^+ions utilizing a dispersion relation integration method at the University of Pittsburgh for photon energies from 1 to 70keV. It has been observed that the contribution form bound-bound transitions to g is more important for ions than for neutral atoms. The primary reason is that in ions there are more inner shell vacancies for which bound-bound transition are allowed. Rayleigh scattering cross sections obtained with the contribution from the major bound-bound transitions included in g, agree well with S-matrix calculation.

E. Theoretical Physics

Foundations of quantum Mechanic

(i) *Investigations concerning the Einstein-Podolsky-Rosen (EPR) Paradox :* Dipankar Home, P. Ghose (S. N. Bose National Centre for Basic Sciences, Calcutta) and M. D. Srinivas (University of Madras).

As a sequel to the earlier work by A. Datta, D. Home and A. Roychaudhuri, the basis of the quantum mechanical theorem claming to prohibit non-local statistical effects (NSE) in EPR-type examples was critically re-examined. It was found that some of the conditions underpinning the theorem could indeed be circumvented by suitable experimental arrangements involving absorptive type measurements.

Difference between NSE and faster-than-light signalling was pinpointed. This analysis would be crucial in interpreting the true significance of the experimental studies currently pursued on this topic.

(ii) *Proposals for New Experiments involving Electron Interferometry* : Dipankar Home, P. Ghose (S. N. Bose Centre, Calcutta) and A. Qadir (Quaid-i-Azam University, Islamabad, Pakistan).

We have proposed a dynamical variant of the single-electron self interference experiment (of the type developed by A. Tonomura et al. at the Advanced Reseach Laboratory, Hitachi Ltd, Tokyo) with a view to empirically discriminating between Single Particle and Ensemble Interpretations of Quantum Mechanics. The feasibility of this proposed experiment is currently being studied by A. Tonomura.

(iii) *Study of the conceptual implications of Neutron Interferometry Experiments* : Dipankar Home, P. N. Kaloyerou (Institut Henri Poincare, Paris, France)

New variations of Einsterin's two-slit experiment have recently been performed using neutron interferometry by H. Rauch et. al. (Vienna, Austria). We analysed the experimental results to decipher their implications for the complementarity principle and contrasted them with the de Broglie-Bohm causal interpretation.

(iv) *Study of the Ensemble interpretation of Quuntum Mechanics* : Dipankar Home, M. A. B. Whitaker (Queen's University of Belfast, N. Ireland)

A comprehensive review of the Fnsemble Interpretation and its comparison with other Interpretations of Quantum Mechanics is under preparation as commissioned by Physics Reports.

(v) *Wave-Particle Dualism of Single-Photon States :* Dipankar Home and P. Ghose (S. N. Bose Centre, Calcutta).

An experiment is proposed involving wave-particle dualism of "Single Photon States" and the possibility of their optical tunneling which will have significant bearing on the formalism of quantum optics and the validity of the complementarity principle in its usual form. Interaction is being puresed with relevant experimental groups in France and Japan to explore the possible of carrying out this experiment and develop its further variants.

F. Condensed Matter

(i) *Critical Phenomena in lattics statistical models :* I. Bose (Supervisor) and S. B. Santra

The study of lattice animals initiated earlier has been extended. For spical lattice site animals embedded in the square lattice, a relation $\theta_G = \theta_0 - \alpha c$ has been conjectured where θ_G is the animal number exponent for animals with c loops, θ_0 is the exponent for trees and α is a numerical constant of approximate value 1.62. This result is different from the relation $\theta_G = \theta_0 - C$ whieh holds true for both undirected and directed animals. A study of percolation under rotational constraint has been initiated.

(ii) *Low Demensional Magnetism* : I. Bose

A spin model consisting of a chain of octahedra has been constructed. The spins interact through Heisenberg antiferromagnetic exchange interaction. In a certain parameter regime of the Hamiltonian, the exact ground state is shown to be of the resonating valence bond type. Several exact excited states have also been obtained. Work has been initiated to extend the spin model results to higher dimensions and also to consider more general Hamiltonians like the t-J model.

G. General Physics

(i) *Studies on Phase Anholonomies in Quantum Systems :* M. H. Engineer

The studies have yielded exact formalism in the two state case. As a result corrections to the adiabatic limit for the phase *and* the transition rates were calculated. The geometric phase was shown to affect transition rates. The possible effects of the geometric phase solid state physics was studied for one dimensional superconduction, conducting polyacetyline and poly-diacetyline. The results so far got indicate new, exciting possibilities in this area of applications of the phase idea.

(ii) *Studies on Two Phase Flow in Porous Media* : M. H. Engineer

There is great necessity for determining exact solutions of the non-linear dynamical equations describing two flow in Porous media. It has been found that this can be done, and, an infinite family of exactly solvable models have been discovered which model both the capillary pressure and relative permeability pehnomena

adequately and also allow for a wide range of initial and boundary condition pertinent to experimental situations. The techniques of Lie analysis were used in this investigation.

H. Physical, Chemical and Structural studies on Proteins

(i) *Studies on protein folding :* Tapan K. Chaudhury and N. K. Sinha (Supervisor)

The basic trypsin-subtilisin inhibitor containing 110 amino acid residues and six disulphide bonds in a single chain was purified from turtle eggwhite for its folding studies. The inhibitor was unfolded in 6M guanidine hydrochloride at pH 7·5 without disrupting the disulphide bonds. The unfolded inhibitor which was devoid of any inhibitory activity was allowed to refold in 0·1M guanidine hydrochloride at pH 7·5 and at room temperature. The refolded inhibitor regained 60% of its activity in 10 minutes. Further work is in progress.

(ii) *Studies on sering protease inhibitor from Luffa acutangnla seeds :* Umes Ch. Haldar and N. K. Sinha (Supervisor).

The seeds of the plant family *Cucurbitaceae* were surveyed for detection of inhibitory activity of serine protease inhibitors. High inhibitory activity towards trypsin was found in the seeds of *Luffa acutangula*. Its isolation and purification are in progress.

(iii) *Studies on low molecular weight trypsin inhlbitor from Monordica charntia seeds :* S. Saha and N. K. Sinha (Supervisor).

A basic trypsin inhibitor was isolated from the seeds of *Monordica charantia* and was purified by gel filtration through Sephadex G-75 followed by ion-exchange chromatography on CM-cellulose at pH 5. Its homogeneity was checked by polyacrylamide gel electro-phoresis in presence and absence of SDS. Its molecular weight determined in SDS-urea gel electrophoresis was found to be 4000.

(iv) *Studies on enzyme-inhibiior interaction-determination of kinetic constants :* M. K. Guha (Pool-Officer of C. S. I. R.).

S-2-Hydroxyacylglutathione hydrolase (glyoxalase II) is a specific thiolesterase which catalyzes the hydrolysis of hydroxythiolester to hydroxycarboxylic acid. Synthesis of an active site directed competitive inhibitor. p-bromobenzyldithioglutathione, has been designed to study the kinetics of the binding and hence the thermodynamic parameters for this enzyme-inhibitor interaction. Synthesis of the

target compound will be achieved by transestcrification between glutathione and p-bromobenzyldithiophenol, the synthesis or the latter compound has been completed as judged in NMR/IR spectroscopy. Further work is in progress.

I. *Chemical investigation of an orchid (Cymbidium aloifolium) :* Bikash Baran Ghosh, Sarmila Ray and A. K. Barua (Supervisor).

Earlier the isolation of a new violet quinonoid compound Cymbinodin-A was reported. It was considered to be either 5-hydroxy-3-methoxy phenanthrene-1, 4-quinone or 5-hydroxy-2-methoxy phenanthrene-1, 4-quinone.

By detailed NMR studies including $^{13}C-^{1}H$ correlation experiment with the acetate of the above compound the final structure of cymbinodin-A has been established as 5-hydroxy-3-methoxy 1, 4-phenanthraquinone.

Further studies on another red coloured compound has been made. On the basis of physical date (^{1}H NMR and ^{13}C NMR etc) it appears to be a quiuonoid compound having a hydroxyl group, two methoxyl groups and an aliphatic ether side chain.

This work is being carried out in collaboration with Dr. Amarendra Patra of the Department of Chemistry, University College of Science & Technology, Calcutta University.

J. (a) *Phytochemical studies on phylogenetically related members of the Angiosperm :* Uttara Das, Sarbani Santra, Shyamali Roy (past worker) and D. P. Chakraborty (Supervisor).

(i) The structure of Coriandol has been settled.

(ii) Structures of tricosanthiol and xanthindiol have been shown to be bioactive steroid with double bond at 16-17 position and its isomer.

(iii) The chemistry of some terrestrial algae and some angiosperms with allelochemic properties are being worked out (collaborative with Botany Department, Calcutta University).

(b) *Synthetic studies in relation to phytochemical and some other newer synthetic method :* Uttara Das, Sarbani Santra, Shyamali Roy (part worker) and D. P. Chakraborty (Supervisor).

(i) Continuation of aminocarbonylation work with less enolisable ketones showed that both $AlCl_3$ catalysed aldol reaction and urethane addition to ketones took place giving rise to complex molecular structures which are being worked out.

(ii) Several carbazoles have been synthesised using Lewis Acid catalysed diazocoupling.

(iii) Photochemical amide transfer leading to quinolosinone synthesis has been accomplished.

K. *Studies on heterocyclic and organosulphur compounds :* G. K. Biswas and P. Bhattacharyya (Supervisor).

(i) Regioselective ring opening of epoxide with sodium-p-toluene sulfinate using Montmorillonite clay as catalyst :

Epoxides have been found to be cleaved regioselectively when treated with the sodium salt of p-toluene sulfinic acid in the presence or Montmorillonite clay at room temperature. The method has been found to be suitable for the preparation of α-hydroxy sulfone and some useful α-hydroxy sulfones have been prepared by this method.

(ii) *An efficient synthesis of sulfones using Polysorbate 80 as Phase transfer catalyst :*

Polysorbate-80 appears to be an extremely efficient phase transfer catalyst for the synthesis of sulfones. Several interesting sulfones have been prepared by this method and have been characterised by physical data. This work was done in collaboration with Dr. M. Chakrabarty.

(iii) Simple and rapid preparation of sulfones :

Appropriate alkyl halides and sodium p-toluene sulfinates react rapidly in DMF-water and room temperature under the influence of ultrasound to afford sulfones. Using this procedure a wide variety of sulfones have been prepared.

L. (i) *Synthesis of indolocarbazoles :* Archana Batabyal and Manas Chakrabarty (Supervisor)

Since 1977 about a dozen of antibiotics have been reported, all of which are derivatives of indolocarbazole. With a view to preparing the parent indolocarbazole skeleton the Fischer indole synthesis of a number of oxotetrahydrocarbazoles and dihydroindolocarbazoles has been attempted in one-pot processes through the employment of a Lewis acid catalyst. The characterisation of the products by spectral studies and standardisation of the conditions for better yields are in progress.

(ii) *Reactions of quinazoliue—4(3H)-thiones* : Archana Batabyal and Manas Chakrabarty (Supervisor)

2-Substituted-3, 1-benzothiazine - 4—thiones have been reported to react with diazomethane to give the corresponding 1, 3—dithioles by one group whereas the formation of the episulfides has been reported by another group. In view of this controversy and because of the remarkably wide variety of reactions whtch the biologically important class of compounds, viz. 4-quinazolinones undergo, the reaction with diazomethane was extended to various substituted quinazoline—4 (*3H*)—thiones. The 2-substituted compounds behaved differently from 1- and 3-substituted ones. More surprisingly, in case of former some unexpected products are formed. Attempts are being made to characterise these products and rationalise the course of the reactions.

(iii) *Attempted hydrolysis of phenyl ketene trimer ester* : Archana Batabyal ,and Manas Chakraborty (Supervisor)

In an attempt to hydrolyse the 4-phenylacetoxy derivative of Wedekind's pyronone (Ann. Report, 1987-88) by alcoholic alkali a bright yellow coloured compound was unexpectedly obtained. Mainly on the basis of its UV, IR, ^{1}H and ^{13}C NMR (PND and DFPT 135), XHCORR and LR (2 bond-) XHCORR and mass spectral data it was identified as a hydroxy napthoquinone derivative. A plausible mechanism of its formation has been thought of and experiments are now being conducted to check the validity of this postulated pathway.

(iv) *Chemical invesiigation of polyalthia longifolia* : Amar Chandra Nath and Manas Charabarty (Supervisor)

In continuatton of our earlier work on the non-basic fraction of the petrol extract of the bark of *Polyalthia longifolia* yet another metabolite has been isolated. Its preliminary spectral data reflect its stuctural resemblance with the earlier isolated diterpenoid. For its complete characterisation attempts are being made to isoiate a larger amount of this compound.

(v) *Chemical investigation of Laggera aurita* : Amar Chandra Nath and Manas Chakrabarty (Supervisor)

A thorough tlc examination of the butanol extract of the whole plant *L. aurita* revealed the presence of inseparable metabolites. To oboviate this difficulty, a part of the extract was acetylated (Py/Ac_2o) and then subjected to repeated column chromatographies. So far a low melting compound has been obtained. From its spectral data, specially ^{1}H NMR data, it appears to be an interesting unsaturated carbonyl compound probably attached to an aromatic nucleus. Work is in progress to identify the compound.

(vi) *Chemical investigation of Meyna laxiflora* : Amar Chandra Nath and Manas Chakrabarty (Supervisor)

In view of the reported biological activity of this plant, specially of its fruits, a thorough chemical examination of its various parts was contemplated. The neutral part of the petrol extract of the bark of this plant (Family : Rubiacase) furnished, after repeated column chromatographies, three fatty compounds and a sterol. The characterisation of these compounds is underway.

M. (i) *Dietayy fatty acid of specific structure and heart diseases* : *effect of hilsa fish oil rich diet on atherosclerosis* : Ishani Bandopadhyay, Sagarmay Saha and Jyotirmoy Dutta (Supervisor)

A hilsa fish-oil-rich diet, containing cholesterol at a level as high as 1.5% of the total diet. has been found to effectively prevent induction of atherosclerosis in rabbits even after feeding for 40 days. The same amount of cholesterol in a diet supplemented by groundnut oil instead of hilsa fish oil produced atherosclerosis in this animal model within 40 days of feeding. This induction of athérosclerosis by cholesterol supplemented groundnut-oil-rich diet as well as the prevention of such induction by hilsa fish oil supplement diet have been clearly established through the histological studies of the section of thoracic aorta and coronary artries. Hilsa oil rich diet has been found to reduce symptoms of atherosclerosis including the removal of atherosclerotic plaque from the thoracic aorta and coronary arteries of atherosclerotic rabits within 70 days of feeding. It has been possible to correlate the presence of substantial amout of n—3 polyunsaturated fatty acids and high eicosapentaenoic to arachidonic acid ratio in hilsa fish oil with its curative and preventive properties against atherosclerosis. The results so far obtained indicate high potentialities of hilsa fish oil in the management

atherosclerosis both as a dietary component and a therapeutic agent. Experiments with human patients and normal persons are at hand.

(ii) *Studies on the pheromones of tigers and leopards* : An inter-institutional project, Joint Supervisors J. Dutta, Bose Institute and R. L. Brahmachary, Indian Statistical Institute, Mousumi Poddar Sarker (fellow)

Fifteen free fatty acids between acetic to octanoic acid all straight chain, including normal, iso, anteiso saturated and unsaturated ones have been definitely characterized in the marking fluid (pheromones) of tigers ond tigress. The ratios of the major components like acetic, isovaleric and octanoic acids were found to be different in different animals, again each set of the values for a particular animal changed seasonally, specially in the case of the tigres. Thus throug these values the animals can communicate its identity as well as sexual status. Existance of low carbon aldehydes and ketones are also identified as the marking fluid.

N. (i) *Effect of metalions on PGE_2 Synthetase system of goat seminal microsomes* : Eli Mukherjee and Dolly Ghosh (Supervisor)

We previously reported that Ca^{2+} ion plays an important role in modulation of PG-synthetase complex activity of goat seminal microsomes ; e.g. Ca^{2+} stabilizes the highly unstable multienzyme complex during biosynthesis of PGE_2 as well as enhances the activity of the enzyme complex. So we thought it would be worthwhile to study the effect of some metal ions which can replace Ca^{2+} ion like Tb^{3+}, La^{2+} etc, some metal ions of biological importance like Na^+, K^+, Mg^{+2}, Mn^{+2} and other bivalent cations Ca^{2+}, Sr^{2+}, Ba^{2+}, Tb^{3+} which could be used as probe for investigating the the binding site of Ca^{2+}, mimics the effect of Ca^{2+} (4mM) on enzyme activity but at much lower concentration (0.mM) The hysteretic effet of Tb^{3+} like that of Ca^{2+} could be reversed by calmodulin (at μg level). La^+ also shows similar hysteretic effect and also enhances the enzyme activity at an optimum concentration of 0.4mM. The optimum concentrations of other bivalent cations for stimulatory effect on the enzyme activity are Cd^{2+} (0.8mM), Sr^{2+} (6mM), Ba^{2+} (6mM). Na^{+2}, K^+, Mg^{2+} at physioclogical concentrations show no effect on the enzyme system. Mn^{2+} shows strong inhibitory effect on the enzyme activity.

(ii) *Stabilization of PG-synthetase by immobilization of goat seminal microsomes* : Eli Mukherjee and Dolly Ghosh (Supervisor)

The multienzyme complex. Cyclo-oxygenase peroxidase-isomerase, present in microsomes of seminal vesicles responsible for prosta-glandin synthesis, is highly unstable even at—20°C and this instability makes it difficult to utilize the enzyme for large scale production of PGE_2. With an aim to stabilize the enzyme complex, we tried several methods of immobilization of the complex on solid matrics along with the addition of ligands (Ca^{2+}) related to PGE_2 synthetase. We reported earlier that the Ca^{2+} ligant stabilizes the PG-sythetase to a considerable extent, Here we are reporting our attempt for stabilization of PG-synthetase by immobilivation of goat seminal microsomes on several solid matricer ; controlled pore glass, DEAE sephadex, alumina-G, silica gel-A, silica gel-G. Microsomal particles immobilized on silica-gel G and alumina-G (both of which containing about 13% $CaSO_4$) improved the yield of prostaglandin synthesized by repeated cycles of reaction and product isolation and thereby stabilizes the enzyme complex. Microsomal particles adsorbed on other adsorbing agents mentioned above have failed to improve the yield of prostaglandin showing that the presence of Ca^{2+} helps to stabilize the enzyme. Microsomes immobilized on silica gel G increased the product yield by 1.5 fold and enhances the half life of the enzyme complex 2.5-12 days.

(iii) *Tissue specific distribution of certain polyunsaturated fatty acids (prostaglandin precursors) in mammals* : Anirudha Aich and Dolly Ghosh (Supervisr)

It has been reported earlier that goat seminal vesicles as well as the subcellular fractions of this tissue (i.e. microsomes, plasma membranes, nucleus) contain considerable amount of eicosatrienoic acid, (homo-γ-linolenic acid i.e. 20 : 3, ω-6). This fatty acid is not commonly present in mamalian tissues and is known to be the substrate for the synthesis of PGE_1 as well as substrate for eicosatetraenoic acid (arachidonic acid, i.e., 20 : 4 ω-6', whereas arachidonic acid is known to be the substrate for PGE_2. To find out whether this fatty acid is a controlling factor for prostaglandin biosynthesis at the substrate level, the fatty acid composition of different goat tissues as well as tissues other mammals like rat, rabbit have been analysed. The tissue where prostaglandins are synthesized as in seminal vesicles (here PGE_2 synthesis takes place) in aorta (PGI_2 synthesis occurs) eicosatrienoic acid (20 : 3ω-6) is present in considerable amount compared to arachidonic acid. Percent of homo-γ-linolenic acid and arachidonic acid in seminal vesicular glands and aorta in mammals were as follows :

Goat seminal vesicles (6.0 and 6.5) rat seminal vesicles (2.5 and 3.0) rabbit seminal vesicles (5.0 and 6.0), goat aorta (2.5 and 2.0) rat aorta (2.5 and 4.0) rabbit

aorta (2.5 and 5.5). In other tissues of the above mentioned mammals liver, heart, kidney and testes or only traces of homo-γ-linolenic acid could be detected. In these tissues average percent of arachidonic acid ; liver (7.0 , heart (5.0), kidney (6.5), testes (9.0).

O. Chemical and Biological Studies on Biomembranes :

(i) *Abnormalities in the erythrocyte membrane in acute lymphoid leukemia :* M. Kundu, J. Basu, M. M. Rakshit and P. Chakrabarti

Erythrocytes from patients suffering from acute lymphoid leukaemia (ALL) show decreased proportions of spectrin tetramers and altered spatial distribution of band 4·1 and ankyrins. These abnormalities of the cytoskeleton are probably responsible for altered membrane fluidity and transbilayer distribution of phosphatidylethanolamine in ALL. ALL is associated with severe anemia and usually, but not always, with overproduction of lymphocytes. To our knowledge, this is the first report of abnormalities in the erythrocyte membrane in ALL which may, in part, be responsible for the observed anemia.

(ii) *Erythrocyte membrane abnormalities in chronic myelogenous leukemia :* M. Kundu, J. Basu and P. Chakrabarti

Chronic myelogenous leukemia (CML) is a hematologic malignancy characterized by excessive growth of myeloid cells and their progenitors. CML is almost always associated with anemia. We have identified some abnormalities of the erythrocyte membrane which may be responsible for altered biological recognition of CML erythrocytes resulting in their premature removal from the circulation. CML erythrocytes are thermally more sensitive and contain an increased proportion of spectrin dimers compared to normal erythrocytes. Vesicles prepared from them show reduced ankyrin binding ; suggesting possible alteration in the cytoplasmic domain of band 3 (CDB3). Possible alterations in primary sttucture of CDB3 were ruled out since CDB3 isolated from CML band 3 showed the same K_i of inhibition of ankyrin binding to vesicles as normal CDB3. Using anti-band 3 antibodies, no unusual proteolytic fragmentation of CML band 3 in vivo was observed. Possible conformational alterations in band 3 are being investigated.

(iii) *Characterization of a phospholipid transfer protein from Neurospora crassa :* J. Basu, M. Kundu and P. Chakrabarti

Phospholipid transfer proteins have the ability to transfer phospholipids between both natural and artificial membranes. They have therefore been proposed to play an important role in the intracellular movement of phospholipids and function in membrane biogenesis and maintainance of steady-state levels of phospholipids. They have been purified from animals, plants, bacteria and yeast. We report for the first time, the purification of a phospholipid transfer protein (PLTP) from a filamentous fungus, *Neurospora crassa*. This PLTP has been purified to homogeneity from the post-microsomal supernatant of *N. crassa* by fractionation of DEAE-cellulose, Sepha dex G-75, and chromatofocusing in the pH range 4-7. The purified protein was found to transfer phosphatidyl choline between membranes, had a M38 KDa and required -SH, free amino and tryptophan residue for maintenance of transfer activity. Its role in membrane biogenesis is under investigation.

(iv) *Studies on human uterine tumor :* Subhansu Ray and P. Chakrabarti (Supervisor)

Human uterine tumors at different stages of development and different pathology have been collected from hospital patients and investigated for the presence of oncogenic lipids. The whole tissue have been homogenised for extraction of lipids. Total lipids have been separated into neutral lipids and phospholipids using different techniques. The phospholipid portions have been separated into individual sub-classes. These individual sub-classes have been subjected to alkaline hydrolysis and different fractions collected. The phosphatidylcholine and phosphatidyl ethanolamine fractions of fibroid tumor have been found to contain significant amount of their ether analogs, Ether lipids could not be detected in some type of tumors (e.g. myoma tumor). The fatty acids from both phospholipids and glycerides are being analysed to identify the presence of the eicosanoid family of fatty acids. Further investigation is in progress to detect the above interesting lipids in other types of uterine tumors and to study the enzymes involved in their bio-synthesis.

(v) *Investigation on lipids of goat sperm plasma membranes during various stages of epididymal maturation* : Gopal C. Majumder, (IICB), Suniti Misra (Calcutta University) and Amitabha Ghosh (Supervisor)

Detailed investigations have been made on the variation of lipids of goat sperm plasma membranes obtained from caput, corpus and cauda regions of epididymis. Neutral lipids as well as the phospholipids have been studied thoroughly. Lipids from the inner and outer leaflets of the membranes were also investigated by using various probes and enzymatic techniques.

(vi) *Regulation of membrane structure and function during seasonal adaptation in Channa punctatus :* Ramaballav Roy, Dolly Ghosh (Supervisor) and Prof. A. B. Das (Supervisor) Visva-Bharati University, Santiniketan

The membrane fluidity and the fatty acid composition of the brain membranes (viz. synoptosomal, mylein and mitochondrial membrane) of summer-adapted and winter-adapted fishes, *Channa punctatus* have been conducted. The role of environmental temperature causing the seasonal reorganization of the fatty acid profile and the lipid composition of both summer-and winter-adapted fishes, have been assayed by acclimating the summer-adapted fishes to low temperature and the winter adapted fishes to high temperatures. During warm adaptation either nature or in laboratory, the membrane become rigid compared to that of cold adapted fishes, as observed by polarization values measured by DPH-fluorescence. The increase in rigdity of the membrane resulted in the increase of total saturated fatty acid and a decrease in the ratio of n-3 fatty acid to n-6 fatty acid. The results support the 'homeoviscous adaptation' of the membrane during seasonal adaptation of the fishes.

P. *Macromolecules-Studies on Transport Enzymes*

(i) *Biochemical characterization of a Ca^{2+}-ATPase from goat spermatozoa :* Rita Sikdar and Parimal C. Sen (Supervisor)

We have previously reported the presence of both Mg^{2+}-dependent and independent Ca^{2+}-ATPase enzyme activity in the microsomal membranes of goat spermatozoa. In our study we have found that both Mg^{2+}-dependent and independent Ca^{2+}-ATPase activities are inhibited by different calcium channel blockers e.g. verapamil, diltiazem and nifedipine in a concentration dependent manner. The dependent enzyme is more sensitive to these inhibitors. Trifluoperazine, an active calcium transport inhibitor, has been found to inhibit the independent enzyme activities which led to believe that ATPase plays some role in Ca^{2+} transport. Modification of functional groups viz. $-NH_2$ or -SH group of enzyme are found to inhibit ATPase activities. We have found that $-NH_2$ group specific probe TNBS inhibits both enzyme activities whereas -SH group specific probe DTNB at lower concentration stimulates but at higher concentration significantly inhibits the Mg^{2+} dependent enzyme activity, whereas only a slight inhibition was observed with Mg^{2+} independent enzyme. The stimulation by DTNB at a lower concentration may be due to the binding of non-essential -SH group(s) which when react facilitates the binding of ATP and/or ligand thus led to the increasein activities. At a higher concentration the probe

reacts with -SH group(s) which inhibits the dependent enzyme more than the independent enzyme indicating different role of -SH group(s) on these two enzymes.

(ii) *The Interaction of Chloroquine with transport enzymes in different organs of rat in vivo :* S. Chandra and Parimal Chandra Sen (Supervisor)

Chloroquine, a potent antimalerial drug was found to inhibit different transport enzymes like Na^+-K^+-ATPase, Ca^{2+}-ATPase, acetyl choline esterase, PNPPase in the microsomal membrane of different organs of rat *in vivo* on time and in concentration dependent manner. The inhibition of the enzyme activities was reversed back to the normal level after one week of the cessation of drug injection. The lipid composition of the different organs just immediately after the drug injection and after the withdrawal of the drug was also studied and found almost similar to both of the cases. The study got an important pharmacological significance since chloroquine affects adversely some of the enzyme activities.

(iii) *The interaction of chloropromazine with transport enzyme in different organs of rat in vivo :* G. Adhikary and Parimal C. Sen (Supervisor)

Chlorpromazine is a potent amphiphilic drug used as male contraceptive. It has been found that chlorpromazine strongly inhibit the activity of membrane bound enzymes like Na^+-K^+-ATPase, PNPPase, Acetyl thiocholine esterase Mg^{+2}-dependent and Mg^{2+}-independent Ca^{2+}-ATPase *in vivo* system. Injecting this drug to different set of rats, it has been found that after certain interval of time all these enzymes activity comes to normal level. Due to drug injection cholesterol content also increases, after certain interval it comes to normal basal level. The fatty acid content and fluidity profile change of membrane also studied which strongly correlate the inhibition of enzyme activity and the withdrawal effect of the drug. This experiment has great pharmacological significance in the sense that chlorpromazine inhibit the membrane bound enzymes on dose dependent manner and the adverse effect removed after certain interval of time.

Q. *Studies on Host-Virus Interaction.*

(i) *Studies on a host killer (hk) mutant of bacteriophage lambda :* S. Maiti and N. C. Mandal (Supervisor)

The mutation earlier referred to as *sk* (super killer) has now been renamed *hk* (host killer). In continuation of the work on the understanding of the mechanism of

host lethality by the above mutation, it has now been conclusively proved that this mutation by itself does not have any host killing effect. By DNA sequencing, this mutation has been shown to change a single base from G to A replacing glycine by glutamic acid at the 48th codon of *cro* gene of lambda. The plasmids pMR24 and pMR45 were constructed by cloning the segment of DNA from the middle of *c*I gene to the right of *t*R2 flanked by HindIII and BamHI sites from the wild type and *hk* mutant lambda respectively. Extensive studies were made using those plasmids as well as their various derivatives having restriction deletion of different genes like *P*, *O cII*, *hk-t*Rl, *cro*, *nin*5 region ; results of these studies show that the host killing is absolutely dependent on functional *P* gene only, and for showing the killing effect, the *hk* mutation is not needed if the expression of *P* gene is increased by deleting the transcription terminator *t*Rl. The result that host killing by P is shown in absence of functional *O* gene proves that this type of lethal action of P is not dependent on lambda DNA replication. Using the plasmids constructed by cloning 651 bp *hk-t*Rl segments from both wild type and *hk* mutant lambda between *lac* promoter and *gal* K gene in pMZ240, it has been shown that the *hk* mutation does not have any *cis* type of effect on termination at *t*R1 of transcription from *p*R. The above HindIII-BamHI segments from wild type and *hk* mutant lambda were cloned immediately upstream of *galk* in pKOTWl. Assay of galactokinase using those plasmids as well as those derived by deleting different terminators *t*R1 and *t*R2 from them, show that the expression of galactokinase has been increased 7-8 fold in presence of *hk* mutation compared to that in its absence. All these results suggest that the *hk* mutation actually affects the negative regulatory property of cro at *p*R which increases the total transcription from this promoter, and since the fraction of the *p*R transcript being terminated at *t*R1 is constant (≈65%), the fraction of the above increased transcription from *p*R continuing beyond *t*R1 (≈35%) in presence of *hk* mutation is increased which in turn expresses *P* at higher level to show lethal effect.

Now, to identify the component(s) in the host which is (are) the target(s) of lambda P for its lethal interaction, attempt is being made to isolate host mutants which would be resistant to lambda *P* lethality.

(ii) *Genetic studies of the control of lysogenic and lytic developments of temperate mycobacteriophase L1.* : Subrata Sau, Biswendu Chowdhury and N. C. Mandal (Supervisor)

Mycobacterial genetics is poorly developed. One of the several reasons for this being the lack of suitable well studied vector which can be utilized in mycobacterial

gene transfer. We are particularly interested in studying genetically the temperate mycobacteriophage L1 with respect to its properties that would be helpful in developing suitable vector for use in mycobacterial gene transfer. This phage has wide host range and has certain similarity with coliphage lambda. Our initial aim is to study the control of lysogenic and lytic developments and identify essential gene functions involved therein.

To study the control of lysogeny, an attempt has been made to isolate temperature sensitive mutations in the repressor gene of L1 and study their properties. For this, the lysogen of L1 in *M. smegma* mc²6 (a sub-strain of ATCC 607 obtained from B. Bloom) was mutagenized with NTG to less than 1% survival by standard procedure and then grown to saturation. The culture was then induced at 39°C to lyse the temperature-sensitive lysogen. From the phages in this lysate, two mutant L1 have been isolated which produced turbid plaque at 32°C and formed clear plaque at 38°C. These two mutants do not complement each other in forming turbid plaque at 38°C indicating that the mutations are in the same gene and possibly in the gene coding for repressor. Using lysogens of these L1 mutants several parameters relating to growth of the phage have been studied. More mutants of L1 are being isolated which would be defective in lysogeny and belong to different complementation groups, and these would help in identifying the regulatory circuit for the lysogenic development.

The study of the regulation of the lytic development of L1 was initiated by the isolation of *ts* mutlants defective in growth at 41°C. The wild type L1 does not plate well at 41°C. So first an L1 mutant forming clear plaque at 32°C was isolated, and from this a strain was again isolated which forms normal clear plaque 41°C. This last phage variant was then mutagenized with hydroxylamine to around 0.1% survival. This was then assayed at 32°C. After incubation for about 20 h when the plaques were visible as tiny ones, the plates were transferred to 41°C and incubated for another 20 h. The prospective mutants with *ts* growth character were then isolated from among the plaques which remained tiny after 20 h incubation at 41°C. In this way 4 growth defective *ts* mutants have been isolated which complement each other. This indicates that all four mutants have mutation in 4 different genes all essential for lytic growth. All these 4 *ts* mutants revert to wild type phenotype at the frequency range of $10^{-6} - 10^{-7}$. More mutants of this type are being isolated. (Supported by CSIR, Govt. of India).

R. *Studies on Structure, function and dynamics of lambda repressor* :

(i) *Studies on the mutant repressors of lambda with genetically altered affinities* : Rina Saha, Nandan K. Jana, B. Bhattacharyya, S. Roy and N. C. Mandal (Supervisor)

Studies of the properties of mutant repressors of lambda with altered affinities for its operators and identification of the change of amino acids by sequencing would help understanding the structure and function relationship of this gene regulatory protein. Various *ts* mutations in the *c*I gene impose conditional reduction in the affinity of the repressor for the operators. To identify the amino acid changes in these mutant proteins and to study the properties of the purified proteins *in vitro*, these genes are being cloned in a high expression vector. This work is in progress. (partly supported by CSIR, Govt. of India)

(ii) *Biophysical studies on the higher order structure of lambda repressor* : Rina Saha, N. C. Mandal, S. Roy and B. Bhattacharyya

In continuation of the study of the structure and function relationship of lambda repressor using an external fluorescent probe bis-ANS, further work has been done with purified N-and C-terminal domains of the wild type repressor. Papain digestion of the lambda repressor produces two large fragments. One includes the amino terminus (residues 1-92) and the other the carboxyl terminus (132-236). The N and C termini were separated by column chromatography. Purified N terminal and C-terminal domains were separately titrated with bis-ANS and enhancement of bis-ANS fluorescence was observed with C-terminal domain only. Change of fluorescence in the case of N-terminal domain was exactly same as that of control. This clearly indicates that bis-ANS binds exclusively to the C-terminal domain of lambda repressor. We also found earlier that when bis-ANS repressor complex is titrated with operator DNA, there is enhancement of bis-ANS fluorescence which implies that upon DNA binding to N-terminal domain a conformational change occurs which is transmitted to the C-terminal domain. Supporting experiment proves that this change is due to the lowering of dissociation constant of bis-ANS/repressor complex.

S. *Tubulin substructure and identification of its functional domains* : Krishnendu Mukhopadhyay, Dipta Bhattacharyya, Dulal Panda, Manjari Mazumder, S. Roy and B. Bhattacharyya (Supervisor)

We have been interested in understanding the substructural organization of tubulin with respect to the diverse interactions related to its biological functions.

The regulatory role of the highly negatively charged C-termini of tubulins in colchicin binding was studied. By controlled digestion of tubulins with the protease subtilisin, 15 amino acid residues from C-termini of either both the subunits (forming truncated protein tubulin S) or from β only were removed. Results of the comparative studies of the colchicine binding properties of the above digested proteins and the native tubulins indicate that the regulatory switch for colchicine-tubulin interaction is located within the 15 amino acid of the C-terminus of the alpha subunit. Further studies employing quenching of intrinsic tryptophan fluorescence as well as various experiments with an extrinsic fluorescence probe, bis-ANS, demonstrated a major change in conformation of tubulin upon cleavage of its C-termini.

Studies of tetramer-dimer and dimer-monomer equilibria and effect thereon of different drugs, colchicine, colcemid and divalent cation should give us better understanding of polymerization properties, tetramer-dimer-monomer geometry and differences in structure and behaviour of tubulin and tubulin S.

Dimer-monomer equilibrium may be shown as follows :

$$\alpha\beta \rightleftharpoons \alpha + \beta$$

$$K_D = \frac{[\alpha][\beta]}{[\alpha\beta]}$$

Where K_D is the dimer monomer dissociation constrant.

Tubulin was separately labelled with two different fluorescence probe fluorescein 5-maleimide (FM) and 7- diethylamino-3 (4)-maleimidyl (phenyl) 4 methyl coumarin (CM). The FM-labelled tubulin when mixed with CM labelled tubulin, subunit exchange takes place and hybrid tubulin dimers are produced according the following reaction :

$$\alpha^{FM}\beta^{FM} + \alpha^{CM}\beta^{CM} \rightleftharpoons \alpha^{FM}\beta^{CM} + \alpha^{CM}\beta^{FM}$$

Now the fluorophores CM and FM in hybrid dimer are in proximity for enrgy transfer to take place. But on dilution when the equilibrium is shifted towards monomer there will be no subunit association when the concentration is reached below a critical value. Now the fluorephores FM and CM are not in proximity for energy transfer to take place. So a plot of energy transfer Vs log of tubulin concentration produced a sigmoidal curve indicating tubulin dimer dissociation on dilution. From this plot K_D was determined. Similar Studies with Tubulin S are in progress.

The -SH groups present in goat brain tubulins (both α and β) have been determined according to Elman's method by titration with Dithiobisnitrobenzoic acid (DTNB). Results show that there are 20 sulphydryl (-SH) groups per molecule of

each tubulin. Both native and urea denatured tubulin have been show to contain the same total of -SH groups. This indicates that all the 20 -SH groups are in exposed condition. For the purpose of doing some physical studies of the colchicine binding site, the -SH groups present around this site have been labeled with some sulphydryl specific fluorescent probes viz., FM (fluorescein-5-maleimide) and 1,5-IAEDANS (2- (iodoacetyl) amino ethyl aminonaphthalene 5-sulfonic acid. By determining the fluorescence of these bound fluorephores, we have done Weber-perrin plot and calculated the correlation time of the fluorophores attached around the site as 33 nsecs.

Fluorescence quenching experiments of that site has been done using acrylamide as the quencher substance. From these experiments it could be concluded that the colchicine binding site of tubulin is not totally rigid but has some flexibility and about 50% of this domain is exposed to environment.

Aminonaphthalene compounds 1,8-ANS, bis ANS and PRODAN are efficient fluorescent probes for hydrophobic pocket of proteins and these bind to tubulin and inhibit its assembly into microtubules. The fact that bis-ANS has been shown to bind at multiple binding sites on tubulin made it difficult to establish which site is responsible for the inhibition of self-assembly. Therefore in an attempt to search for suitable fluorescent aminonaphthalene drug which would inhibit polymerisation but would bind to tubulin with a stoichiometry of 1 : 1, show a comparative study of the interactions of ANS, bis-ANS and PRODAN with tubulins has been done. The measurements of binding parameters like dissociation constant and stoichiometry reveals that Prodan binds to tubulin with a K_D of 20 μM and stoichiometry of 1 : 1. Fluorescence polarisation measurement indicate that all the aminonaphthalenes bind to tubulin at a rigid site and solute quenching experiments show that the binding sites are shielded from the solvent. A competetion experiment using ^{3}H-ANS for the first time clearly demonstrated that ANS, bis-ANS and prodan binds to a common site on tubulin. According to the microtubule polymerisation inhibitory potential, these probes can be arranged as prodan$\cong$bis-ANS-$\geqslant$ANS.

(These works were supported by CSIR, New Delhi).

T. *Initiation of DNA Replication in the yeast S. cerevisiae* : Alo Pal, Amit Maiti, Nilanjan Roy and Pratima Sinha (Supervisor)

We have been trying to identify genes coding for proteins needed to initiate and / or regulate the initiation of DNA replication on the genome of this yeast. To this end we had earlier isolated several mutants which could not maintain yeast

minichromosomes carrying different ARSs+ (*mcm* mutants). A class of these *mcm* mutants maintained the minichromosomes depending upon the ARS present. It was suggested that the ARS-specific *mcm* mutants could code for initiator proteins.

Here we are trying to characterize one such ARS-specific mutant, M46, carrying the mutation *mcm2*. Our aim is to determine whether the *mcm2* locus codes for an initiator protein that is defective in M46. One approach is to study the stabilities of yeast chromosomes in this mutant. We could (i) delete one or more ARSs from a chromosome ; (ii) add one or more ARSs and ask the questions—does deletion of an ARS decrease the stability of this chromosome in the mutant more than that in the wild type ? Also, does addition of more ARSs increase the stability of this chromosome in the mutant strain while not appreciably changing the value in the wild type. If so, the results would be indicative of the mutant strain suffering from a lack of functional ARSs. Several ARSs were introduced, one at a time into a 60 kb ring chromosome (derived from chromosome III) that was unstable in the mutant. It was found that the addition of functional ARSs in this chromosome stabilised it in the mutant strain—an observation consistent with the conclusion that the mutant M46 is indeed unable to initiate replication efficiently at its chromosomal origins. Deletion experiments are in progress.

We have also studied the maintenance of an endogenous plasmid, the two micron (2 u) circle, in this mutant. It has been found that even this plasmid needs the *mcm*2 gene produced for its replication. During the course of these experiments the mutant was found to lose another extrachromosomal element. Studies on the loss of this element are in progress.

We are also studying two ARS-nonspecific mutants, *mcm*25 and *mcm*51, wiih a view to determine the cause of minichromosome instability. Preliminary results indicate that *mcm*25 may affect the maintenance of linear plasmids more than that of the circular one. Efforts are on to clone their genes so that it gets easier to understand the mechanism of action of their gene products. (Supported by CSIR, New Delhi).

U. *Study of Molecular Organization of Tubulin Genes* (α & β) *in Mimosa pndicaa* : Asis Roy Choudhury and Susweta Biswas

We have characterized the α and β tubulin genomic organization in *M. pudica* genomic DNA. When *Mimosa pudica* DNA was digested with HindIII, BamHI,

+ ARSs are believed to be chromosomal replication origins.

EcoRI, Pst I, Xba I and hybridized with ^{32}p labelled pT ∝ 221 (chicken ∝ tubulin cDNA clone) and pTB581 (chicken β-tubulin cDNA clone), both of them hybridized with a genomic DNA fragment of≂23 kb. This indicates that ∝ and β genes of *M.pudica* are organized in cluster and not in random fashions. That the Hybridization with a single band is not due to incomplete or partial digestion of *M. pudica* DNA is checked by staining after the run with ethidium bromide. All these enzymes do not have any site within this 23 kb fragment. The result shows that the probes hybridized with a large fragment (≂23 Kb) ; the actual size and number ofl copies of ∝ and β tubulin genes per haploid genome of *M. pudica,* is however, not known. Next, we want to clone the 23 Kb fragment of DNA containing both ∝ and β genes through ∝ packaging and finally sequencing in order to study the actual structure and organization of tubulin genes in *M. pudica*.

V. *Substrate-profile of a novel beta-lactamase enzyme of A. brasilense RG and expression of the beta-lactamase* (*bla*) *gene in different Gram-negative bacteria :* Sib Hari Dutta, Sudip Chattopadhyay and S. Ghosh (Supervisor)

We have previously reported that *A. brasilense* cannot express TEM-2 type beta-lactamase coded by Tnl of the promiscuous plasmid RP4, though it satisfactorily express as its own *bla* gene (Dutta & Ghosh, Plasmid, 1988, *22*, 298).

We have determined the substrate-profile of this novel beta-lactamase using twelve beta-lactam antibiotics (seven penicillins and five cephalosporins) as substrate and crude extracts of the wild type *A. brasilense* RG cells as the source of the enzyme—it was found to be a cephalosporinase type beta-lactamase (CEP-enzyme). One other important property of this novel beta-lactamase is that, unlike RP4 (Tnl) specified beta-lactamase in *E coli*, nearly 50% of the enzyme activity is leaked into the growth medium of *A. brasilense* RG as growth reaches the stationary phase.

Using the pLAFRI cosmid genomic library of *A. brasilense* constructed in our laboratory, we have also identified a clone containing the *bla* gene of *A. brasilense* by complementing a *bla*$^-$ mutant of *A. brasilense* RG. The pLAFR1 cosmid vector with the *bla*$^+$ insert was isolated from the complemented *A. brasilense* RG-D16 (pLAFR1-*bla*$^+$) strain, *E. coli* S17.1 was transformed and the pLAFRI-*bla*$^+$ plasmid was transferred by conjugation from the transformed *E. coli* S17.1 to other Gram-negative bacteria including *A. tumefaciens*, *R leguminosaram* and *A. brasilense* RG-D16. *A, brasilanse* RG-D16 Ap^r (bla$^-$) on receiving the recombinant pLAFR1-*bla*$^+$ by

conjugation from *E. coli* S17.1 becomes Ap-resistant and expresses the *bla*$^+$ gene as usual. *E. coli* S17.1 and *A. tumefaciens* failed to express the gene ; however, *R. leguminosarum* su391 was found to be capable of expressing the *bla*$^+$ gene of *A. brasilense*. Hence, we conclude that expression of *bla*$^+$ gene of *A. brasilense* is host-specific.

W. *Cloning and Characterization of Repetitive DNAs from farm Animals :* Sk. Golam Faruk and P. Gupta (Supervisor)

Genomes of higher eukaryotes contain multiple copies of related DNA elements that form families, members of which may be reiterated from 10 to 10^6 fold. Functions of such repetitive DNAs are still not conclusive. Repetitive DNA sequences are classified into two major groups : 1. Tandem repeats and 2. Interspersed repeats. A 550 bp long Pst I family of repeats has been identified from four different economically important livestock species viz., goat (*Capra hircus*), sheep (*Ovis aries*), cattle (*Bos taurus*) and buffalo (*Bubalus bubalis*). The Pst I repeat of goat does not cross hybridize with previously reported 870bp goat EcoRI tandem repeat. Complete nucleotide sequence of the previously reported pig (*Sus sorofa*) Sau3A 142 bp repeat showed considerable homology with another interspersed DNA element of miniature swine. Two internal Sau3A sites are spaced after 47 bp and this sequence is moderately GC rich. Computer search for open reading frame (ORF) predicted a full length transcript. Northern analysis is being carried out to check this prediction.

Similarly, a 140 bp Tag-I repeat from cattle genome has been identified, cloned and sequenced. This sequence has several internal repeats and the predicted secondary structure of the RNA shows dyad symmetry.

X. *Genome organisation of the Indian Breed of Murrah Buffalo* : R. Srinivasan and P. Gupta (Supervisor)

Total genomic DNA was isolated from the peripheral blood lymphocytes drawn from the jugular vein of Murrah buffaloes. Purified DNA was digested with several restriction endonucleases, electrophoresed on 0·8% agarose, blotted and probed with radiolabelled housekeeping genes like G6PD and HPRT from other mammalian species. Hybridization conditions have been modified to pull out the homologous sequences for G6PD and HPRT genes from buffalo genomic library.

Y. (i) *Fundamental of Chemotherapy at molecular level* : Indrani Dey, Goutam Biswas, Albert Gomes, Sampa Pain, R. Banerjee (Jadavpur University) and Asok Banerjee (Supervisor)

This is an exciting project encompasing molecular biology, X-ray crystallography and medical Science. Structural and Conformational features of a series of nucleoside analogs and β-lactams (both active and inactive) have been investigated, tabulated in a data-base in order to investigate the structure-activity relation. An understanding has been achieved in terms of conformation of functional groups in the interaction mechanism in a typical nucleoside and β-lactam system.

A new series of anti protozoa drug analogs are being investigated with success.

(ii) *Studies on specific drugs and Drug-DNA complexes :* Bankim Das, A. C. Gomes, B. Das (Vivekananda College) and Asok Banerjee.

Studies on several drugs and Drug-DNA complexes are continuing. Structure of several planar and non-planar drugs have been modelled and their mode of interaction with DNA is studied. The X-ray diffraction technique along with Computer modelling and solution study is proving fruitful.

(iii) *Studies on Mycobacterium Cell wall constituents* : Sampa Pain, A. Bera, M. Das, Asok Banerjee

(a) Exhaustive modelling studies have been done to understand the conformation and structure of cell wall constituents. Interesting insight (a Pseudo twofold symmetry) is achieved on peptidoglycan structure, a major cell wall component of mycobacteria. Further work is in progress.

b) 3-dimensional structure determination and characterisation of some modified β-lactam analogues and their mode of interaction with bacterial cell wall component β-lactamase have been studied by biophysical methods and computer aided molecular modelling.

We have already solved crystal structure of a modified β-lactam analogue and another two are in progress. The solved structure is communicated and accepted in the Journal 'Acta Crystallographica'. The Crystal Structure of β-lactamase from S. Aureus PCI. Science Vol. 236, pp 694-701, (1987) by Osnat Herzberg & J. Moult) is loaded in our Quanta-Charmms Programme in Iris Workstation. We are now interested to find out the conformational necessity of the subtrate β-lactam

antibiotics for binding to the active site of the β-lactamase. This has a potential promise in designing a suitable inhibitor which will preferentially bind to the active site of β-lactamase but will not dissociate fast. We contemplate to do spectroscopic (UV) investigation for drug binding affinity of β-lactamase with different modified β-lactams, both active & inactive. We envision to get a correlation of activity and conformation from these valuable data.

(iv) *Studies on bio-critical phenomena/nucleic acid, protein and protein-nucleic acid interaction :*

(a) *DNA base pair schemes and transition characteristics* : Bankim Das, B. Das, G. Biswas and Asok Banerjee (Supervisor)

Critical studies on DNA Polymorphic forms and their transition topology in relation to structure and function are continuing. A rule and probable role of the base pairs in transition topology is highlighted.

(b) *Protein Crystallography* : Bankim Das. G. Biswas, Sampa Pain, N. K. Sinha (Chemistry) and Asok Banerjee.

Plant protease Calotropin DII is crystallised. The total characterisation of the protein via column Chromatography is done in the Department with help of Chemistry Dept., Bose Institute. The Crystals are screened for preliminary checking and the optimised enzyme crystals are ready for X-ray data, work is in progress.

Z. (i) *Structure and Conformation of λ-repressor* : Utpal Banik, Sumita Banerjee, Rina Saha, B Bhattacharyya, N. C. Mandal and Siddhartha Roy.

Repressor consists of two domains, N and C-terminal domains. N-terminal domain is known to interact with operator DNA and the C-terminal domain is thought to play an important part in co-operative interaction between two DNA bound repressors. Using a non-Covalent fluorescent probe. Bis-ANS, we have shown that upon binding to DNA a conformational change takes place which is transmitted to the C-terminal domain.

Progressive urea denateration has revealed that the C-terminal domain denatures in two phases : One in relatively low urea two, in very high urea which follows subunit dissociation. Studies with isolated repressor domain has indicated that C-terminal domain may be interacting with the hinge or the N-terminal domain in the intact repressor. We have also labeled the repressor with dansyl chloride and studied

the dimer-tetramer equillibrium and its thermodynamics. The tetramerization is thought to play important role in co-operativity.

(ii) *Glutaminyl tRNA Synthetase/tRNAglu interaction :* Tista Bhattacharyya, Anushree Bhattacharyya and Siddhartha Roy

Glutaminyl tRNA synthetase is different fron *most other* tRNA Synthetases from the point of view that it does not Catalyze Pyrophosphate exchange. The molecular and mechanistic basis of this anomaly is not understood and neither is its biological and evolutionary implication. We have looked into this aspect by first looking tnto substrate binding properties of this enzyme. We have studied ligand binding by quenching of the protein fluorescense upon substrate binding. Such studies revealed that all the substrates bind more or less independently indicatin, lack of binding of ATP and Glutamine in the absence of tRNA is not the reason for lack of pyrophosphate exchange. Alkyl AMP (Phosphodiester) binds tightly to tRNA synthetases which Catalyze pyrophosphate exchange mimicing the intermediate amino-acyl adenylate. Methyl AMP (Phosphodiester) however has only a very weak affinity for the enzyme in the presence and absence of tRNA indicating amino acyl adenylate could only be an unstable intermediate.

Since tRNA is known to promote pyrophosphate exchange in this enzyme we have investigated whether tRNA binding produces a global conformational change in this enzyme. Using Bis-ANS and Pyrene labeled Glutaminyl tRNA Synthetase we have shown that there is no detectable evidence of a global conformational change. Thus any tRNA promoted conformational change is likely to be localized at the active site.

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Institutional Project No. IV : Studies on ecology Environmental pollution and related health problem

A. (i) *Immunization status of human children* : Debasis Ghosal and A. K. Barua (Supervisor), in collaboration with Goutam Ghosh, Rupali Dey, Ratna Majumdar, Institute of Child Health, Calcutta

A study to assess the efficacy of the extended programme of immunization among children (age group 2 to 10 months) brought to the Institute of Child Health, Calcutta was undertaken. Anthropometric measurements were taken and blood was collected prior to 1st dose of oral Polio vaccine and again after 3 doses of OPV and 2 doses of DPI vaccines. Immunoglobulin levels (IgG, IgM and IgA) were measured by RIA and Hb%, DC, TC and neutrophil and lymphocyte (T & B) enzymes and B cell surface Igs were assayed. Result showed that 73%, 33% and 13% children (age 2—3 mo) had little or no change in their IgA, G, M levels respectively, inspite of immunization, of which 66% and 46% had pre and post immunization IgA level $\leqslant$21·4 mg%. 83% children (age 3—4 mo) have preimmunization IgA$<$30·0 mg% though post immunization status in all the Igs were higher ($p<0·05$). 40%, 33% and 33% children of age groups 5—6, 7—12 and 24—60 mo respectively showed suppression in postimmunization IgG, A levels than their preimmunization state. Results seem to suggest that children having Hb% $<$10·0 Gm were prone to be deficient in Ig levels specially in their IgA conc. No correlation to this effect with blood protein concentration, body wt. or height was found ; mid arm circumference value has some direct correlation with blood protein levels. The study on enzymes are underway.

(ii) *Studies on a bone marrow derived bio-immunomodulator on AFS tumorogenesis in Swiss albino mice* : Debasis Ghosal and A. K. Barua (Supervisor) in collaboration with S. K. Roy and Subha Manna (Department of Microbioloy)

We have reported earlier that a bone marrow derived factor plays an immunododulatory role in malnourished immunosuppressed animals. This factor is now believed to be having a suppressive role in the development of Ascites fibro Sarcoma in mice. Further study is in progress.

B. *Studies of biochemical function of phytochemicals* : D. P. Chakraborty (and post workers Mala Roy, K. K. Mohanty and Shyamali Roy)

(i) Finalisation of the structures of Tricoxanthiol and Xanthindiol two bioactive constituents of *Tricoxanthes diocea* have been confirmed by their ^{13}C NMR spectrum.

(ii) Oxygen heterocycle with growth inhibitory properties have been isolated and its part structure has been arrived at. (Collaborative work with Botany Department, Calcutta University).

(iii) A new pyranocarbazole alkaloid with biological activity has been isolated from a member of the family Umbelliferae (collaborative work with Botany Department, Calcutta University).

C. *Studies in relation to vitiligo* :

Further studies in this area have revealed that some inhibitors may inhibit the enzyme tyrosine hydroxylase.

D. (i) *Volumetric aeropalynology of Central Calcutta (Bose Institute)* : Sunirmal Chanda (Supervisor) and Swapna Banik

Qualitatively 65 types were observed in the year 1985-86 and 70 types in 1986-87. Both the years showed the presence of the pollen of *Trema*, Grass and Cyperaceae as dominant types. In 1985-86 peak incidence of pollen were observed in the month of May followed by September and August and in 1986-87 highest frequency occurred in the month of August followed by May and September. The volumetric mean concentration of pollen grains in the atmosphere of Central Calcutta for the year 1985-86 has been 0·0045/litre and for 1986-87 it has been 0·0063/litre, i.e. 10,000 litres of air contained 45 pollen in the 1st year and 63 grains for the 2nd year.

(ii) *Comparative aeropalynology of Calcutta (urban) and Madhyamgram (semirural) using vertical cylinder trap* : Sunirmal Chanda (Supervisor) and Swapna Banik

Madhyamgram (semirural area) showed higher pollen concentration (total 9720) than urban area i.e. Central Calcutta (total 4068). Urban area was domi nated by tree pollen with some dominating herbaceous types whereas in semirural area herbaceous types showed higher frequency. In urban area Poaceae was followed by *Trema orientalis* and *Cocos nucifera* and in semirural area Poaceae was followed by Cyperaceae and Ama-chenopodiaceae group. Regarding monthly concentration highest incidence in urban area were observed in January and in semirural area in September.

(iii) *Chemical and clinical analysis of some allergenic pollen grains* : Sunirmal Chanda (Supervisor), Swati Gupta, Pabitrananda Ganguly, Indrani Kundu (Institute of Child Health, Calcutta).

A few allergenic pollen were chemically analysed including its protein compo nents by gel electrophoresis. The pollen grains of *Datura metel*, *Carica papaya*, *Cocos nucifera*, *Azadirachta indica* show high protein content. Work on lipid content of these varieties is in progress.

Skin tests were done with the antigens of the said pollen grains. *Cocos nucifera* followed by *Azadirachta indica*, *Carica papaya* showed a high number of positive reactions. Clinically one out of six patients showed ELISA positive reaction to *Parthenium* pollen. The work is in progress.

(iv) *Aerobiological studies in the Salt Lake City* : Sunirmal Chanda (Supervisor) Swati Gupta

An aerobiological survey using Burkard seven day automatic volumetric sampler was done in Salt Lake City for one year. A total of 59 atmospheric pollen types were recorded. The most common types were Grass, Cyperaceae, *Trema*, Amaranthacese/Chenopodiaceae, *Areca*, *Azadirachta*, *Cocos*, *Emblica*, *Psidium*, *Phoenix*, *Mimusops*, etc. Pollen grains of *Parthenium* were also trapped from the air of Salt Lake but the frequency was found to be insignificant. Maximum concentration of pollen grains were encountered during spring. In rainy season lowest count was noted.

(v) *Aerobiology of Cooch Behar District, West Bengal* : Sunirmal Chanda (Supervisor) and Manas Ranjan Majumdar

A two—year aerobiological survey was carried out at Cooch Behar district using gravitational sampler from 1985-87. The data obtained have been analysed and concluded. The aeropalynological constituents showed a hetrogenous assemblage of exotic types, like *Alnus*, *Betula*, *Duabanga*, *Pinus*, *Quercus*, *Rhododendron*, etc., probably migrating from the Eastern Himalayas. The dominant pteridophytic spores and angiospermic pollen grains included, *Diplagium*, *Drynaria*, *Polypodium*, *Cannabis*, *Cassia*, *Terminalia*, *Eucalyptus*, etc. Aeromycological assemblage was represented by *Alternaria*, *Cladosporium*, *Curvularia*, *Drechslera*, *Periconia*, *Stemphylium*, etc. Meteorological parametres had a profound effect on the frequency of the different spore types.

(vi) *Further investigations on Quaternary Palaeoecology and Palaeoenvironment of Chilka Lake* : Sunirmal Chanda (Supervisor), Kashinath Bhattacharya (Deptt. of Botany, Visva-Bharati), S. C. Santra (School of Environmental Science, (Kalyani University) and A. B. Goswami (GSI, Eastern Region)

The Quaternary vegetational history of Chilka Lake showed almost identical spectrum of the extant freshwater aquatic vegetation. With the rise of salinity such fresh water elements either disappeared or got restricted to such areas where fresh water supply is still available.

The occurrence of mangrove elements like *Excoecaria, Suaeda, Salicornia*, etc., in Kaimundi formation at the depth of 2·3-3·3 m is interesting. This indicates that mangrove elements could grow in abundance in Kaimundi formation which provide the palaeo-expanse of the Lake.

E. *Degradation of chrome tanned leather by soil streptomycetes* : Sumana Das, and A. L. Chandra (Supervisor)

Streptomyces sp. 5W which tolerated 375μg/ml $K_2Cr_2O_7$ and degraded chrome tanned leather was isolated from soil. The organism was adapted in the laboratory to tolerate 1500μg/ml $K_2Cr_2O_7$ and was designated *Streptomyces* sp. 5M. 5M degraded chrome tanned leather to a greater extent than 5W. The optimum conditions for degradation were, pH 7.0. substrate concentration 6 mg/ml and incubation at 28°C for 6 days. Under optimal conditions 5W and 5M degraded chrome tanned leather and released 67.1 and 110.3μg glycine equivalents of amino nitrogen/mg of leather respectively.

F. (i) *Studies on glutathione S-transferase produced by Aspergillus ochraceus TS* : Jharna Datta and Timir B. Samanta (Supervisor)

The existence of the isozymes of glutathione-S-transferase isozymes (GST isozymes) in *Aspergillus ochraceus* TS was further substantiated by chromatofocussing. GST isozymes produced by *A. ochraceus* TS are apparently embeded in the microsomes as envisaged by protease treatment. Ionic, non-ionic and zwiterionic detergents were tried for solubilization of microsomes. Almost all the detergents inhibited the enzyme activity and solubilization was found to be partial. Microsomes were, never the less, solubilized by sodium cholate and dialysed against Tris-HCl buffer containing glycerol, EDTA and GSH. The dialysate was loaded on a chromatofocussing column equilibrated with the dialyzing buffer. The elution profile

showed four major peaks having glutathione S-transferase activity with pI values of 7.15, 7.5, 7.7 and 7.85, respectively.

(ii) *Purification of glutathione S-transferase produced by Aspergillus ochraceus TS* : Jharna Datta and Timir B. Samanta (Supervisor)

Isolated microsomes of *A. ochraceus* were solubilized by sodium cholate and were dialysed against phosphate buffer containing glycerol, EDTA and GSH (Buffer A). The dialysate was loaded on to a hydroxyapatite column. The protein eluted from hydroxyapatite column showed five peaks having GST activity against 1-chloro-2,4-dinitrobenzene (CDNB). The pooled fractions were saturated with ammonium sulfate (0-35% saturation). The pellet was dissolved in buffer-A and dialysed against the same buffer. The dialysate was then loaded on to a CM-cellulose column. The protein eluted from the column exhibited at least five peaks all having CDNB activity. Only two of them showed GST activity with ethacrynic acid used as second substrate. A 40-50 fold purification was achieved. Apparently microsomal GST in *A. ochraceus* TS accounts for approximately 2% of the total protein since the purified protein so obtained is believed to be nearly a homogeneous preparation. In fact, all the peaks upon SDS-PAGE showed single band and migrated in a manner corresponding to a molecular weight of about 10 kDa. The isozymes were thus indistinguishable by size. Molecular weight of the purified protein was also determined by gel filtration on a precalibrated Sephadex G-75 column. The test protein had a molecular weight of 54 kDa.

G. *Air-spora over some agricultural crop fields in West Bengal* : Naim Uddin and Roma Chakraverty (Supervisor)

Air survey over some cultivated crop fields in the vicinity of Barrackpore was initiated with the culture plate method.

(i) Air survey over paddy field revealed that the fungal spore concentration was significantly low at the early stages of development of the crop, with a sudden rise during the flowering stage, reaching maximum during the harvesting period. The common and dominant fungi were *Cladosporium, Curvularia, Alternaria* and *Nigrospora* along with some sterile forms. *Aspergillus* and *Penicillium* were recorded to be appreciable during the harvesting period.

(ii) Air-spora over wheat field showed similar trend of occurrence. The only exception was the occurrence of *Helminthosporium* frequently, in significant concentrations.

(iii) Air-spora over jute field revealed the same constituents in addition to *Aspergillus* and *Penicillium* which were observed frequently in appreciable numbers.

The intensity of plant pathogens like *Alternaria*, *Curvularia*, *Helminthosporium* and *Nigrospora* in air, indicates a relationship with the different host crops studied.

H. *Air borne fungal spores in urban Calcutta in relation to occupational area and population density* : Tilak Banerjee, A. K. Roy Chowdhury and Roma Chakravery (Co-supervisors) and K. Sen (Supervisor)

In continuation of our earlier study, fifty different sites under seven heterogeneous areas of Calcutta city were surveyed.

Total number of colonies counted in an area varied from 3675 to 11,551, depending mainly upon number of sites selected in a particular area. Total number of colonies counted during the two years (March 1986—February 1987 and March 1987—February 1988) were 49,944 and 45,694 respectively. *Aspergillus*, *Penicillium*, *Curvularia*, *Alternaria*. *Helminthosporium*, *Cladosporium*, and the sterile forms were among the common fungal forms from the air. The genus *Cladosporium* and the sterile forms are strictly seasonal. High incidence of *Aspergillus* and *Penicillium* in the densely populated and the open green areas clearly indicates the effect of different environmental and ecological conditions on the atmospheric air-spora. On the other hand, plant pathogens like *Curvularia* and *Alternaria* occur at higher incidence in the open green and the sparsely populated areas than in other areas of Calcutta. From the statistical analyses of the incidence of *Aspergillus*, *Penicillium* and *Curvularia* it is concluded that besides climatic factors ecological conditions of a locality are also of no less importanct in affecting the incidence of the saprophytic members.

I. *Environmental Physiology and Hormonal Regulation*

(i) *Thyroid hormone-induced neurochemical alterations* : *Stimulation of acetylcholinesterase activity by triodothyronine in brain of Singi fish, Heteropneustes fossilis (Bloch)* : Srabani De, A. K. Dasmahapatra and A. K. Medda (Supervisor)

In our ongoing investigation on L-triiodothyronine-induced neuro-chemical alteration in the brain of Singi fish, *Heteropneustes fossilis* Bloch, responsiveness of acetylcholinesterase (AchE) activity of this hormone was investigated as an important physiologic parameter. Three consecutive day injections of T_3 (0.025, 0.05, 0.1 and

1 μg/g) significantly elevated the AchE activity. The higher doses of 0.1 and 1 μg of T_3/g induced more increase in enzyme activity compared to the effect with 0.025 μg/g. T_3 dose of 0.012 μg/g was found to be ineffective. The specificity of T_3 action on AchE activity was supported by complete inhibition of the enzyme activity by cycloheximide. Thiourea treatment for 30 days decreased the AchE activity below the control level. This reduced level of the enzyme activity brought back even above the control level by T_3 injections. Thus it is suggested that thyroid hormone is involved in the sustenance of AchE activity in fish brain and it may have a role in cholinergic neurotransmission. Such action documents the responsiveness of Singi fish brain to thyroid hormone.

(ii) *Demonstration of putative thyroid hormone receptor in the brain nuclei of Singi fish, Heteropneustes fossilis (Bloch)* : A. K. Dasmahapatra, Srabani De and A. K. Medda (Supervisor)

As our earlier studies showed responsiveness of fish brain to thyroid hormone, search were further directed to know whether nerve cell nuclei are the sites of this hormone action. Single injection of [125I] triiodothyronine (T_3) (with or without stable T_3) in Singi fish, *Heteropneustes fossilis* (Bloch), showed that the fish brain has saturable binding sites and the specific uptake was 60-70% higher than the non-specific uptake. The distribution kinetics of [125I] T_3 in the serum, whole brain and brain nuclei after single injection of the labeled hormone showed that the removal of [125I] T_3 from the serum was very rapid with the $t_{\frac{1}{2}}$ of about 3.3 hours and the incorporation of the hormone into the brain and brain nuclei were very slow and achieved a maximal value after 4-6 hours of post injection.

The binding of [125I] T_3 to the isolated brain nuclei of Singi fish was further studied *in vitro*. Binding was linearly increased with the increasing concentrations of the DNA (Nuclei). The binding achieved equilibrium between 15—20 minutes at 27° and was stable at least for one hour. The binding was reversible in the presence of excess unlabeled T_3. Scatchard analysis showed only a single class of binding sites. The mean dissociation constant (kd) was $2.15 \pm 0.45 \times 10^{-10}$M and maximum binding capacity (MBC) was 0.044 ± 0.024 pmol/μg DNA. The relative binding affinities of thyroid hormone analogs for T_3 sites were as follows : TRIAC>T_3>TETRAC>T_4>reverse T_3>T_2. These findings were similar with other animals. Therefore, the nuclear binding sites in Singi fish brain, as demonstrated, may be regarded as thyroid hormone receptors.

(iii) *Characterization of triiodothyronine binding sites in the liver nuclei of Singi fish, Heteropneustes fossilis (Bloch)* : A. K. Dasmahapatra and A. K. Medda

To characterize the triiodothyronine (T_3) binding sites in the liver nuclei of Singi fish, nuclear receptors were labeled with [125I] T_3 at 27° and dissolved in 0.4M KC1. Then it was eluted through a Sephadex G-150 column at 4°C. It was observed that the radioactivity present in the eluted material contained three peaks. The first peak (20% radioactivity) was equivalent to void volume, the 2nd peak (25-30% radioactivity) was equivalent to receptor and the 3rd peak (45-50% radioactivity) was equivalent to free iodine. The molecular weight of the T_3-receptor peak eluted was about 60,000 d.

(iv) *Effect of cyanocobalamin on mitochondrial «-glycerophosphate dehydrogenase, malic enzyme and acetylcholinesterase activities in brain of Singi fish, Heteropneustes fossilis (Bloch)* : Uma Bhattacharya and A. K. Medda (Supervisor)

Cyanocobalamin of different doses (0.5, 1, 2 and 4 μg/g) increased the mitochondrial «-glycerophosphate dehydragenase («-GPD) and cytosolic malic enzyme (ME) activities in the brain of Signi fish, except the dose of 0.5 μg/g which was ineffective in case of malic enzyme. A dose-response relationship was noted between the activity of «-GPD and ME. The «-GPD activity increased in a non-linear fashion, while the ME activity followed almost a linearity with different doses of cyanocobalamin. The induced activity of either of the enzymes was inhibited by cycloheximide.

The acetylcholinesterase (AchE) activity was detected in considerable degree in Singi fish brain, and there was a differential distribution of the enzyme activity in different parts of the brain of normal fish. The cerebrum showed comparatively less AchE activity, gradually followed by higher activity in cerebellum and more so in midbrain and medulla oblongata. Cyanocobalamin treatment was not found to cause any change in AchE activity in whole brain. But analysis of the data obtained from individual sub-structures, such as cerebrum, cerebellum, midbrain and medulla oblongata, revealed that there was reduction in AchE activity in cerebellum and midbrain in comparison to the control, while the cerebrum and medulla oblongata showed no alteration in enzyme activity after cyanocobalamin treatment.

(v) *Effect of lead, zinc, mercury and copper on the serum acetylcholinesterase activity in Magur fish (Clarias batrachus)* : Abhijit Panigrahi, A. K. Dasmahapatra and A. K. Medda (Supervisor)

In Continuation of the investigations on the effects of heavy metals on different systems of Magur fish, the effects of lead, zinc, murcuric and cupric acetates on serum acetylcholinesterase activity were studied. A significant enhancement of this enzyme activity after injections of these salts of the heavy metals was found on 3rd, 7th, 10th and 17th day after first injection.

J. (i) *Effect of carbofuran 75 DB technical on growth and maturation of gonads of catfish, Singi (Heteropneustes fossilis, Bloch)* : Sudipta Chatterjee and Rama Ghosh (Supervisor)

In view of the dangers and hazards of the random use of pesticides in the cultivated fields which affects paddy pisciculture and pisciculture in lakes and ponds, studies have been undertaken to understand the extent of damage to the fishes due to pesticide contaminations which leads to reproductive failure. An assessment of the sublethal dose of pesticide on female gonad after long-term exposure has been made as a continuation to our earlier studies on determination of LC_{50} value and mortality of the fishes at different doses of carbofuran. The preliminary data shows that fish exposed to 1 ppm of carbofuran continuously, even for 2 months, exhibits significant inhibition of gonadal development (as evidenced by histological studies) and gonadosomatic index (above 50%) with respect to control. The detailed studies of effects of carbofuran on gonadal development of both male and female fishes are being undertaken.

(ii) *Measurement of pesticide residue in different tissues of catfish, Singi (Heteropneustes fossilis Bloch), exposed to carbofuran 75 DB technical* : Sudipta Chatterjee and Rama Ghosh (Supervisor)

Carbofuran, purified from the technical carbofuran and carbofuran 75DB technical were checked by GLC (Gas-Liquid-Chromatography). Standard curves of 98% analytical carbofuran and 3-OH carbofuran were prepared by GLC.

A method has been standardized for the extraction, cleaning-up and estimation of carbofuran and its metabolites in different tissues of the fish and its environment (i.e., water in the aquarium where treatment has been made) after 15 days exposure

in 1ppm dose of carbofuran technical. It has been possible to detect the residue of carbofuran pesticide and its bioaccumulative product, 3-OH carbofuran in flesh, liver, ovary, testis and water. The work is in progress to determine the residues quantitatively.

K. (i) *Regulation of gonadal activity in fresh water prawn (Macrobrachium)* : Debjani Ghosh and A. K. Ray (Supervisor)

In our efforts to develop means for induced breeding in fresh water prawn throughout the year, the role of estrogen in gonodal maturation is currently being investigated. Earlier studies indicated that estrogen increases protein and RNA contents in hepatopancreas and accumulation of vitellogenin-like protein in hemolymph plasma. As lipovitellin is the only variety of vitellogenin protein in fresh water prawn, which plays an important role during egg maturation, further studies have been directed to investigate lipogenic action of estrogen in hepatopancreas of fresh water prawn.

The activities of two lipogenic enzymes viz., NADP-linked cytosolic malic enzyme and NADP-linked glucose-6-phosphate dehydrogenase were increased after three consecutive injections of different doses of estradiol ranging from 0.1 to 2μg per g. Simultaneous use of tamoxifen (anti-estrogenic compound) with estradiol counteracted the estradiol-induced increase in these enzyme activities. Cycloheximide also inhibited the estrogenic effects on malic enzyme and glucose-6-phosphate dehydrogenase activities. The experiment shows estrogen-specific stimulation of the lipogenic enzymes involving protein biosynthesis in hepatopancreas. Lipid synthesis may have a role in the formation of lipovitellin in hepatopancreas and its accumulation in hemolymph plasma.

(ii) *Influence of thyroid hormone on ovarian functions in fish* : Manju Das and A. K. Ray (Supervisor)

Although, the growth promoting and stimulatory effects of thyroid hormone in fish are well known, role of this hormone in fish reproduction remains unclear. Considering the above facts studies have been undertaken in this laboratory to demonstrate the effects of thyroid hormone on ovarian function in Singi fish (*Heteropneustes fossilis* Bloch).

Single injection of triiodothyronine (T_3) at various doses indicated increased levels of protein and RNA contents in liver and ovary on the 3rd day in comparison

to the control animals. Alkaline phosphatase activity showed a rise both in liver and ovary while acid phosphatase activity remaind unaltered in these organs with moderate doses of T_3 (1 and 2 μg/g). Lower doses of T_3 appeared to be ineffective in causing any change in these physiologic parameters. Moreover, a seasonal effect of T_3, being more effective in breeding season, particularly in case of alkaline phosphatase activity, was indicated in the study. Further experiments are being made using vsrious doses of T_3 at different experimental conditions to confirm the metabolic effects of T_3 in ovary.

(iii) *Thyroid hormone regulation of mammalian brain function* : Pradip Kumar Sarkar and A. K. Ray (Supervisor)

In view of the lack of adequate evidences for action of thyroid hormone through membrane related energy-linked processes involved in impulse generation and transfer in nervous tissues, the present search has been directed to investigate action of this hormone on Na^+-K^+-and Mg^{2+}-ATPase activities in different subfractions of adult rat cerebral cortex.

Standardization of methods for isolation and purification of synaptosome and non-synaptic mitochondria were made and the purity of these subfractions were checked by assessment of some marker enzymes like, Na^+-K^+-ATPase, succinic dehydrogenase, lactate dehydrogenase and acetyl cholinesterase activities. In our initial stage of study a significant stimulation (increase) in synaptosomal Na^+-K^+-ATPase activity was found on the 3rd day after single injection of 0.5 and 1.0 μg per g of L-triiodothyronine (T_3), in comparison to the control values. Similar nature of activation of Na^+-K-ATPase was found in non-synaptic mitochondria with lower dose (0.5 μg/g) of T_3 but higher dose (1.0 μg/g) caused less degree of increment. T_3 with both the doses suppressed Mg^{2+}-ATPase activity significantly in synaptosome and non-synaptic mitochondria.

The present study indicates role of T_3 in membrane-related energy-linked processes in nervous tissues. Further studies are being made with different parameters and doses of T_3 to demonstrate the dose-response relationship, mechanisms and the chronology of T_3 action in brain.

(iv) *Pharmacologic effects of metoclopramide on spermatogenesis in rat* : Rupali Sarkar and A. K. Ray (Supervisor)

Metoclopramide is a dopamine receptor blocker, very often used as an

antiemetic agent and also in the treatment of gastric ulcer. Chronic use of metoclopramide causes rise in serum prolactin level (hyperprolactinemia) which is thought to affect spermatogenesis. The present search is directed to understand whether metoclopramide in chronic and short term use affects spermatogenic and somatic cell function in testis of adult rat. The various physiological parameters like activities of acid and alkaline phosphatases, cholesterol, and fructose contents were examined in testis of metoclopramide treated (chronic) rats to get some indications about hydrolytic and metabolic actions of this drug.

At the initial stage of our experiment chronic treatment of male rats with metoclopramide (2 mg and 5 mg per kg, 15 consecutive injections) showed high level of acid phosphatase activity and low level of alkaline phosphatase activity, with increase in cholesterol and fructose content. Sperm count also showed a significant decrease in rats after chronic treatment with different doses of metoclopramide. The result shows hydrolytic and low metabolic effect of chronic exposure to metoclopramide with an indication of decreased utilization of cholesterol for testosterone biosynthesis, and depression in metabolic activities of germ cells (as evidenced from high level of fructose content) and spermatogenesis. The work is in progress.

L. *Control of Growth and Development of Silkworm and Silk Production.*

(i) *Effect of thyroxine and cyanocobalamin on silkworms, Bombyx mori L.*: A. K. Dasmahapatra and A. K. Medda (Supervisor)

Previously, enhancement of body growth, silk production and egg production and shortening of the larval period of silkworms, *Bombyx mori* L., were induced by thyroxine and cyanocobalamine treatments in the larval period. In recent experiments, it was found that if the eggs were treated with thyroxine and cyanocobalamin and the treatment continued during the larval period, better stimulation with respect to shortening of the larval period and enhancement of the production of silk and number of eggs could occur. Some possibility was indicated on the production/induction of better variety or high yielding variety of silkworms with prolonged treatment starting from the early embryonic stage.

(ii) *Collaborative research work with Physiology Section. Central Tasar Research and Training Institute, Ranchi.*

(a) *Further study on the cholesterol turnover during pre-pupal, pupal diapause and adult stages of development of Tasar silkworms, Antheraea mylitta* D.: O. P. Dubey, A. Chaudhuri, M. L. Kapila, S. S. Sinha and A. K. Medda

Turnover of cholesterol content in haemolymph plasma, fat body and gonad of each sex of tasar silkworm *Antheraea mylitta* D. was investigated from pre-pupal to adult stages covering the entire gamut of pupal diapause development. Total cholesterol level in haemolymph, fat body and gonads underwent more or less specific pattern of changes during developmental stages studied. However, the pattern of variation during the period was not identical in testes and ovaries though it was almost similar in haemolymph plasma and fat body in both sexes. Specific cholesterol variations manifesting as rise and fall in biomolecules of tissues (haemolymph and fat body) and other organs (gonads of A.*mylitta*) were, however, found to be aimed at utilization, transformation and accumulation of cholesterol during the developmental stages. The drastic fall in plasma cholesterol content during pupal-adult transformation and its gradual reduction in fat body since last quarter of pupal diapause period to adult emergence besides a sharp rise of cholesterol in gonads, particularly the ovaries, followed by earlier fall, reflected as an overall natural trend for a strict sterol economy on account of the highest demands of cholesterol warranted for post-pupal stages of reproduction such as ovarian maturation, oogenesis and hatching besides genital tract maturation and sperm development.

M. *Control of breeding and gonadal activity in silkworms (Bombyx mori* L.): Shantanu Das and A. K. Ray (Supervisor)

In our attempt for hormonal and nutritional manipulation for better growth, development and breeding in silkworms, studies are in progress to understand the physiologic role of estrogen in reproduction of these worms.

Earlier studies showed estrogen-induced increase in protein and RNA contents in fat body and gonad, and protein content in hemolymph. During our further investigation on the lipogenic action of estrogen in fat body we have found a stimulation of activities of both NAD-and NADP-linked malate dehydrogenase in fat body of 5th instar larvae of *Bombyx mori* injected with different doses of estradiol-17β. Use of tamoxifen (antiestrogenic compound) inhibited such estrogeu-induced rise in the enzyme activities. The results indicate role of estrogen in lipid synthesis for formation of lipovitellin in fat body which is an important lipoprotein complex for oocyte maturation in ovary.

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Institutional project No. V : Studies of microbes and parasites for Industrial and Medical applications

A. *Studies on Mycobacteria* :

(i) *Studies on mycolic acid biosynthesis in mycobacteria* : M. Kundu, J. Basu and P. Chakrabarti

Earlier studies have indicated that mycolic acid biosynthesis might be the target of some antituberculous drugs. We have isolated a mutant of *M. smegmatis* defective in mycolic acid biosynthesis. TLC profile clearly indicated the absence of typical mycolic acid in the mutant. HPLC profile revealed the presence of some fatty acids eluting in the same position as standard mycolic acid ester. To explore the characteristics of the molecular ion species, the HPLC purified material was analysed by mass spectrometry which clearly indicated the accumulation of long chain fatty acids ($C_{30}-C_{40}$) in the mutant. Further detailed studies on characterisation of the intermediates (as revealed by mass spectrometry) present in the mutant and their final conversion into mycolic acid are in progress.

B. *Beneficiation of bauxite ore through microbial removal of silica* : Suparna Ghosh, B. K. Mohanti and A. K. Mishra (Supervisor)

Bacteria isolated *in situ* were capable of releasing 50 μg/ml silica from bauxite ore. Using a stainless steel air-lift percolator leaching of silica from bauxite ore was studied. The maximum release of silica was observed to occur within 10 days of incubation at 37°C using commercial sugar as the carbon source. X-ray diffraction studies of treated bauxite ore showed that microbes did not produce any change in the property of bauxite with respect to production of aluminium.

(i) *Biotechnological enrichment of magnesite ore* : B. K. Mohanty and A. K. Mishra (Supervisor)

Laboratory scale fermentation studies showed that 80% silica was removed from high silica containing magnesite ore through microbial means. A 5 metric ton pilot plant has been erected at Salem (Tamilnadu) to standardise the biobeneficiation at the industrial level.

(ii) *H_2S oxidation by Thiobacillus ferrooxidans* : A. Das, P. Roy and A. K. Mishra (Supervisor)

Thiobacillus ferrooxidans is able to oxidise H_2S efficiently. However, at higher concentration the gas is toxic to the cells. The phenomenon is being investigated to remove H_2S contaminants from natural gas.

(iii) *Regulation of Fe and reduced sulfur oxidation by Thiobacillus ferrooxidans* : A. Das, P. Roy and A. K. Mishra (Supervisor)

Thiobacillus ferrooxidans oxidises both Fe and reduced sulfur compounds for its energy. The iron oxidation is found to be inducible by Fe whereas elemental S-, sulphide, sulphite and thiosulphate oxidations are found to be constitutive ones.

Iron is found to repress the synthesis of thiosulfate-oxidizing system.

(iv) *Anaerobic growth of Thiobacillus ferrooxidans* : A. Das and P. Roy and A. K. Mishra (Superuisor)

Anaerobic growth of *Thiobacillus ferrooxidans* on elemental sulfur has been achieved successful with Fe^{3+} ion acting as a terminal electron acceptor. This anaerobic elemental sulfur oxidation takes place through a different route compared to that of aerobic sulfur oxidation. It has also been observed that the ferric iron reducing activities of anaerobically-grown cell is double that of the aerobically grown cell.

(v) *A novel species of Thiobacillus* : S. K. Das, P. Roy and A. Mishra (Supervisor)

A motile, rod shaped gram-nagative bacteria with ability to oxidise reduced sulfur compounds isolated from soil was identified as a new species belonging to the genus *Thiobacillus* as demonstrated by its physiological properties. The genetics of sulfur oxidation as well as its regulation is poorly understood in *Thiobacillus* group of bacteria ; the isolated strain could be useful, applying the knowledge of conventional genetics as well as of molecular biology, to study the genetics of sulfur oxidation and its regulation.

Broad host range plasmid RP_4 could be transferred from *E. coli* to the strain (at low frequency). The strain, however, behaves as a good donor of congugative plasmid when another strain of this species or *E. coli* were used as recipients. *In vivo* construction of plasmids, with appropriate transposons (Tn_5, Tn 1721 Tn_7), is going on to use them for transpositional mutagenesis.

(vi) *Development of Bacteria with useful characteristics for the enhancement of recovery of oil* : Indrani Roy, Chirajyoti Deb, P. Roy and A. K. Mishra (Supervisor)

In continuation of our previous study, we observed that the strain *Pseudomonas stutzeri* isolated by us well suited for direct application in microbial enhancement of oil recovery, though there is production of high amount of surface active compounds. We are now investigating the nature of this surface active compound, and its oil enhancing property.

Besides this, two facultative strains capable of producing biosurfactants and polymers respectively were procured. These two strains in direct application are able to reduce the surface tension of the oil water interface without degrading the thick crude oil. We are now studying with sand core model of oil well quantify the recovery.

C. *A Streptomycete collagenase* : R. P. Mukhopadhyay and A. L. Chandra (Supervisor)

The collagenase produced by *Streptomyces* sp. A-11 was purified and characterized. The optimal pH and temperature for activity were found to be 7.8 and 30°C respectively. An incubation period of 2 h was required for optimal activity of the enzyme. The enzyme activity was inhibited by 84.2% with 5% para chloromercuri benzoate. Sn^{2+}, CO^{2+} and Mo^{2+} at 5 mM inhibited the enzyme activity by 50%.

Glycine, proline and hydroxyproline at 12 mM inhibited 49, 52.5 and 50% of enzyme activity. The enzyme was found to be stable at pH 7.8 and at 30°C. The Km values determined with bovine achilles tendon-, human placenta-, calf skin- and rat tail- tendon collagen were 2.3, 3.6, 3.7 and 2.6 mg/ml respectively. The Ki value was found to be 1.5 X 10^{-3} M with $AgNO_3$ as non-competitive inhibitor. The UV absorption maximum of the enzyme was at 215 nm which was similar to the UV absorption maximum of the collagenase produced by *Clostridium histolyticum*.

(i) *Proteolytic soil actinomycetes* : B. S. Jaiswal and A. L. Chandra (Supervisor)

Fifteen soil samples were collected from various parts of Calcutta and Howrah and plated on agar media by the dilution plate method. One hundred eighteen actinomycetes were isolated and 73 actinomycetes were found to be proteolytic by the gelaiion agar-$HgCl_2$ method. Three strains liquefied gelatin stabs in 24 h.

D. *Studies of glucoamylase production by a fungal strain* : Anuradha Ghosh and Arati Das (Supervisor)

By mutagenic treatment a highly potent glucoamylolytic strain of *Aspergillus terreus* NA-170 was developed. It produced about 1.8 times more glucoamylase than the parent strain. Studies were undertaken to find the raw starch digestion capacity of the enzyme of *A. terreus* NA-170. Results indicated that 10 gm of raw wheat starch granules were completely hydrolysed in 10 hours with 2310 U of the enzyme. On increasing the starch content to 20gm the corresponding hydrolysis rates were 100% and 80% in 48 hours. A study of raw starch adsorption capacity of the purified enzyme indicated that wheat starch was most suitable for complete adsorption of the enzyme at the pH range of 2.0—6.0.

A comperative study was carried out on the raw starch hydrolysis and adsorption capacity of the enzyme of *A. terreus* NA-170 and those of other commercial preparations. The potency of the enzyme under study was found to be comparable with them.

(i) *Microbial production of L-DOPA by mutagenesis* : Sharmila Chattopadhyay and Arati Das (Supervisor)

To improve the potency of L-DOPA production, a wild type strain of *Aspergillus terreus* was treated with mutagens, UV, ethylmethanesulphonate (EMS) and nitrous acid (NA), in stepwise fashion. A mutant was isolated which produced 22% more L-DOPA than the wild parent. A number of antioxidants were tested to evaluate their efficiency for better transformation of L-tyrosine to L-DOPA and among the compounds tested the most effective was L-ascorbic acid followed by araboascorbic acid, hydroquinone, resorcinal and pyrocatechal.

Experiments were also undertaken to immobilize free cells of *A. terreus* with calcium alginate for continuous production of L-DOPA from L-tyrosine by tyrosinase activity of the mycelia. Results showed successful immobilization of the cells using calcium alginate for the production of L-DOPA.

E. *Production, purification and characterization of xylanase from Aspergillus ochraceus* NG-13 : Geeta Nanda

Enhancement of the productivity of xylanase and β-xylosidase of *Aspergillus ochraceus* was investigated by multistep mutagenesis. The spores of the wild strain

were subjected to UV and NTG. The hyperxylanolytic mutant NG-13 produced maximum xylanase in liquid medium. The xylanase from NG-13 was purified to homogeneity by ammonium sulphate precipitation and gel filtration. The purified enzyme showed a pH optimum of 6.0. The molecular weight of the enzyme was estimated to be 4.8×10^4 by SDS polyacrylamide gel electrophoresis. The enzyme is endotype producing higher oligosaccharides at an early state of reaction and xylobiose and xylotriose as the main end products.

(i) *Isolation of a new xylanolytic fungus from decaying vegetation* : Mousumi Ghosh and Geeta Nanda (Supervisor)

A number of microorganisms (bacteria, fungus and actinomycetes) were isolated from soil and decaying vegetation which were screened for the extracellular production of xylanase. From both qualitative and quantitative estimations a fungus with high xylanase activity was selected. This fungus was identified as *Aspergillus sydowii*. The production media was standardized and conditions were optimized for high xylanase production. It was found that xylanase production by *A. sydowii* was maximum after 4 days of incubation at 30°C and pH 4.0.

(ii) *Agricultural waste utilisation as nitrogen source for the production of protease by Nocardia sp. T. P. 8.* : Sangita Sinha Roy and Geeta Nanda (Supervisor)

Various agricultural wastes were used in the media as nitrogen source for production of alkaline serine protease by a soil-isolated thermophilic strain T.P.8.

Of the different wastes used, i.e., wheat bran, rice bran, groundnut, maize, mung, arhar & chhola, groundnut was the optimum choice. The enzyme activity with groundnut was found to be 119 μg/ml.

(iii) *Production of α-amylase from Bacillus megaterium B-71* : Swapan K. Ray and Geeta Nanda (Supervisor)

The soil-isolated strain, *Bacillus megaterium*, produced saccharifying α-amylase in starch minimal medium. The enzyme is stable in the pH range of 5.5 to 8.0. Optimum activity is observed to be between pH 4.8 to 6.5. The enzyme required calcium for catalytic activity. Electrophoresis of the purified α-amylase showed four active protein bands, although the enzyme behaved as a single peak during ultracentrifugation.

(iv) *Studies on cellulose fermentation and effect of substrate pretreatment on microbial growth* : Bandana Banik and Geeta Nanda (Supervisor)

The effect of physical, chemical and enzymatic treatments on microbial digestibility of cellulosic substrates was investigated using the fungal strain *Aspergillus fumigatus* C5. With a treatment of 1% NaOH for 1hr, ballmilled cellulose became susceptible for conversion to glucose. Paddy straw, sugar cane bagasse, delignified saw dusts, ball milled cellulose (filter paper), cellulose pulp (FP), wheat bran, groundnut husk and banana leaf were used as test substrates. Treatment with alkali increased the digestibility of cellulose from 28.5% to 71%. Ball milling increased the digestibility of cellulose from 50% to 90%. Addition of ballmilled cellulose to the growth medium increased FPase, CMCase and β-glucosidase activities 2.8, 3.5 and 7-fold respectively. Highest cellulase activity per ml of crude obtained was FPase, 25 ; CMCase, 40 ; and β-glucosidase, 185 units.

F. *Studies on lichen* : Kalyani Sen

Litmus production in the form of granules or powder from the lichen is cost effective.

Partial purification of the components of a lichen has been achieved.

(i) *Search for new fungi for industrial chemicals* : Kalyani Sen

Search for plant growth substatance/nutrient from the fungal strains obtained from different depths of soil (10-500 ft) is being continued.

G. *Conversion of C_{21} steroid to its C_{19} derivative through Baeyer-Villiger oxidation by a novel Gram positive bacteria* : Aloke Dhar and Timir B. Samanta (Supervisor)

Transformation of progesterone, a C_{21} steroid to its hydroxy derivative by a bacterial strain G_4 was reported. Further probe on the identity of the bioconverted product (s) revealed that both of the products formed during transformation under liquid culture condition were C_{19} steroids. The transformed products were identified by physical methods, viz., UV, IR. NMR. Spectroscopic data revealed that both the compounds suffered lysis of C_{17}-C_{20} bond and Δ^1 dehydrogenation. The lysis of C-C bond may be rationalised by a chemical Bayer-Villiger type oxidation catalysed by microbial enzyme which is presumably a cytochrome P-450 linked monooxygenase. The reaction under *in vitro* condition with NADH as cofactor showed positive results.

(i) *Immobilization of fungal spores for 11-oxygenation of steroid.* : Tapan K. Dutta and Timir B. Samanta (Supervisor)

The results of immobilization of fungal spores catalysing 11-oxygenation in steroid in respect of matrix and techniques have been reported. To compare the efficacy of different preparations in respect of 11-oxygenation in steroid molecule the physical parameters, e.g., pH, temperature and dissolved oxygen tension, etc. were optimised. Subsequently, under optimal conditions half life of each immobilized preparation, both as activated and non-activated, was determined. The immobilized gels were activated either by solvent or nutrients. The results showed that agar-agar and calcium alginate entrapped spores has greater half life and was about 14 days. Furthermore, activation by nutrients exhibited better results than by organic solvents.

In another study of 11-oxygenation of steroid by immobilized spores assay methods which are quick and precise have been developed. The bioconverted product can be estimated with or without separation by these methods more accurately.

H. *Regulation and production of amylase from a cellulolytic fungus Myceliophthora thermophila D-14 (ATCC 48104)* : Ramkrishna Sadhukhan and S. L. Chakrabarty (Supervisor)

The production of amylolytic enzymes by a thermophilic cellulolytic fungus, *M. thermophila* **D-14** was investigated by batch cultivation in CD medium, pH 5.5, at 45°C on a rotary shaker. Starch, amyloprotein, dextrin induced the enzyme synthesis while glucose, fructose, galactose and lactose inhibited it. Methyl α-D-glucopyranoside was also found to be inhibitory. When the preinduced, actively growing cells were transferred to media containing glucose, the enzyme synthesis was immediately repressed. Hence, the amylase synthesis in the organism was inducible and subject to catabolite repression. CAMP was unable to revive this repression.

The crude enzyme was active at a board temperature range (50° to 60°C) and entirely stable for several hours even at 55°C.

(i) *Saccharification of cellulosic wastes by cellulase complex of Myceliophthora thermophila D-14* : Samir Kumar Roy and S. L. Chakrabarty (Supervisor)

The organism *M. thermophila* **D-14** was grown at optimal culture conditions for the production of extracellular cellulase complex. Different pretreated cellulosic wastes, after proper grinding, were treated with the enzyme solution. The reducing

sugar thus produced was estimated. Pretreatment and saccharification of different pretreated cellulosic wastes revealed that 5% NaOH treatment was most effective. The saccharification values varied between 35-60% depending on the nature of the cellulosic materials.

(ii) *Studies on xylanase production by Myceliophthora thermophila* D-14 : Samir Kumar Roy and S. L. Chakrabarty (Supervisor)

The thermophilic fungus *M. thermophila* D-14, previously repoted as cellulose decomposer, also produces appreciable amount of xylanolytic activity in culture fluid. The effects of carbon sources, substrate concentrations, culture pH and temperature on the production of extracellular xylanase were evaluated. High extracellular xylanase activity was measured when the culture was grown on xylan, Solka floc and α-cellulose. Only low enzyme activity was noticed with glucose, xylose and cellobiose. The enzyme is primarily located in the extracellular culture filtrate. Relatively low activity of the enzyme was also detected in the intracellular and cell bound fractions. Maximum xylanase activity was observed at pH 5.2 at 65°C. The enzyme was stable between the pH 4.2 and 7.4 when stored at 4°C for 48 h.

(iii) *Studies on L-asparaginase producing bacteria with regard to antineoplastic activity* : Subha Manna and S. L. Chakrabarty (Supervisor)

The bacterial strain *MB-405* isolated from muddy drainage soil possessed appreciable L-asparaginase activity. It was identified as *Pseudomonas* sp. The fermentation medium for optimum enzyme production was standardized. The enzyme was inducible in nature and was produced only in the presence of specific substrate. The temperature and initial pH for growth as well as enzyme production were 30°C and 7.0 respectively. The enzyme yield reached its maximum during the early stationary phase when the pH of the fermentation broth increased to 8.8 to 9.0. Extraction and purification of L-asparaginase from the strain *MB-10* have now been carried out.

(iv) *Studies on L-asparaginase activity in Vibrio proteus* : Amaresh Sinha and S. L. Chakrabarty (Supervisor)

The L-asparaginase producing bacteria *Vibrio proteus* received from Dr. R. Sakazaki (NIH, Tokyo, Japan) was grown in TAYG medium and the growth pattern was studied. Under both aerobic and anaerobic conditions effects of the 20 amino acids on L-asparaginase synthesis were studied. It was observed that anaerobic condition was more suitable for enzyme production. The production of the enzyme was

also observed at different pH, temperature and also by varying the medium constituents. Optimum pH and temperature were 6.5 and 30°C, respectively.

Three cancer cell lines e.g., Ascites fibrosarcoma, Dalton's lymphoma and Erlich carcinoma are being maintained by serial transplantation (2X 10^4 cells per mouse) in swiss mice inorder to study the antineoplastic activity of the *V. proteus*-L-asparaginase.

(v) *Purification and immunobiological characterization of L-asparaginase from Cylindrocarpon obtusisporum* MB-10 : Syamal K. Raha and S. L. Chakrabarty (Supervisor)

L-Asparaginase (2000 units) has been purified from the cell-free extract of *C. obtusisporum* MB-10 following the steps of acetone precipitation, ammonium sulfate fractionation, DEAE-Sephadex A-50 chromatography and rechromatography on a column of the same matrix. A group of 8 male swiss mice aged 6 to 8 weeks and weighing 18-20 g were injected (i.p.) with the L-asparaginase (10 units each) in 50 mM sodium phosphate buffer on 1, 8, 15 and 28th day of tumour induction. Blood serum of the mice was collected on 33rd day. With Ouchterlony double diffusion method the serological relationship of this antitumour L-asparaginase with that from *E. coli* was determined.

(vi) *Immunobiological studies of L-asparaginase of Vibrio cholerae* : Susanta K. Dey and S. L. Chakrabarty (Supervisor)

The immunological cross-reactivity of L-asparaginase from *V. cholerae* and *E. coli* was examined by double-diffusion method in agar using on antiserum raised against *E. coli* L-asparaginase. It was found that L-asparaginase from *V. cholerae* did not cross react with the antiserum of *E. coli*-L-asparaginase. The lack of cross-reactivity between L-asparaginase of *V. cholerae* and antiserum raised against L-asparaginase of *E. coli* suggested that these enzymes were immunologically different.

I. *Outer membrane protein and cellular adherene properties of V. cholerae* : Dilip K. Sen Gupta, Tapas K. Sen Gupta and A. C. Ghose (Supervisor)

(a) Immunochemical relatedness of major outer-membrane protein of *V. cholerae* 01 strain.

Immunochemical relationship of several major outer membrane protein (MOMPs) of *V. cholerae* 01 strain was studied. Antisera were raised in rabbits against the four MOMPs (45k, 36k, 26-28k, 20k) of *V. cholerae* 01 strain and the immunochemical reactivity of these antisera rendered specific for the respective proteins after absorption were tested by ELISA and Western blott analysis. Results showed that other *V. cholerae* 01 organisms (belonging to different biotypes and serotypes) also expressed antigenically related MOMPs of subunit melecular weight mentioned above. The antigenic relatedness of these OMPs was further substantiated by the observation that both haemagglutinating and intestinal adherence atcitvities of a heterologous *V. cholerae* 01 strain could be inhibited by the anti-OMP sera.

(b) Identification of an outer-membrane protein of a non-01 *V. cholerae* strain that is involved in the cellular adherence process.

A non-01 *V. cholerae* strain 10259 showed higher haemagglutinity and intestinal adherence activities when grown in the enriched medium Tryptican Soya Broth as compared to those of cells grown in a synthetic medium (Trisbuffer or T-medium). An antiserum raised against TSB grown cell and subsequently absorbed with the T-medium grown cell, primarily recognised an outer membrane protein of subunit molecular weight 22k of the TSB grown cells only. The absorbed antiserum also inhibited the haemagglutination and intestinal adherence activities of the parent non-01 organism but not of other 01 organisms.

These results suggest the involvement of a 22k protein of the non-01 organisms 10259 in the cellular adherence process.

(i) *Plasmid mediated expression of haemagglutinin and Hep2/Hela cell adherence factor of enteropathogenic Escherichia coil* : Samir K. Barari and A. C. Ghose (Supervisor)

Several enteropathogenic *Escherichia coli* (EPEC) strains were isolated earlier from infantile enteritis cases. These organisms were shown to express mannose resistant haemagglutinin (MRHA) and Hep-2/Hela cell adherence factors that are plasmid mediated. Maximum expression of MRHA activity was noted when the organisms were grown in Luria broth at 37°C while organism grown at 30°C or 42°C failed to express any such activity.

(ii) *Characterisation of antigen of Leishmania donovani* : Prabir K. Ghosh, Ashis K. Ghosh and A. C. Ghose (Supervisor)

Studies on the somatic antigens of the parasite *Leishmania donovani* were

initiated. Promastigotes (UR-6) were cultivated in a liquid culture, based on McCoy's SA medium with supplementation, which supported generous growth of the parasite. On SDS-PAGE analysis, the parasite homogenate showed the presence of several protein bands of subunit molecular weight, ranging from 16-80 kd, the more prominent ones being the 66 kd and 54 kd bands. Interestingly, excretory-secretory antigens of *Leishmania donovani* showed on electrophoresis two diffusely stained protein bands located around 63 kd and 50 kd. Immunochemical properties of these antigens are being evaluated.

(iii) *Immunobiology of cell surface proteins of the parasite Entamoeba histolytica* : Amit K. Chakraborty and A. C. Ghose (Supervisor)

Axenic cultivation of the *E. histolytica* strain NIH : 200 was established and antiserum was raised by immunization of rabbits with viable trophozoites of NIH : 200. The antiserum agglutinated whole trophozoites as well as reacted to the soluble amoeba antigen in counter immuno electrophoresis.

The reactivity of the antiserum to cell surface protein of the plasma membrane is being evaluated.

(iv) *Studies on snake venom toxins* : Neena Ghosh Dastidar and A. C. Ghose (Supervisor)

Studies on the snake venom toxins were initiated to determine the immuno chemical basis of cross-reaction and cross-protection between these toxins derivated from animals belonging to the same or different family. Preliminary studies carried out with the Russel's viper venom collected locally failed to detect any haemolytic activity so far. On SDS PAGE, the crude viper venom showed several protein bands of sub unit molecular weight ranging from 10 kd to 90 kd (or less), the majority being located in the low molecular weight region.

J. *Molecular Biology of Entamoeba histolytica* : Anuradha Lohia, Nezam Haider and B. B. Biswas (Supervisor)

(a) In continuation of the work reported last year we have further characterized a repetitive DNA family in *E. histolytica* which contains *S. Cerevisiae* ARS consensus 11 bp sequences. Member of this family were seen to transform *S. Cerevisiae* cells at a high frequency, when linked to a selectable marker. A "bent DNA" sequence was also identified by sequence analysis in one member of this repititive DNA family.

(b) Two temperature sensitive mutants were isolated after EMS mutagenesis and cloning in agar. The mutants were seen to lack the ability to recover after heat shock at 43°C. Further characterisation of the mutants is in progress.

K. *Genetic Studies on Mycobacteria* : Santanu Roy Chowdhury and N. C. Mandal (Supervisor)

As c-AMP level in mycobacteria is around hundred fold higher than that in *E. coli.*, we are particularly interested in studying the regulation of c-AMP metabolism in mycobacteria. For this, our initial aim is to clone the adenylcyclase gene from mycobacteria into *E. coli* and study properties of the enzyme and sequence the gene to understand its regulations at various levels of expression that might explain its high level of occurrence. For this, a lac$^+$ sorb$^+$ *cya*$^-$ *r*$^-$ *m*$^-$ strain of *E. coli* was constructed. DNA from *M. smegmatis* mc^2 6 after partial digestion with Sau3Al was ligated withe BamHI digested pBR322 DNA and transformed into above *E. coli*. The *cya*$^-$ bacteria are phenotypically *lac*$^-$ and produce white colonies on MacConky-lactose plate. The bacteria carrying *cya* clone would produce red colonies on the above indicator plate due to complementation by producing c-AMP. By such biological complementation we could not get any *cya* positive clone. Alternative approach is being made to identify the *cya* clones by Southern blot using *E. coli cya* DNA as probe.

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14. Hemagglutination and intestinal adherence properties of clinical and environmental isolates of non-01 *Vibrio cholerae*, K. Datta-Roy, C. Dasgupta and A. C. Ghose ; *Applied and Environmental Microbiology.* 55 : 2403-2406, 1989.

15. Identification of some antigenically related outer-membrane proteins of strains of *Vibrio cholerae* 01 and non-01 serorars involved in intestinal adhesion and the protective role of antibodies to them ; D. Dasgupta, K. Datta-Roy, K. Banerjee and A. C. Ghose ; *J. Medical Microbiology*, **29** : 33-39, 1989.

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17. Identification of plasmid encoded mannose resistant hemagglutinin and Hep-2 /Hela cell adherence factors of two diarrhoeagenic *Escherichia coli* strains belonging to enteropathogenic serogrup, R. Pal and A. C. Ghose, *Infection & Immunicty*, **58**, 1106-1113, 1990.

Investigations not included under Institutional Projects

A. *Pollen Morphology of some Indian Leguminosae (Fabaceae) with special reference to taxonomy :* Sikha Manna and Sunirmal Chanda (Supervisor)

Morphology of 211 pollen types of Fabaceae—studie, which revealed a wide range of variations regarding the number, position and character of apertures, exine stratifications, etc. The pollen grains of the Mimosea are mostly united in tetrads in *Mimosa pudica* and polyads in a number of species, e.g. *Samanea samani nga dulcis*, *Acacia nilotica*, etc. and only a few species are found to produce monads in *Leucaena glauca, Entada scandens.* The grains of this suborder are mostly smooth surfaced, sometimes granulated, finely reticulate and reticulate. The apertures in a great majority of the members have simple pores. Colpate and colporate apertures are uncommon. The pollen grains of Papilionaceae and Caesalpinieae are invariably monads and largely colpate, colporate or colporoidate. The porate grains repersent smaller numbers. The shape varied from prolate to oblate, surface ornamentation psilate, granulate, reticulate to striato-reticulate with or without free bacula in the lumina.

B. *Palaeoaerobiology of Quaternary Sediments of Calcutta :* Nimai Chandra Barui and Sunirmal Chanda (Supervisor)

Past and present aerobiological surveys of Greater Calcutta show incidence of large number of atmospheric fungal spores and pollen grains. Dominating grass pollen grains probably originated from *Elusina indica*, *Cynodon dactylon*, *Setaria glauca*, etc. Tree pollen in Calcutta constituted 34.5% of the total count. It has been reported that a high frequency of grass pollen grains are there in the atmosphere of Greater Calcutta followed by Arecaceae and Cheno-Amaranthaceae. However, a rather different picture gets emerged while studying thə palaeoaerobiology of the same area during Late-Quaternary period about 7030 Y.B.P. after analysing the sub-surface peat samples. The result reflected a typical swampy mangrove vegetation which occur in the present day Sunderbans, the largest mangrove complex in the southern part of West Bengal. The dominant pollen types recorded from the deposits were *Heritiera* along with *Suaeda*, *Bruguiera*, *Sonneratia*, *Barringtonia*, *Excoecaria*, *Phoenix*, *Nipa*, etc., most of which originated from typical mangroves. Pollen grains of grass along with some fresh water elements and fern spores were also recorded in large quantities. *Heritiera* is

almost totally absent from the present day mangrove complex in western part of Sunderbans. It is therefore, interesting to note the total change of vegetational pattern and consequently the change of forest character in the course of last several centuries. This has happened probably due to changed climatic condition and continued river silting, occasional tectonic movements and lately by biotic influence.

C. *Survey of Wall-flora in Calcutta and Medinipur :* Abhaya Prasad Das and Sunirmal Chanda (Supervisor)

An extensive floristic survey has been made on the Wall-vegetation of Calcutta and Medinipur, which recorded a large number of lichen, bryoptypes, pteridophytes and angiosperms. The study revealed some very interesting aspects of plant-association and life-form transformation in such inhospitable habitat. The effect of such plants on the indoor-aerosplora of Medinipur, qualitatively and quantitatively indicated a direct correlation between these two.

D. *Quaternary vegetational history, biostratigraphy and palaeoecology of Kashmir Valley :* Sunirmal Chanda (Supervisor), Kashinath Bhattacharya (Dept. of Botany, Visva-Bharati) and D. P. Agrawal, Physical Research Laboratory, Ahmedabad)

The Quaternary samples of two profiles recovered from Kashmir Valley were palynologically investigated. The results revealed a typical temperate type of vegetation dominated by *Pinus, Abies, Picea, Larix, Quercus, Carpinus, Myriophyllum,* etc. The association of *Pinus-Abies-Picea* varies from zone to zone with a fluctuation corresponding to their neighbouring elements. The work is in progress.

E. *Studies on Lithium Intercalated transition metal oxides and the non-stoichiometric V_6O_{13} :* S. Sanyal and Monisha Bose (Supervisor)

Though susceptibility wise, the room temperature intercalate δLiV_2O_5 is very similar to the high temperature intercalate γLiV_2O_5, ^{51}V NMR clearly brings out the structural difference. Thus γ undergoes a structural distortin (Phase transition) around 150K, while the highly distorted δ undergoes no further distortin even at 110K. A comparative study of the Oxygen enriched $V_6O_{13\cdot27}$ and V_6O_{13} revealed a plateau in the former, instead of the susceptibility peak at 150K in the latter. However, three inequivalent Vanadium sites were observed in both. Finally bipolaronic spin-pairing has been indicated around 150K both in γ and δLiV_2O_5 and in V_6O_{13} and $V_6O_{13\cdot27}$.

F. *Work on Discotic Liquid Crystals :* S. Sanyal and Monisha Bose (Supervisor)

A very detailed ^{13}C CPMAS NMR study of the classic discostic liquid crystal benzene-hexa-n-heptanoate from 150-360K has thrown light on the conformation, dynamics and phase transitions (solid-solid, solid-meso and meso-isotropic of this compound.

G. *Detection of neutrons and tritons during electrolysis of D_2O :* S. Sanyal and Monisha Bose (Supervisor)

Neutrons have been detected during electrolysis of 0.1M LiOD in D_2O with titanium disc as cathode and platinum foil as anode, using a NE 213 liquid scintillator (maximum count $\sim 5.2\pm1$) per 100 secs. over the background. After 29 hours of electrolysis, triton counts$\sim$90 per min. above the background count of 2.6/100 secs from 100μ1. of electrolyte were measured with a Beckman LS1800 liquid Scintillation Counter. The results have been interpreted as a low-energy (as distinct from high energy) reaction mediated by high Z, Ti/Pd atoms of the lattice through their strong polarising action on the highly unstable deuterium nuclei.

H. *Structure of a new Myoinositol Trisphosphate generated by phytase action on Nyoinositol Hexaphosphate from ^{13}P NMR :* S. Sanyal and Monisha Bose (Supervisor)

The structure of a new myoinositol trisphosphate (IP_2) a cellular second messenger (generated by phytase action on myoinositol hexaphosphate) which can regulate Ca^{2+} release from mung bean (Vigna radiata) has been determined from ^{31}P FTNMR studies. From a comparative study of ^{31}P chemical shifts in 1, 4, 5 and 1, 3, 4 myoinositol trisphosphate and the new IP_3, as also in I-1-P and I·2-P myoinositol monophosphates under identical conditions, the new IP_3 has been identified as 2, 4, 5 myoinositol trisphosphate.

Publications

1. Inbreeding in zoo animals ; A. K. Roychoudhury ; *Zoo's print* ; **4**(8), 15-16, 1989.

2. White tiger : A gift of Nature ; A. K. Roychoudhury ; *Science Courier*, **1**(2), 8-11, 1990.

3. Late Quaternary palaeoenvironment of Brahmaputra basin, North Eastern India ; Kashinath Bhattacharya and Sunirmal Chanda ; *IPPCCE Newsletter*, **5**, 12-14, 1989.

4. Origin and evolution of life on earth ; Sunirmal Chanda and Kashinath Bhattacharya ; *Science Courier*, **1**(1), 31-34, 1989.

5. Late Quaternary Vegetational history and biostratigraphy of Loktak Lake of Manipur, India ; Partha Roy and Sunirmal Chanda ; *Trans. Bose Res. Inst.*, **50**(3), 73-80, 1987.

6. Late Quaternary Vegetational history and datings of some sediments of Loktak Lake and adjoining areas of Manipur, India ; Partha Roy and Sunirmal Chanda ; *Journal of Palynology*, **25**, 1-14, 1989.

7. Application of pollen phenolics in understanding plant affinity and phylogeny—a preliminary report : K. K. Mukherjee and S. Chanda ; *Grana*, **29**, 157-159, 1990.

8. ^{51}V NMR of Layered δLiV_2-O_5 ; M. Bose and A. Basu ; *J. Solid State Chem.*, **81**, 30-34, 1989.

9. A comparative study of $V_6O_{13\cdot 27}$ and V_6O_{13} ; M. Bose, *J. Solid State Chem.*, **81**, 147, 1989.

Participation in Academic Activities, Conferences/Symposia/Training Programmes

Department of Physics :

Prof. M. H. Engineer

(i) Visited and delivered an invited talk at Univ. of Marburg in August 1989 on 'Berry's Phase'.

(ii) Visited the University of Cardiff, Wales for one week in Sept. 1989 on invitation.

(iii) Visited the University of Marbarg for one week in Aug-Sept. 1989 on invitation.

(iv) Delivered an invited talk on "Exactly solvable two phase flows", at the International Workshop on Non-linear Dynamics, Bharatidasan University, Nov. 1989.

(v) Delivered an invited survey talk on 'Current Status of Cold Fusion' at the Seminar on Cold Fusion held at SINP, June 1989.

(vi) Participated in the Teaching Programme of Bose Institute.

(vii) Gave a course on BIO STATISTICS of Calcutta University.

2. Prof. S. C. Roy attended the following Seminars/Symposia :

(i) Ninth International Conference of vacuum ultraviolet Radiation (VUV9) held in Hawaii during July 17-21, 1989.

(ii) Topical meeting on Radiation in many splendours held at VECC, Calcutta during September 14-15, 1989.

(iii) One day seminar on Fifth Symposium on Atomic Collisions held at University of Kalyani on January 13, 1990.

(iv) 8th National Symposium on Radiation Physics (NSRP-8) held at Bombay during January 17-19, 1990.

(a) Prof. S. C. Roy visited University of Pittsburgh for two months in connection with the collaborative research project on Photon-Atom Scattering during May-July, 1989.

(b) Prof. S. C. Roy visited Siti Sains Malaysia, Penang in connection with the collaborative project on photon-atom scattering during December 18-31, 1989.

(c) Prof. S. C. Roy participated in the Teaching Programme of Bose Institute.

3. Dr. A. K. Chatterjee attended and participated in the 8th National Symposium on Radiation Physics held at B. A. R. C., Bombay in the month of January, 1990. He presented two papers at this symposium.

4. Dr. I. Bose paticipated in and presented papers at

(i) The Solid State Physics Symposium, organised by the Department of Atomic Energy, held at Indian Institute of Technology Madras, (December 19-22, 1989).

(ii) The International Conference on Superconductivity held at Bangalore (January 10-14. 1990).

(a) Dr. I. Bose Participated, on invitation, in the Research Workshop in Condenced Matter, Atomic and Molecular Physics, held at International Centre for Theoretical Physics, Trieste, Italy for the period of July-August, 1989.

(b) Dr. I. Bose participated, on invitation, in the Indo-Soviet Workshop in Condensed Matter Physics held in the Indian Institute of Science, Bangalore (February 20-24, 1990).

(c) Dr. I. Bose delivered on invitation

(i) two lectures at the Centre for Solid State Research, Presidency College, Calcutta,

(ii) a set of lectures on High Temperature Superconductivity at Saha Institute of Nuclear Physics (SINP), Calcutta,

(iii) a seminar talk on order-parameter preserving antiferromagnets at SINP, Calcutta,

(iv) a talk at the Workshop on Physics of Ceramic Superconducting Materials held at SINP, Calcutta (December 28, 1989—January 6, 1990),

(v) a set of lectures on High-T_c superconductivity at the Indian Association for the Cultivation of Science, Calcutta,

(vi) two lectures at I.C.T.P., Triests Italy,

(vii) One lecture at the S. N. Bose National Centre for Basic Sciences, Calcutta,

Dr. D. Home gave the following talks :

	Date	Place	Title of Talk
(a)	May 17-19, 1989	Indian Institute of Technology, Madras (Workshop on "A Modern Course in Quantum Mechanics" sponsored by ICTP, Trieste and UGC, India)	Conceptual Foundations of Quantum Mechanics I, II and III).
(b)	August 28, 1989	Central Research Laboratory, Hitachi Ltd, Tokyo, Japan (Third Int. Symp. on Fountions of Quantum Mechanics in the Light of New Tecnology)	Search for New Tests and Facets of the EPR Paradox from Eelementary Particle Physics.
(c)	September 1, 1989	Department of Physics, Waseda University, Tokyo, Japan	Bell-type Inequalities for $k^{\alpha}k^{\sigma}$ Type Systems.
(d)	September 4, 1989	Advanced Research Laboratory, Tokyo	Time-dependent Aharonov-Bhom Effect.
(e)	November 6, 1989	Indian Institute of Technology, Kharagpur (INSA sponsored Lecture)	Foundations of Quantum Mechanics : Open Questions and New Challenges.
(f)	January 6, 1990	Research Centre for Mathematical and Physical Science, Chittagong, Bangladesh (Int. Conf. on Foundations and Philosophy of Mathematical and Physical Sciences)	Causality and Realism in Quantum Mechanics.

Dr. D. Home visited and participated in the following :

1. Int. Conf. on Conceptual Foundations of Quantum Theory, New Delhi, Dec. 28, 1989-Jan, 2, 1990.
2. Research Centre for Mathematical and Physhical Sciences, Chittagong, Bangladesh, Jan. 4-10, 1990.
3. Annual Meeting of the Indian Science Writers Asssociation as a Member of the National Executive Committee, October 21, 1989.

1. Dr. B. K. Chatterjee participated as an invited speaker in the panel discussion on "Cold Fusion" held at Saha Institution of Nuclear Physics on June 6, 1989.

2. Dr B. K. Chatterjee attended a conferance on "Radiation in many splendours" at VECC, Calcutta, held during September 14-15, 1989.

3. Dr. B. K. Chatterjee delivered an invited talk on "Experimental Investigations of Ion-Molecule Reactions" at the Fifth Symposium on Atomic Collisions held at the University of Kalyani on January 13, 1990.

4. Dr. B. K. Chatterjee attended a conferance on "PATPA-90" held at SINP/VECC/BARC during February 5-7, 1990.

Department of Chemistry

1. Prof. A. K. Barua delivered an invited lecture on 'Drugs from the sea' in a Seminar on "Ocean and its Resources in the service of Mankind" organised by the Royal Society of Chemists (Eastern India Section) on Nov. 11, 1989 held at The Indian Institute of Chemical Biology, Calcutta.

2. Prof. A. K. Barua participated in the Pre-IUPAC meeting held at IICB, Calcutta from 31st Jan. to 2nd Feb. 1990 as a member of the Local Organising Committee.

3. Prof. A. K. Barua participated in the Workshop 'On Marine Natural Products' held at USIS Library Auditorium on Feb. 1, 1990 both as a speaker and as one of the organisers.

4. Prof. D. P. Chakraborty was declared the Acharya P. C. Ray Memorial Awardee of 1988 of the Indian Chemical Society.

5. Prof. D. P. Chakraborty delivered a "Platinum Jubillee Lecture" in the Chemistry Section of Indian Science Congress Association at Cochin ISCA Session.

6. Prof. D. P. Chakraborty as the Scientist-in-Charge of Organic Chemistry Section of Annual Convention of Chemists Organised a Seminar on "Economic organic chemicals."

7. Prof. J. Dutta as the "Scientist-in-Charge" of the Biochemistry Section of the Annual Convention of Chemist 1989, organised by the Indian Chemical Society, held at Indore in December 1989, organised a symposium on 'Microbial

Oxidation'. He delivered a plenary lecture entitled "Effect of Hilsa Fish Oil on Atherosclerosis".

8. Prof. J. Dutta took part in the teaching programme in the Department of Chemical Technology, Calcutta University as an Invited Lecturer.

9. Prof. P. Chakrabarti :

was invited and presented a paper entitled "Characterization of a lectin from *Mycobacterium smegmatis*" in the 11th International Lectin Meeting in Tallinn, USSR,

—delivered a lecture on "Erythrocyte membrane abnormalities in chronic myelogenous leukemia" in the 2nd International Symposium on Biochemical Roles of Eukaryotic Cell Surface Macromolecules in New Delhi,

—chaired a session in the above symposium,

—delivered a lecture at the Max-Planck Institute for Biophysik, Frankfurt, FRG,

—delivered a lecture at the Shemyakin Institute of Bio-organic Chemistry, Moscow, USSR.

—Organized the IUB-cosponsored "International Conference on Structure and Functions of Biomembranes" in Calcutta with support from DST, DBT, CSIR, INSA, UGC, ICMR, DAE and the National Science Foundation, U.S.A.

—delivered a lecture in the above Conference

—delivered a lecture in the National Symposium on Biophysics at the Saha Institute of Nuclear Physics, Calcutta.

10. Dr. A. Ghosh has delivered an invited lecture on the "Structure, function and Biological activities of Marine Lipids at the "Pre-IUPAC Symposium 1990, Chemistry of Natural Products", at IICB during Jan. 31—Feb. 2, 1990.

11. Dr. A. Ghosh participated in the teaching programme of Bose Institute and delivered a series of lectures on "Lipidology" to the advanced students.

12. Dr. (Mrs) Dolly Ghosh and Eli Mukherjee attended the "International Conference on Structure & functions of biomembranes" on December 1989 at Calcutta. Title of the paper 'In vitro studies on prostaglandin biosynthesis in goat seminal vesicles : effect of Ca^{2+} ion."

13. Dr. Manas Chakrabarty and Sm. Archana Batabyal participated in

(a) "Calcutta : Natural Products Symposium, 1990 (Pre-IUPAC Symposium 17)" held at Indian Institute of Chemical Biology, Calcutta during 31.1.90 to 2.2.90.

(b) "Sixth National Symposium on Recent Advances in Organic Chemistry" held at the University of Kalyani, Kalyani during March 15-16, 1990.

14. Dr. Manas Chakrabarty participated in the Teaching Programme (Course Work) of Bose Institute.

15. Dr. Manas Chakrabarty has been elected a Member, Board of Associate Editors of the Journal of Indian Chemical Society (J. I. C. S.), Calcutta for the 1.1.90—31.12.91.

16. Dr. Manas Chakrabarty has been elected a Member, Publication Committee of the J. I. C. S. for 1990.

17. Dr. Manikuntala Kundu :

—worked in the University of Hull, UK and the University of Wisconsin, U. S. A. with Prof. Colin Ratledge and Dr. Kuni Takayama under a World Health Organization Training Programme,

—organized the "International Conference on Structure and Functions of Biomembranes" in Calcutta,

—participated in the 2nd International Symposium on "Biochemical Roles of Eukaryotic Cell Surface Macromolecules" in New Delhi.

18. Dr. Joyoti Basu :

—organized the "International Conference on Structure and Functions of Biomembranes" in Calcutta,

—participated in the 2nd International Symposium on "Biochemical Roles of Eukaryotic Cell Surface Macromolecules" in New Delhi,

—participated in a Amino Acid Analyser Training Course in Cambridge, England.

19. Sri Subhansu Ray :

—participated in the "International Conference on Structure and Functions of Biomembranes" in Calcutta,

—participated in the 2nd International Symposium on Biochemical Roles of Eukaryotic Cell Surface Macromolecules in New Delhi.

20. T. Anoopkumar :

—participated in the International Conference on "Structure and Functions of Biomembranes" in Calcutta,

—presented a paper in the Indo-US workshop on "Bioactive Substances from Marine Organisms" in Calcutta.

21. Eli Mukherjee presented a paper entitled "Subcellular localization of prostaglandin E_2 synthetase of goat seminal vesicle" in the Calcutta Chapter seminar of Society of Biological Chemists in April 1989.

22. Dr. Ramaballav Roy presented a paper entitled 'Role of fish oil in the lipogenesis of rat liver, at the setellite meeting on 'Polyunsaturated fatty acid and eicosenoids' held at Nizem Institute of Medical Science, Hyderabad Nov. 1989.

23. Dr. Ramaballav Roy presented a paper entitled 'Effect of n-3 enriched fish oil in the lipogenesis of fish level' at the National Seminar on '40 years of Aquaculture held at Central Inland Fisheries Research Institute, Kausalyaganj, Bhubaneswar, Orissa during December 1989.

24. Dr. Ramaballv Roy attended the International Conference on Structure and function of biomembranes' held at Calcutta during Dec. 1989. Title of the paper "Regulation of membrane structure and function during cold adoptation in *Cyprinus carpio*'.

Department of Botany

Dr. B. Majumder attended National Seminar on Recent advances in Genetics and Plant Breeding Research in India. BHU, Varanasi, 15-16, Nov. 1989 and presented paper entitled 'Induced mutations in rice for its improvement'.

Prof. Sunirmal Chanda participated in the following Seminars/Symposia/ Conferences :

1. Attended a workship on "Coastal Proeesses and coastal Quaternaries of Eastern India" at the Geological Survey of India, Eastern Region, Calcutta on 9 and 10 May 1989, Chaired a session on "Overview of Coastal Scenaries" on 9 May

and "Environmental impact of Management" on 10 May, Delivered the Plenary lecture in the concluding session.

2. Attended "Joint Canadian and Panamerican Symposium on Aerobiology and Health" from 7 to 9 June 1989 at Ottawa under the joint auspices of Canadian Ministry of Health and Welfare and University of Montreal, as an observer in the capacity of President, International Association for Aerobiology.

3. Attended "World Environment Day" Seminar of the Calcutta Electric Supply Corporation at Titagarh Generating Station as Guest-of-Honour on 4 July 1989 and delivered a lecture on "Role of environmental biopollutants in urban and rural India".

4. Took part in Refreshers' Course in "Trends in Plant Taxonomy" at the Botany Department, Patna University as guest speaker and delivered a course of three lectures from 2-8 August, 1988,

   (a) Aspects and prospects of pollen morphology in plant taxonomy ;

   (b) Palynological technology and microtechniques, and

   (c) Quaternary pollen analysis and vegetational history.

5. Attended 5th National Conference on Aerobiology under the auspices of the Dept. of Botany, University of Kashmir from 25-30 September 1989, delivered the inaugural key-note address, a Guest Lecture and Chaired two scientific sessions.

6. Attended a colloquium on "Environmental aspects of climatic change" under the auspices of Centre for Atmospheric Sciences, University of Calcutta at the Saha Institute of Nuclear Physics from 19 to 21 Jan., 1990 and Chaired a Technical Session pertaining to "Palaeoclimatic in relation to International Geosphere and Biosphere Programme".

7. Delivered two invited lectures sponsored by Kharagpur Chapter of the Indian National Science Academy in the Indian Institute of Technology, Kharagpur on 6 and 7 February 1990 entitled (a) Palynology and environmental biopollutions and (b) Palynology and biostratigraphy.

8. Attended a Seminar on "Problems of air pollution in industrial and mining environments" under the auspices of Centre for Study of Man & Environment on 14 March 1990 at the Bose Institute where delivered an invited lecture on "Environmental biopollution".

9. Delivered two visiting Professorship lectures at Visva-Bharati, Santiniketan on 22 and 23 March, 1990, entitled (a) Origin and evolution of life through ages and (b) Applications of Palynology.

10. Attended "National Seminar on Advances in Botanical Research" from 24-25 March, 1990 at the Botany Department, Visva-Bharati, Santiniketan, delivered an invited lecture on "Implications of Quaternary Pollen analysis in India" and Chaired a scientific session.

11. Attended National Science Day Celebration jointly organized by the State Council of Education, Research and Training, Govt. of West Bengal and All India Science Teachers' Association at the SCERT on 29 March, 1990 and deliverd a key-note address on "Environmental biopollution and its impact on human health".

Department of Microbiology

Prof. A. C. Ghose acted as a member of the scientific panel of several PRC of the Indian Council of Medical Research, New Delhi. He also acted as a member of the Scientific Advisory Committee of the National Institute of Cholera and Enteric Diseases, Calcutta. He was associated with the teaching of M. Sc. students of the Department of Biochemistry, Calcutta University.

Prof. S. L. Chakrabarty acted as a member of the Scientific panel of the Indian Council of Agricultural Research (Fisheries), New Delhi.

Prof. A. K. Mishra acted as a member of the Ph.D. committee of Botany of University of Calcutta. He was associated as an expert panel member on Biology of the Indian Jute Industries Research Association, Calcutta.

Dr. Arati Das and Dr. Geeta Nanda attended the 33rd Annual General meeting of the Indian Mycological Society, held on September, 1989, in the Department of Botany, Calcutta University.

Dr. T. B. Samanta attended the International Symposium on Biological oxidation systems held at Indian Institute of Science, Bangalore during October 23-26, 1989 and

delivered lectures on "Biological probe into a novel microsomal glutathione S-transferase in *Aspergillus ochraceus* TS" and "Substrate specificity and siructure of the active site of linalool-8-monooxygenase."

Dr. Roma Chakravarty was nominated as one of the members of the Editorial Board of the Indian Journal of Microbiology. She delivered an invited lecture on Environmental pollution on June 5, 1989 at the Science Club, Basirhat.

Dr. Sharmila Chattopadhyay attended the 7th Plant tissue culture conference held in NEHU, Shilong, during October 18-20, 1989 and presented a paper, "Elicitor-induced accumulation of L-DOPA in suspension culture of *Mucuna pruriens*."

Shri Tapas K. Sengupta and Shri Ramkrishna Sadhukhan attended the 58th Annual meeting of the Society of Biological Chemistry (India) held at IVRI, Izatnagar during October 16-18, 1989. Shri Tapas Sengupta received the "Best Poster" award (Microbial Biochemistry).

Departmental Seminars were organised by Dr. Arati Das, Dr. Bijoy Mohanty and Shri Subha Manna.

Department of Biochemistry

Prof. B. B. Biswas participated in the following symposia/meetings.

1. Delivered valedictory lecture of Refresher Course on Plant Sciences at Meerat University under UGC programme in April, 1989.
2. Delivered lecture in Plant Molecular Biology Workshop sponsored by DBT at Delhi in May, 1989.
3. Participated in Annual Meeting of Indian Academy of Sciences held at Bhopal in November, 1989.
4. Visited several laboratories in U. K., Germany, Belgium and USA and FAO Office in Rome, Italy under the UNDP progromme and delivered lectures in September-October, 1989.
5. Participation in Embo Symposium on Molecular Communication in Higher Plants at Heidelberg in September, 1989.
6. Delivered inaugural address in National Symposium on Astrophysics held at VEC, in January, 1990.

7. Valedictory lecture in National Test House in February, 1990.
8. Valedictory lecture in the Workshosp on for mathematical Models in Biology at Calcutta Mathematical Society on 24th February, 1990.
9. Participated in Bhatnagar Laurate Meeting held in Delhi in April, 1990.
10. Participated in Post-Graduate teaching in Molecular Biology and Biophysics, Calcutta University.
11. Delivered 1989 Parija Memorial Lecture at Utkal University, in March, 1990.
12. Acted as a member of the Jawaharlal Nehru Univertity Biotechnology Advisory Board Meetings, 1989-90.
13. Attended the Council Meeting of Indian Statistical Institute as a member.
14. Attended the Governing body meeting of Presidency College as a member.
15. Participated in the meetings of Senate, Calcutta University.
16. Participated in the meetings of Faculty of Interdisciplinary and Applied Sciences, University of Delhi (South Campus).
17. Participated as a member in several Committe Meeting of DBT and ICAR.

Prof. S. Ghosh participated in the following symposia/meetings.

1. Acted as a member of "Board of Studies" Department of food Technology and Biochemical Engineering, Jadavpur University.
2. Acted as a member of "Board of Biotechnology Programme" Madurai Kamraj University, Madurai, Tamilnadu.
3. Acted as a member of Guha Institute of Biochemistry, Calcutta.
4. Delivered a lecture in the International Conference of Structure and Function of Biomembranes" held at Bose Institute, November-December, 1989.
5. Acted as an Honorary Lecturer in the Department of Physiology, Calcutta University.

6. Acted as an Honorary Lecturer in the Department of Biophysics, Molecular Biology and Genetics, Calcutta University.

7. Conducted a practical course of Genetic Engineering Techniques for Biotechnology Programme, Jadavpur University.

Prof. R. K. Mandal participated in the folliwing symposia/meetings/Seminars.

1. Lecture on "Impact of man on Nature" on world Environment Day celebration meeting organized by Kandi Bijnan Parishad, Murshidabad.

2. Seminar lectures on "Impact of Man on Nature" and "Island and Sea Environment of Andaman Islands" at the Central Sericultural Research and Training Institute, Berhampore, W. B.

3. Talk on "Biotechnology : Problems and Prospects" at the P. G. Biology Teachers Orientation Course for Central Schools, organized by Kendriya Vidyalaya, Salt Lake City, Calcutta.

4. Popular lecture on "Genetic Engineering and Biotechnology in Human Welfare" in the National Science Week Celebration at Jadavpur University.

5. Talk on "Biotechnology in Animal Science" at the seminar on "Breeding policy for livestock in state of West Bengal", organized by West Bengal Dairy and Poultry Development Corporation.

6. Acted as Guest Lecturer/Examiner of different Life Science Departments of Calcutta, Jadavpur and Kalyani Universities.

7. Visited U.S.A., U.K. and Italy under the study tour programme of UNDP-FAO project on "Plant Improvement using Modern Biotechnology" and delivered seminar lectures at the Department of Agronomy, University of Kentucky, Lexington ; Department of Biology, University of Tennessee, Knoxville ; Oak Ridge National Laboratory, Oak Ridge ; University of Texas Health Centre at Tyler, Texas ; Department of Chemistry and Biochemistry, University of Notre Dame, Indians. Besides these, also visited USDA Agricultural Research Center, Beltsvilla ; NIH, Bethesda ; University of Texas at San Antonio ; University of Wisconsin ; Agra-Cetus Corporation, Madison ; Albert Einstein College of Medicine, New York ; Plant Breeding Institute, Cambridge, U.K. and F.A.O., Rome.

Prof. N. C. Mandal participated in the following symposia/meetings/seminars :

1. Returned after spending two years (on study leave from Bose Institute) at NIH, USA as Visiting Scientist and joined the Department on 02.05.1989.

2. Attended G.R.C. Meeting held at Laksha Dwip.

3. Chaired a session on "Structure and Function of Proteins" in one day Symposium organized by the Calcutta Branch of the Society of Biological Chemists (India), held at I.I.C.B., Calcutta.

4. Participated in teaching on Molecular Biology in M.Sc. (Biochemistry) courses of Calcutta University.

5. Participated in predoctoral teaching programme of Bose Institute.

6. Delivered several lectures on Developmental Regulation in Bacteriophage Lambda in the UGC Summer courses for the teachers of under-graduate Colleges organized in the Department of Botany, Calcutta University.

7. Delivered lectures in Technician Training course on Techniques in Recombinant DNA Research.

8. Supervised a student for carrying out a research project as part fulfillment of M.Sc. Examination in Biophysics, Molecular Biology and Genetics, Calcutta University.

Dr. B. Bhattacharyya :

1. Received the SS Bhatnagar award of CSIR for the year 1988 for his outstanding contribution in Biological Sciences.

2. Participated in Pre-doctoral teaching programme of Bose Institute.

Dr. P. Gupta Participated in the following Symposia/meetings and delivered lectures :

1. Conducted a Department of Biotechnology sponsored Technician Training course on "Techniques in Recombinant DNA Research" during May 15 to July 21, 1989.

2. Acted as Examiner for M.Sc. Examination of Calcutta University, Calcutta and for Ph.D. Genetics students of Indian Veterinary Research Institute, Izatnagar.

3. Delivered a talk on Chromosome structure at an intensive Training programme

for postgraduate teachers (Biology) on 23.6.1989 at Kendriya Vidyalaya No. 1, Salt Lake, Calcutta.

4. Delivered a symposium lecture on "DNA probes in sex determination" in the symposium on Advances in Biotechnology, 58th Annual General Meeting of the Society of Biological Chemists (India) held at IVRI ; Izatnagar during October 16-18, 1989.

5. Acted as joint Convener, Course Committee for Ph.D. course work Programme 1989-90 of our Institute and taught in the Advanced courses on Genetic Engineering & Biotechnology and Genetics.

6. Presented two lead papers in the National Seminar on Genetics Applied to Livestock Production held at Veterinary College, Anand, Gujarat during October 23-25, 1989.

7. Invited to teach in the refresher course on Statistics for Biologists at the School of Biological Sciences, Madurai Kamarj University and M.Sc. Biotechnology students at Poona University, Pune.

8. Participated in the international conference on Sex determination and Dosage compensation held at IISc, Bangalore during November 6-9, 1989.

9. Presented our work on cloning and characterization of some repeated DNA sequences of farm animals at VIII All India Cell Biology Conference held at CCMB, Hyderabad during December 27-29, 1989.

10. Delivered a lecture on "A closer look at the chromosomes" at the National Bureau of Animal Genetic Resources & National Institute of Genetics, NDRI Campus, Karnal, Haryana on 14.2.1990.

11. Visited Central Institute of Research on Goats, Farah, Mathura during February 16-17, 1990.

12. Participated in the Seminar on Formulation of Breeding Policy for Livestock in West Bengal held at Great Eastern Hotel, Calcutta during March 23-24, 1990.

13. Acted as a resource person in the DBT sponsored short term training course on "Chromosome and gene manipulation in fishes held at School of Biological Sciences, Madurai Kamraj University, Madurai during March 26-31, 1990.

Sk. Golam Faruk presented a talk on "Cloning and characterization of repeated DNA sequences isolated from goat and pig genomic DNAs" at the 58th SBC(I) meeting held at IVRI, Izatnagar during October 16-18, 1989.

Sk. Golam Faruk presented a talk on "Characterization of repetitive DNAs of farm animals" at the one day seminar on "Structure and Function of Nucleic acids & Proteins" organized by the SBC(I) Calcutta Branch held at IICB, Calcutta on March 21, 1990.

Sri Sib Hari Datta presented a talk on "Lack of expression of β-lactamase gene of RP4 in *A. brasilense*" at the one day seminar on "Structure and Function of Nucleic acids & Proteins" organized by the SBC(I) Calcutta Branch held at IICB, Calcutta on March 21, 1990.

Department of Biophysics

1. (a) Dr. Asok Banerjee visited USA (June '89) at the invitation of NSF, USA to attend a meeting of conversation on biomolecular structure & dynamics, at State University of Albany, USA in June '89.

   (b) Dr. Banerjee visited NIH ; Medical foundation, Buffalo (Prof. Duax) ; Rochester Medical Centre, (Prof. Sobell) USA and had formal talks and scientific discussions with scientific colleagues (1989) on various collaborative projects on application of Computer modelling & Crystallography in biology.

   (c) Dr. A. Banerjee delivered an invited talk on Mathematical molecular modeling in biology & medicines, (Feb. 22-24, 1989) at I.I.C.B. Workshop, Calcutta.

   (d) Dr. Banerjee delivered a talk on mathematical molecular modeling and application computers in modern biology & medicine at Institute of Engineers, Calcutta (1989).

   (e) Dr. Banerjee participated as one of the Organisers of "National Symposium on Biophysics" (Feb. 20-22, '90) held at Saha Institute of Nuclear Physics, Calcutta.

   (f) Dr. Banerjee invited to present four accepted papers at International Union of Crystallographic Congress, Bordeaux, France (1990) & nominated by INSA as Indian deligate member.

2. Mr. Goutam Biswas/Miss. Sampa Pain/Asok Banerjee presented papers at XX

National Seminar on Crystallography, December (27-29), 1989 at BARC, Bombay.

Dr. Monisa Bose gave the following talks at different Institutes, Universities, Convention etc.

1. "Phase Transitions in a Discotic Liquid Crystal from ^{13}C NMR" Talk given in October 1989 at NCL, Pune under the Emeritus Scientist's Programme.
2. Conformation and Dynamics of the simplest discotic mesogen from ^{13}C NMR. Talk given at the Nucelar Physics Division at BARC, Bombay in Nov. '89.
3. "High Resolution NMR in organic Solids" as Invited speaker at Symposium on "The Chemistry of Economic Organic Chemicals including Applications of Modern Methodlogy" at the Annual Convention of Chemists, Indore, December 1989.
4. Delivered a Two week Course on 'Solid State Physics' at the Physics Deptt., University of Mysore as UGC Visiting Professor from Feb. 26—March 9, 1990.
5. Delivered a talk on "Chain Dynamics, Conformation and Phase transition on in benzene-hexa-n-heptanoate from ^{13}C NMR" at Raman Research Institute, Bangalore in March 1990.

Animal Physiology Section

Prof. A. K. Medda delivered invited lectures at the Kendriya Vidyalaya Sanghatan, Calcutta Branch, on Comparative Thyroid Hormone Physiology. Dr. Rama Ghosh and Dr. A. K. Dasmahapatra presented papers in the 77th Session of Indian Science Congress Association at Cochin in February, 1990. Dr. A. K. Ray participated in the teaching course of Bose Institute, Calcutta.

Ph.D. Degree Awarded

Name of the Candidate	Title of the Thesis	Name of the Research Guide
Department of Physics		
1. Haimanti Chakrabarti	Investigation on the Concentration dependence of diffusion coefficient in electrolytic solutions.	Dr. S. N. Changdar

Department of Chemistry		
2. Gopal Chandra Kundu	Studies on protease inhibitor from the seeds of *Artocarpus integrifolia* Linn.	Prof. N. K. Sinha
3. Parames Chandra Sil	Studies on basic trypsin-subtilisin inhibitor from marine turtle eggwhite	Prof. N. K. Sinha
4. Dipak Kumar Mandal	Studies on alpha-2-macro-globulin-like protease inhibitor from marine turtle egg-white	Prof. N. K. Sinha
5. Debasis Ghoshal	Water soluble vitamin deficiency and immunocompetence	Prof. A. K. Barua
6. Kishore Kumar Mohanty	Investigations in relation to Insecticides of Plant origin	Prof D. P. Chakraborty
7. Uttara Das	Structure and synthetic Studies on Natural Products	Prof. D. P. Chakraborty
8. Amit Chakrabarti	Structure, synthesis and Phytochemistry of some Phytochemicals	Prof. D. P. Chakraborty
9. Manua Mukhopadhyay	Effect of fatty acid supplementation on some biochemical parameters of *Neurospora crassa*	Prof. P. Chakrabarti
10. Tapan Kumar Dhar	Studies on Marine Lipids of Sunderban Mangrove area	Dr. A. Ghosh
11. Sagar Sona Jash	Studies on Heterocyclic Compounds	Dr. P. Bhattacharyya

12. Barsanjit Mazumder	The interactions of amphiphilic drugs with transport enzymes and lipids in different organs of rat *in vitro* and *in vivo*	Dr. P. C. Sen
Department of Botany		
13. Partha Roy	Quaternary pollen analysis and biostratigraphy of the sediments of Loktak area, Manipur, India	Prof. Sunirmal Chanda
14. Abhay Prasad Das	On the floristic and palynological surveys of Darjeeling and adjoining places	Prof. Sunirmal Chanda
Department of Microbiology		
15. Indrani Roy	Studies of Nitrogen fixing and hydrocarbon utilizing bacteria	Prof. A. K. Mishra
16. Subhas Chandra Jana	Studies on relationship among member of the Azotobacteraceae and effect *in vitro* of some pesticides on Nitrogen fixation in *Azotobacter chroococcnm*	Prof. A. K. Mishra
17. Syamal Kumar Raha	Studies on L-asparaginase activity of a fungus	Prof. S. L. Chakraborty
18. Suchismita Datta	A study on the resistance pattern of a chromate tolerant bacterium	Dr. A. L. Chandra
Department of Biochemistry		
19. Anand Bachhawat	Studies on Iron Transport and outer Membrane Proteins of *Azospirillum brasilense*	Prof. S. Ghosh

20. Amit Mukherjee	Biochemical Studies on the Utilization of Fructose by *Azospirillum brasilense*	Prof. S. Ghosh
21. Debasis Raha	Cloning of Tubulin genes of *Vigna radiata* & Studies of Their Expression during Germination	Prof. B. B. Biswas
22. Maitrayee Rudra	Myoinositol-1-P dehydrogenase from *Vigna radiata* : Regulation of Expression of this enzyme in Plant	Prof. B. B. Biswas
23. Tapas Das	Studies on the High affinity Mutant Repressor of Bacteriophage Lambda	Prof. N. C. Mandal
Animal Physiology Section		
24. Swades De	Subcellular action of thyroid hormone in fish	Dr. Arun Kumar Ray
P. M. C. G. Section		
25. P. Nayak	Application of Plant Cell Culture technique in certain Monocotyledonous crop plants for their use in plant genetical research	Prof. S. K. Sen
26. Krishna Dhar	Tissue culture *Chrysantheum cinerariaefolium* Vis. with special reference to pyrethrin synthesis in callus cultures	Dr. Amita Pal

GRANT-IN-AID-SCHEMES

Council of Scientific & Industrial Research

Scheme No. 1. Progression on cellular senescence in embryos of deteriorating wheat and rice seeds

Investigator-in-Charge : Dr. Swati Sen-Mandi

Senior Research Fellow : Smt. Smritimala Ganguly (upto 28.2.90)

Scheme No. 2. Heat induced cellular events in crop plants

Investigator-in-Charge : Dr. (Mrs) Bharati Ghosh

Junior Research Fellows : Shri Sadhan Kumar Chowdhury (upto 28.2.89)

: Smt. Anindita Bose (From 8.9.89)

: Smt. Malabika Roy (From 7.3.90)

Scheme No. 3. Protein folding : Structure-function relationship in unfolding and refolding of a double-headed proteinase inhibitor from turtle eggwhite.

Investigator-in-Charge : Prof. N. K. Sinha

Junior Research Fellow : Sri Tapan Kr. Chaudhry

Scheme No. 4. Regulation of membrane structure and function during seasonal adaptation in *Channa punctatus*

Investigators-in-Charge : (i) Dr. (Mrs.) Dolly Ghosh
Bose Institute, Dept. of Chemistry

(ii) Prof. A. B. Das
Viswa Bharati University
Santiniketan

Research Associate : Dr. Ramaballav Roy

Scheme No. 5. Investigation on the role of Ca^{2+} in the regulation of Prostaglandin Biosynthesis

Investigator-in-Charge : Dr. (Mrs) Dolly Ghosh

Junior Research Fellow : Sri Manas Kr. Pathak

Scheme No. 6. The interaction of drugs with transport adenosine triphosphatase and lipids in model membranes Part II

Investigator-in-Charge : Dr. P. C. Sen

Junior Research Fellow : Sri Goutam Adhikary

Scheme No. 7. Synthetic Approaches to indolocarbazoles

Investigator-in-Charge : Dr. Manas Chakrabarty

Junior Research Fellow : Sm. Archana Batabyal (From 7.8.89)

Scheme No 8. Structure Function and Sequence Homology of Cytochrome P_{450}

Investigator-in-Charge : Dr. Timir B. Samanta

Senior Research Fellow : Dr. Debjani Datta (upto 31.1.90)

Scheme No. 9. Immobilization of steroid transforming micro-organisms

Investigator-in-Charge : Dr. Timir B. Samanta

Junior Research Fellow : Shri Tapan Kr. Dutta

Scheme No. 10. "Characterization of cell-associated haemaglutinin adherence" factor of enteropathogenic *E. coli* by biochemical, immunological and genetic approaches. Development of immunological assay and genetic probes for the organism".

Investigator-in-Charge : Prof. A. C. Ghose

Junior Research Fellow : Shri Samir Kumar Barari

Scheme No. 11. Production and purification of L-asparaginase from *Vibrio cholerae* for the study of antineoplastic activities"

Investigator-in-Charge : Prof. S. L. Chakraborty

Senior Research Fellow : Shri Susanta Kumar Dey (upto 31.10.89)

Scheme No. 12. Production of ethanol from cellulosic wastes

Investigator-in-Charge : Prof. S. L. Chakraborty

Senior Research Fellow : Shri Samir Kumar Roy

Scheme No. 13. Clinical evaluation of an L-asparaginase from *Cylindrocarpon obtusisporum* MB10, a soil isolated fungus

Investigator-in-Charge : Prof. S. L. Chakrabarty
Senior Research Fellow : Shri Syamal Kumar Raha (upto 18.9.89)

Scheme No. 14. Biochemical studies on the movements of higher plants (upto 31.12.1989)

Investigator-in-Charge : Dr. (Mrs.) S. Biswas
Research Scholar : Sm. Ambalika Roy (upto 31.12.89)

Scheme No. 15. Tubulin substructure and identification of its functional domains

Investigator-in-Charge : Dr. B. Bhattacharyya
Research Scholars : Krishnendu Mukhopadhyay
Sm. Manjari Majumdar

Scheme No. 16. DNA replication in the Yeast *Saccharomyces cerevisiae* : A Genetic approach

Investigator-In-Charge : Dr. (Mrs.) P. Sinha
Research Scholar : Sri Nilanjan Roy (Form 29.07.89)

Scheme No. 17. Thyroid hormone regulation on mammalian brain function

Investigator-in-Charge : Dr. A. K. Ray
Junior Research Fellow : Sri Pradip Kumar Sarkar

Indian Council of Medical Research

Scheme No. 1. Immunobiological characterization of the 63kd and 54kd glucoprotein of *Leishmania donovani* promastizotes and evaluation of their role in protective immunity against visceral leishmaniasis

Investigator-in-Charge : Prof. A. C. Ghose
Senior Research Fellow : Shri Prabir Kumar Ghosh
Research Assistant : Shri Ashis Kumar Ghosh

Scheme No. 2. Studies on L-asparaginase producing bacteria with regard to antineoplastic activity

Investigator-in-Charge : Prof. S. L. Chakraborty
Junior Research Fellow : Shri Subha Manna

Scheme No. 3. Microbial synthesis of L-DOPA by mutagenesis

Investigator-in-Charge : Dr. Arati das
Research Associate : Dr. Sharmila Chattopadhyay

Scheme No. 4. Evaluation of fish oil diet as a Curative and Protective measure against occlusiveh heart diseases

Investigator-in-Charge : Prof. Jyotirmoy Dutta
Senior Research Fellows : Smt. Ishani Banerjee
Shri Sagarmoy Saha

Scheme No. 5. Phenylhydrazine hydrochloride-thyroid hormone-cyanocobalamin interactions in animals

Investigator-in-Charge : Prof. A. K. Medda
Junior Research Fellow : Smt. Mitali Pramanik

Scheme No. 6. Pharmacologic effects of metoclopramide on spermatogenesis in rat

Investigator-in-Charge : Dr. A. K. Ray
Senior Research Fellow : Dr. Rupali Sarkar (From 1.4.89)

U.N.D.P

Scheme No. 1. Approaches to treatment and prevention of leprosy.

Investigator : Prof. Parul Chakrabarti

Seheme No. 2. Plant Improvement using modern biotechnology

Project Co-ordinator : Prof. B. B. Biswas
Project Directors : Prof. S. Ghosh
Prof. R. K. Mandal
Prof. S. K. Sen (Section of Plant Molecular and Cellular Genetics).

Research Scholars : Sri Jaydip Dasgupta
Sri Sibaprasad Bhattacharyya
(From 19.10.1989)

Scheme No. 3. Irradication of Leprosy in India
Project Director : Prof. N. C. Mandal

Indian Council of Agricultural Research

Scheme No. 1. Metabolism of myoinositol phosphates in plants (Upto 12.09. 1989)
Investigator-in-Charge : Dr. (Mrs.) S. Biswas
Research Fellow : Sm. Mita Pal (Upto 11.09.1989)

Scheme No. 2. Biotechnological application of siderophores of *Azospirillum brasilense* for improvement of plant productivity (From 30.09.1989).
Investigator-in-Charge : Prof. S. Ghosh
Co-Investigator : Dr. (Mrs.) P. Sinha
Research Fellow : Dr. Asitava Basu (From 30.09.1989)

Scneme No. 3. A pilot project directed at the expression of proteins of biomedical importance in the milk of farm animals
Investigator-in-Charge : Dr. Prabhakar Gupta

Scheme No. 4. DNA Repair in Seeds
Investigator-in-Charge : Dr. (Mrs.) Swati Sen-Mandi
Senior Research Fellows : Sm. Selva Meena Dass
Sm. Nupur Roy

Department of Atomic Energy

Scheme No. 1. Interaction of drugs with adenosine triphosphatase and lipids in model membranes—Part I
Investigator-in-Charge : Dr. P. C. Sen
Junior Research Fellow : Sri Dipak K. Bhattacharyya
(upto 15.7.89)

Scheme No. 2. Studies on the outer membrane protein of *V. cholerae* and development of an immunoprophylactic against cholera
Investigator-in-Charge : Prof. A. C. Ghose
Senior Research Fellow : Shri Dilip Kumar Sen Gupta

Ministry of Environment and Forests, Govt. of India

Scheme No. 1. Air borne fungal spores in urban Calcutta in relation to occupational area and population density. (scheme terminated on the 13th of August, 1989)
Investigator-in-Charge : Dr. Kalyani Sen
Co-Investigators : Dr. Roma Chakraverty
Prof. Arun K. Roy Chowdhury
(Dept. of Botany)
Senior Research Fellow : Sri Tilak Banerjee (upto 14.6.89)

DBT-Burn Standard Co. Ltd.

Scheme No. 1. Biotechnological enrichment of Magnesite ore with antibiotics as bye products
Investigator-in-Charge : Prof. A. K. Mishra
Research Scientist : Shri B. K. Mohanty

Oil & Natural Gas Commission

Scheme No. 1. Removal of H_2S from oil and/or and recovery of sulfur from H_2S
Investigator-in-Charge : Prof. A. K. Mishra
Co-Investigator : Dr. Pradosh Roy
Research Fellows : Shri Amitava Das
Shri Subrata K. Das

Scheme No. 2. Development of bacteria with useful characteristics for the enhancement of recovery of oil

Investigator-in-Charge : Prof. A. K. Mishra
Co-Investigator : Dr. Pradosh Roy
Research Fellows : Smt. Indrani Roy
Shri Chirajyoti Deb

Burn Standard Co. Limited

Scheme No. 1. Exploration of silica removal from Magnesite from the pilot plant scale to commercial scale

Investigator-in-Charge : Prof. A. K. Mishra
Research Fellow : Smt. Suparna Ghosh

Scheme No. 2. Biotechnological enrichment of Bauxite ore

Investigator-in-Charge : Prof. A. K. Mishra
Research Fellow : Shri B. K. Mohanty (upto 14.2.90)

INDO-US Collaborative Project

Scheme No. 1. Investigations on the Primary Interactions of Gamma Rays with Matter

Investigator-in-Charge : Prof. S. C. Roy
Senior Research Fellow : Shri Krishnendu Chakrabarty

Scheme No. 2. Bioactive Substances from the Indian Ocean
Principal Investigator : Prof. A. K. Barua
Jt. Principal Investigator : Prof. Parul Chakrabarti

C. S. I. R. Ad-hoc Fellows

1. Sm. Dipta Bhattacharyya
2. Sm. Alo Pal
3. Sri Amit Maity
4. Sri Bidyut Ghosh (upto 31.01.1990)
5. Sri Asim Kumar Mandal
6. Sri Dulal Panda
7. Sri Mahadev Pal
8. Sri Utpal Dutta (upto 22.12.1989)
9. Sri Santanu Roychaudhuri
10. Sri Mrinal K. Maity (From 01.10.1989)
11. Sri Biswendu Chowdhury (From 02.09.1989)
12. Sri Nandan K. Jana (From 03.08.1989)
13. Sri Subrata Sau (From 02.09.1989)
14. Sri Sudip K. Ghosh (From 10.08.1989)
15. Sm. Rama Srinivasan (From 10.08.1989 to 29.01.1990)
16. Sri Goutam Kumar Biswas, S.R.F.
17. Sm. Sucheta Chandra, S.R.F.
18. Sri Umesh Chandra Halder, J.R.F.
19. Sm. Rita Sikdar, J.R.F.
20. Dr. (Miss) Swati Gupta
21. Sri Soumen Chattopadhyay
22. Sri Biswajit Bera (From February 1990)
23. Sm. Sujata Saha
24. Sri Tapan Kumar Sen Gupta
25. Smt. Neena Ghosh Dastidar

C. S. I.R . Ad-hoc Research Associates

1. Dr. Manikuntala Kundu
2. Dr. Joyoti Basu
3. Dr. Ramaballav Roy
4. Dr. Prankrishna Dutta

C. S. I. R. Pool Officers

1. Dr. (Mrs.) A. Lohia, (upto 28.12.1989)
2. Dr. Mrinal Kanti Guha

U. G. C. Teacher Fellows

1. Smt. Uma Bhattacharya (upto 20.3.90)
2. Sri Amar Chandra Nath

UGC Fellow

1. Sm. Mousumi Das

I. C. M. R. Ad-hoc Research Associate

1. Sri Debashis Ghosal

R. D. Birla Smarak Kosh Ad-hoc Fellow

1. Shri Amit K. Chakrabarty

LIBRARY

The Bose Institute Library is one of the best Science Reference Libraries in Eastern India. A wing of the Library has been opened at Acharya J. C. Bose Centenary Laboratory Building in 1983 with reading and lending facitities. The Library is primarily meant for the use of its research staff, but it is frequently used and consulated by many research workers and teaching staff of the seven Universities of West Bengal including STM, Medical College, Indian Institute of Chemical Biology (IICB), Central Glass & Ceramic Research Institute (CGCRI), Saha Institute of Nuclear Physics (SINP), Indian Institute of Technology (IIT, Kharagpur),—BHU, BSI, ZSI and other educational organisations and institutions.

The research activitites of the Institute have considerably increased resulting in the increase in number of readers and in number of journals and periodicals. A number of rare and costly journals and periodicals have been subscribed along with annual and serial (foreign) publications. These appear to be inadequate. To overcome this difficulties, library resorted to inter-library loan facilities, which are available within the city of Calcutta. The Reprographic (xeroxing) services are rendered to all faculty members, scholars and staff of the Institute.

Library contain 25,959 voluumes of Books, bound Journals and Maps (16870 Journals, 9085 Books and 4 Maps) upto 31.3.90. During the period under report (1989-90) 148, Journals, 161, Books and 13 Theses were added to the Library stock. The total number of periodicals received was 349, out of which 236 were subscribed (201 foreign and 35 Indian) remaining 113 were received either in exchange or Institute publication or as gift. The Library also received a fairly good number of technical pamplets, circular, reports etc.

Library is kept open from 9-30 a.m. to 7-00 p.m. on weekdays and from 10-00 a.m. to 7-00 p.m. on Saturdays (except 2nd and 4th Saturdays). In the new campus, the Library is kept open from 11-00 a.m. to 6-00 p.m. on weekdays (except 2nd and 4th Saturdays).

During the year (1988-89) following Institute publications were pubiished :

A. Annual Report 1988-89 : English and Hindi versions

B. Transactions of the Bose Research Institute

Vol. 51, nos. (2, 3 & 4), 1988

Vol. 52, no. 1, 1989

During this year (1989) 255 permission cards were issued to outside readers and 6044 readers used the Library for reference works.

During (1989-90) thirteen theses from the following Departments were received a nd duly accessioned in the thesis register :

Biochemistry	2
Botany	4
Chemistry	2
Microbiology	3
P. M. C. G.	2
	13

In 1989-90, 5964 volumes books and journals were issued to Institute borrowers.

Under Inter-Library loan system 11 volumes of Books and Journala were taken on loan and 29 volumes were issued on the same systems to other educational organisations and Institution including INSDOC, within Calcutta. Besides 2645 current loose periodicals add reference books were issued on overnight issue system to Institute faculty members.

During the year under report (1989-90) 1,92,996 (1,00,165 MB+92,831 CB) copies of reprographic (Xerox) services were given to faculty members and staff of the Institute.

Approved budget for 1989-90 Rs. 20.00 lakhs.

WORKSHOP

In order to cope with the pace of the scientific development in the Institute, Bose Institute Workshop is actively involved in this challenging research activities through its units, e.g., Mechanical, Electrical, Refrigeration, Glass blowing, Carpentry and Drawing and attended about 2000 requisitions from the various depts. sections of the Institute.

Most of them are completed,

The following noteworthy jobs were undertaken and completed during the year under review.

(a) Designing and fabrication of Instruments and gadgets :

1. Tube Gel Apparatus
2. Slab Gel Electrophoresis Apparatus
3. T. L. C. Applicaior
4. Perspex combs
5. Circular Electrophoresis Apparatus
6. Microscope chamber
7. Horizontal Electrophoresis Apparatus
8. Radio active chamber
9. Innoculation chamber
10. Microwave Box, stand with glass case

(b) Repair and maintenance of Instruments of laboratories :

Stabilized regulated power supply units, various type of Centrifuges, water bath, Various types of shakers, Autoclaves and water circulation pump and freeze drier. Duct for fumigation chamber and door has been done as per requirement. Magnetic stirrer, Fraction Collector, Rotary Evaporator, Vacuum pumps. Some remarkable parts for scattering experiment of Physics were designed and fabricated in the workshop. Some importants spare parts for RSIC machines like two away coupling for air-compressor.

(c) Some varities of work as follows :

Grilled cage for water purifier Pulley, Al. adapter plates-Brass, nozzles, wooden pippet, Pippet can, spindle for microfuge instrument, out let pipe for X-ray tank, Collimeter adaptor for X-ray generator, Stubs for field work, Brass metal flanges cone for barosil glass tube, Perspex box with light stainless steel colars with suction and delivery system, Gasline coupling with a valve for RSIC, spring clamps filing cabinet, Al. ring, Al. boxes with lid, key for Microscope, etc.

(d) The following works have been completed by the Electricians :

Repairing and maintenance of 200 amps, 100 amps and 60 amps Main Switches, several new lines drawn at Centenary Building and Main Campus and some major rectification in the distribution system of New Campus have been done, The Capacitor Bank of both the campuses have been successfully maintained through-out the year keeping power factor 0.95—0.99 which specified as "Unity" as per the regulation of C.E.S.C. And obtained the rebate all through.

(e) Repair and maintenance of air conditioning plants 4°C cold rooms and other controlled temperature room, room coolers, refrigerators and dep freezes.

(f) Prepare drawing and ammonia for Mechanical, Electrical and Civil works, rectification of drawing of Hostel Complex has already been done. A full size working drawing of Phytograph has been completed. Several eleatrical drawings for 3rd floor New Campus and Hostel complex has been done as per specific requirement. Graphs and drawing for thesis, research publications have completed as per requistions.

(g) Renovation and fabrication of the Acharya J. C. Bose's original Instruments as well as necessary drawing of Phytograph Instrument have been done. 3 nos. Microwave apparatus and 2 nos. Phytograph apparatus are on the verge of completion. 1 no. Sir J. C. Bose's old projector has been re-installed for exhibition. Arrangements of lectures and seminars by providing slide projectors, Overhead projectors and public address system were made. About 300 Institute's lectures and seminars were attended to at both the campuses. A number of lectures and seminars organised by outside organisation/agency were attended. Also assisted in organising Institute's National Seminars/ Symposia/Workshop.

The workshop store purchased workshop materials, tools, building materials and furnitures and also maintained stock books and records of these materials. Kardax system already introduced were utilised fully with inclusion of all store materials. Physical verification work of store materials have been conducted by committee constituted by administration.

In addition, the following works were carried out under the supervision of the Workshop Supdt.

1. Maintenance, repair and daily allotments of 6 nos. Institute Vehicle were carried out.

2. Maintenance of Internal Telephone system by M/s. Mishra Telcome Enterprise at Main Campus and for New Campus internally done.

3. Maintenance and regular check up of various Fire Fighting Equipments installed in the Institute.

4. Maintenance and repair of irrigation pumps and Engine at Experimental Stations.

REGIONAL SOPHISTICATED INSTRUMENTATION CENTRE

An overall resume of services provided by the Centre for the year 1989-90 is given in the table appended :

The RSIC continued to provide analytical instrumentation services to users in the region.

The FT-NMR is yet to provide routine services to users because of frequent breakdowns in the system.

Services on the Mass Spectrometer commenced in March, 1990 but towards the end of the month the probe again suffered damage, rendering the instrument out of commission.

The Transmission Electron Microscope has been put back to commission and user services are once again available from the instrument.

The Scanning Electron Microscope had suffered a breakdown for about four months or so but the instrument is back in operation for routine services.

All the other instruments functioned more or less routinely and continue to do so.

RESUME OF ACTIVITIES

(From April '89 to March '90)

	Outside user		*Bose Institute user*	
	No. of samples	Revenue Earned	No. of samples	Revenue Earned
N.M.R.	8	Rs. 400/-	18	Rs. 550/-
M.S.	NIL	NIL	18	450/-
X-Ray. Diff.	NIL	NIL	NIL	NIL
L.S.	75	Rs. 40/-	NIL	NIL
UV-VIS	195	1914/-	118	218/-
A.Ab.S.	138	20,125/-	8	80/-
E.P.R.	40	1025/-	3	75/-
FT-N.M.R.	3	NIL	7	NIL
F.L.S.	129 *Hrs.*	2425/-	91 *Hrs.*	1835/-
G.L.C.	235 ,,	9649/-	86 ,,	1680/-
S.E.M.	312 ,,	5351/-	178	3800/-
P.U.	NIL ,,	NIL	109	2725/-
T.E.M.	7 ,,	820	2	180/-

J. C. BOSE UNIT AND MUSEUM

Acharya J. C. Bose himself started the display of his Instruments which, as a continuous process, have made their way into the present Museum. The aim and objective of this Museum is to maintain the Original Instruments of Acharya J. C. Bose and to make replica of the same. Besides, highlighting the "Life and Works of Acharya J. C. Bose" is also a major assignment of this Unit.

A compound Lever Crescograph, which was mentioned in the last report as "being processed" has already been duplicated. Out of three two pieces of Micro-wave apparatus are at the final stage and under testing. Two pieces of Oscillating Plate Phytograph instruments are being processed. The projector, used by Acharya J. C. Bose, was lying in the Workshop store for a longtime. This has recently been renovated.

Development of J. C. Bose Museum at Bose Institute is also an important activity of this Unit. It was mentioned in the last report that exchange programme with Visva-Bharati in this regard was in the final stage. The exchange programme has materialised and some materials which have been received from Visva-Bharati are being displayed in the Museum.

At present arrangements are being made to send some materials regarding the Life and Works of Acharya J. C. Bose to Birla Industrial and Technological Museum, Calcutta which is organising an Exhibition on "300 years of Development of Science, Technology and Industry of Calcutta" in connection with the celebration of Ter-Centenary of the City of Calcutta.

Visitors :

During the year under review a good number of visitors both from abroad and within the country visited the Museum.

Exhibition :

Special demonstrations were arranged to mark the following occasions :

1. Nehru and Science day Celebration .... 23rd June, 1989
2. Anniversary Day .... 30th November, 1989
3. Science Day .... 28th February, 1990

During the valedictory session of the Training programme in Millimeter wave Technology (Project sponsored by Electronics Commission, Govt. of India) the pioneering millimeter wave instruments designed and fabricated by Acharya J. C. Bose were demonstrated in working condition on 31st May, 1989 at the Institute of Radiophysics and Electronics, University of Calcutta on latter's request. On invitation the J. C. Bose Unit and Museum supplied Instruments and Manuscripts of J. C. Bose in the exhibition organised by "Bijnan Mela, 90" sponsored by "Bijnan Bikash" (am affiliated organisation of "Paschim Banga Bijnan Mancha") from 14th February to 18th February.

Besides, the J. C. Bose Unit & Museum furnished information, Xerox copies of papers and photographs of Acharya Bose and the Bose Institute to various organisations/ eminent persons on request.

Dibakar Sen participated in the following activities :

I. Being equested by the Chief Investigator and Programme Co-ordinator of Training Programme in Millimeter wave Technology (Project sponsored by Electronics Commission, Govt. of India and Institute of Radiophysics and Electronics, University of Calcutta) he delivered a talk on "Acharya Bose's contribution" on May 31, 1989.

II. A paper entitled "J. C. Bose : A mission to revive the Indian Tradition of Science" was presented (Jointly) at the XVIII International Congress of History of Science, General Theme-Science and Political order, Wissenschaft Und Statt held on 1st-9th August, 1989 at Humburg-Munich.

III. Presented a paper on "J. C. Bose and Science in India" on the occasion of the Ter-Centenary Celebration of Calcutta (Seminar on Calcutta and Indian Science) in December 21-23, 1989, organised by National Institute of Science Technology and Development Studies Centre For Studies in Social Sciences, Calcutta and Birla Industrial and Technological Museum.

IV. Invited article on "Acharya J. C. Bose's pioneering Instruments" was published in the special issue of Indian Journal of Pure and Applied Physics Instruments in India edited by Dr. K. R. Rao, Scientific Officer (G). Bhaba Atomic Research Centre, Nuclear Physics Division, Bombay—1989.

Statement of Accounts for the year 1989-90

Bose

93/1, Acharya Prafulla Chandra Road

Consolidated Balance Sheet as at

FUNDS & LIABILITIES	SCHEDULE NO.	Amount
		Rs. P.
Capital Account	I	23,25,783.11
Grant for Capital Expenditure	II	4,80,69,465.95
Sir J. C. Bose Cent. Building Fund	III	92,74,629.61
Acharya J. C. Bose Cent. Lab. Fund	IV	15,99,768.40
Salt Lake Land Procurement Fund	V	14,46,213.80
Special Fund	VI	10,99,619.68
House Building Advance Fund	VII	17,03,560.00
Bose Institute Council Payable Account	VIII	23,554.23
Excess of Receipts over Expenditure in respect of different Grant-in-Aid Schemes (Net)	IX	78,93,145.38
Deposits and other Liabilities	X	27,60,600.47
Total :		7,61,96,340.63

Sd/-
T. K. Ghorui
Dy. Registrar
Bose Institute

Sd/-
A. J. Datta
Registrar
Bose Institute

Sd/-
Prof. S. K. Sen
Actg. Director
Bose Institute

Institute

Calcutta-700 009

31st March, 1990

PROPERTIES & ASSETS	SCHEDULE NO.	Amount
		Rs. P.
Investment and other properties	XI	23,25,783.11
Fixed Assets from Non-Recurring Grant	XII	4,83,65,702.81
Sir J. C. Bose Centenary Building	XIII	92,74,629.61
Acharya J. C. Bose Cent. Lab.	XIV	15,96,685.19
Land at Salt Lake City	XV	14,46,213.80
Special Fund Investment	XVI	8,61,305.63
House Building Advance	XVII	16,10,720.00
Workshop Stores	XVIII	62,037.65
Security Deposit	XIX	41,254.00
Receivable Account	XX	4,65,566.65
Excess of expenditure over income as per Annexed Accounts		9,83,886.81
Cash and Bank Balance	XXI	91,62,555.37
Notes on Accounts		
Total :		7,61,96,340.63

This is the Balance Sheet referred to in our separate report of even date.

Sd/-
Ray & Ray
Chartered Accountant

Bose

93/1, Acharya Prafulla Ch. Road

Section :

Income and Expenditure Account for the year ended

EXPENDITURE	Non-plan Rs.	P.	Plan Rs.	P.	Total Rs.	P.
To						
A. Salaries, Scholarships & Allowances :						
Director & Administration	4,53,048.40		8,02,761.25		12,55,809.65	
Research (including Farms)	28,71,343.38		42,42,920.41		71,14,263.79	
Workshop	4,94,055.95		6,32,103.00		11,26,158.95	
Library	1,15,709.00		1,75,193.00		2,90,902.00	
Lower sub-ordinate	2,04,459.00		2,44,636.06		4,49,095.06	
Dearness Allowances	12,60,842.87		15,22,277.64		27,83,120.51	
House Rent Allowance	8,07,975.91		12,15,257.11		20,23,233.02	
City Compensatory Allowance	1,38,269.40		1,62,691.96		3,00,961.36	
Medical Benefit	2,25,000.00		2,80,704.46		5,05,704.46	
Pension	12,90,724.10		—		12,90,724.10	
Gratuity	6.39,283.00		—		6,39.283.00	
Leave Salary	2,53,001.10		—		2,53,001.19	
Provident Fund Contribution	19,508.00		—		19,508.00	
Exgratia	8,000.00		—		8,000.00	
Overtime & Honorarium	—		10,030.75		10,030.75	
Ad-hoc Bonus	1,09,495.14		1,43,378.96		2,52,874.00	
Hill Allowance	2,880.00		—		2,880.00	
Arrear Dues			6,34,141.90		6,34,141.90	

Carried Over

Institute

Calcutta-700 009

COUNCIL

at 31st March, 1990

INCOME	Non-Plan Rs.	P.	Plan Rs.	P.	Total Rs.	P.
By						
Grant from Govt. of India	88,00,000.00		1,44,00,000.00		2,32,00,000.00	
Interest from Bank	—		1,61,643.17		1,61,643.17	
Service Charges	25,800.00		38,009.00		63,809.00	
Miscellaneous Receipts	40,700.00		43,014.71		83,714.71	
Excess of Income over expenditure transferred from Governing Body A/C.	27,095.34		—		27,095.34	

Carried Over

Bose

93/1, Acharya Prafulla Ch. Road

Section :

Income and Expenditure Account for the year ended

EXPENDITURE	Non-plan Rs. P.	Plan Rs. P.	Total Rs. P.
B/F			
B. Laboratory Expences :			
Physics	—	1,76,276.63	1,76,276.63
Chemistry	—	1,70,418.85	1,70,418.85
Botany	—	1,94,659.35	1,94,659.35
Microbiology	—	1,99,654.96	1,99,654.96
Biochemistry	—	2,25,580.13	2,25,580 13
Biophysics	—	32,046.35	32,046.35
Animal Physiology	—	93,748.47	93,748.47
Library	—	30,928.50	30,928.50
P.M.C.G.	—	1,25,627.66	1,25,627.66
Workshop	—	1,53,228.08	1,53,228.08
Experimental Farms	—	75,568.57	75,568.57

Carried Over

Institute

Calcutta-700 009

COUNCIL

at 31st March, 1990

INCOME	Non-Plan Rs. P.	Plan Rs. P.	Total Rs. P.
B/F	88,93,595.34	1,46,42,666.88	2,35,36,262.22

Carried Over

Bose

93/1, Acharya Prafulla Ch. Road,

Section ;

Income & Expenditure Account for the year ended

EXPENDITURE	Non-plan Rs.	P.	Plan Rs.	P.	Total Rs.	P.
To Brought Forward						
C. Maintenance & other Establishment Expences :						
General Charges (including Bank Charges, Mortgage Expenses, etc.)	—		3,83,389.10		3,83,389.10	
Building Repair & Maintenance	—		1,17,179.54		1,17,179.54	
Telephone & Telex	—		1,10,789.00		1,10,789.00	
Security Guard	—		1,18,800.00		1,18,800.00	
Electric & Gas Bills	—		14,01,181.07		14,01,181.00	
Travelling (incld. abroad)	—		30,539.60		30,539.60	
Rent & Taxes	—		64.86		64.86	
Publication	—		98,437.98		98,437.98	
Stationary & Printing	—		19,907.80		19,907.80	
Postage	—		25,626.30		25,626.30	
Audit Fees	—		6,300.00		6,300.00	
Garden Maintenance	—		54,660.00		54,660.00	
Scholar's Hostel	—		75,073.69		75,073.69	
Advertisement	—		48,767.25		48,767.25	
Fire Insurance	—		12,726.00		12,726.00	
House Bldg. Loan Fund (By transfer)	—		3,00,000.00		3,00,000.00	
Prof. S. M. Sarkar Memo. Lecture	—		3,766.80		3,766.80	
Legal Expenses	—		42,253.25		42,253.25	
Car Repair & Maintenance	—		1,83,666.75		1,83,666.75	
U. N. D. P. (By transfer)	—		4,00,000.00		4,00,000.00	
Grand Total :	88,93,595.34		1,49,76,962.94		2,38,70,558.28	
To Excess of expenditure over income for this year brought down	—		3,34,296.06		3,34,296.06	
Excess of expenditure over income from last year's account brought forward	—		6,49,590.75		6,49,590.75	
	—		9,83,886.81		9,83,886.81	

Sd/-
T. K. GHORUI
Dy. Registrar
Bose Institute

Sd/-
A. J. DATTA
Registrar
Bose Institute

Sd/-
Prof. S. K. SEN
Actg. Director
Bose Institute

Institute

Calcutta-700 009

COUNCIL

at 31st March, 1990

INCOME	Non-Plane Rs.	P.	Plan Rs.	P.	Total Rs.	P.
By Brought Forward	88,93,595.34		1,46,42,666.88		2,35,36,262.22	
Excess of expenditure over income for this year carried down	—		3,34,296.06		3,34,296.06	
	88,93,595.34		1,49,76 962.94		2,38,70,558.28	
By Balance transferred to Balance Sheet	—		9,83,886.81		9,83,886.81	
	—		9,83,886.81		9,83,886.81	

This is the Income & Expenditure referred to in our report of even date.

Sd/-
RAY & RAY
Chartered Accountants

Bose

93/1, Acharya Prafulla Ch. Road,

Income & Expenditure Account of the Governing

EXPENDITURE	R. P.
To	
Administrative Expenses	300.00
Donation	25,500.00
Travelling Expenses	7,841.20
Building Maintenance	21,278.41
Printing & Stationery	45.00
Darjeeling Station Development Fund	1,00,000.00
Rent & Taxes	1,787.60
Insurance Premium	50.00
Excess of Income over Expenditure	27,095.34
	1,83,847.55

Sd/-
A. J. DATTA
Asst. Secretary
Bose Institute
Governing Body

Sd/-
S. K. SEN
Secretary
Bose Institute
Governing Body

Institute

Calcutta-700 009

Body for the year ended at 31st March, 1990

INCOME	Rs. P.
By	
Interest General	1,64,919.30
Richard Marry Keating Scholarship Fund	10,032.25
Birla Scholarship Fund	2,676.00
Sir J. C. Bose Scholarship Fund	5,500.00
Membership Subscription	120.00
	1,83,847.55

This is the Income & Expenditure referred to in our report of even date.

Sd/-
RAY & RAY
Chartered Accountants

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.1990

	Bose Institute Rs. P.	Governing Body Rs. P.	Total Rs. P.
SCHEDULE NO. I			
Capital Account :			
As per last Account		23,25,783.11	
Add : This year's transfer from interest A/c.		NIL	23,25,783.11
SCHEDULE NO. II			
Grants for Capital Expenditure :			
(From Govt. of India).			
As per last Account		4,17,93,487.96	
Add : Received during this year		19,00,000.00	
		4,36,93,487.96	
Less : Transferred to "Plan A/c." :			
As per last Account		5,00,000.00	
		4,31,93,487.96	
As Transferred to Cent. Buldg. 3rd floor			
As per last Account. 21,13,850.15			
Add : During this year 1,55,119.92		22,68,970.07	
		4,09,24,517.89	

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.1990

	Bose Institute Rs. P.	Governing Body Rs. P.	Total Rs. P.
Add : Grant from Govt. of W.B.			
As per last Account	40,000.00		
„ Sir J. C. Bose Contribution through Trust Fund No. 1			
As per last Account	1,23,402.49		
Add : Transferred from Council Revenue A/c.			
As per last A/c.	9,092.82		
„ Transferred from Grant-in-Aid schemes :			
As per last A/c.	69,72,452.75		4,80,69,465.95
SCHEDULE NO. III			
Sir J. C. Bose Cent. Building Fund :			
Ground & 1st floor			
As per last A/c.	47,44,000.00		
2nd floor			
As per last A/c.	15,00,000.00		
3rd floor			
As per last A/c.	21,25,509.69		
Add : This year	1,55,119.92		
	22,80,629.61		
Annexe :			
As per last A/c.	7,50,000,00		92,74,629.61

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.1990

	Bose Institute Rs.	P.	Governing Body Rs.	P.	Total Rs.	P.
					B/F.	
SCHEDULE NO. IV						
Acharya J. C. Bose Cent. Lab. Fund : (Madhyamgram)						
As per last A/c.						
Grant from Govt. of India			1,54,500.00			
Grant from Govt. of W. B.			2,00,000.00			
Sir J. C. Bose's Contribution through Trust Fund No. 1 (Created by him)						
As per last A/c.			2,00,000.00			
Transfer from N/R Grant for CIT Land instalments						
As per last A/c.			10,45,268.40		15,99,768.40	
SCHEDULE NO. V						
Salt Lake Land Procurement Fund :						
As per last A/c.						
Special grant from Govt. of West Bengal	12,00,000.00					
Transfer from N/R grant	2,46,213.80				14,46,213.80	
SCHEDULE NO. VI						
Special Funds :						
Sir J. C. Bose Scholarship Fund :						
As per last A/c.			50,000.00		50,000.00	

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.90

	Bose Institute Rs.	P.	Governing Body Rs.	P.	Total Rs.	P.
					B/F.	
SCHEDULE NO. VI (Contd.)						
Sir J. C. Bose Medal Fund :						
As per last A/c.			1,11,623.21			
Add : Income this year			11,282.50			
Add : Transferred on Loan from Endowment Fund			3,200.79			
			1,26,106.50			
Less : Expended during the year			19,356.50			
			1,06,750.00		1,06,750.00	
Sir J. C. Bose Endowment Fund						
As per last A/c.			5,40,924.77			
Add : Income this year			54,000.00			
			5,94,924.77			
Less : Trd. to Medal Fund on lone		—	3,200.79			
Less : Expenditure this year			300.00		5,91,423.98	
Rechard Marry Keating Fund						
As per last A/c.			1,04,541.67		1,04,541.67	
Birla Scholarship Fund						
As per last A/c.			20,000.00		20,000.00	
Urmila Devi Benevolent Fund						
As per last A/c.			8,800.00		8,800.00	
Sir Nilratan Sarkar Prize Fund						
As per last A/c.			22,533.33			
Add : Income this year			880.00			
			23,413.33		23,413.33	
Samir Sinha Memorial Fund						
As per last A/c.			10,500.00			
Add : Income this year			1,000.00			
			11,500.00		11,500.00	

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.90

	Bose Institute Rs. P.	Governing Body Rs. P.	Total Rs. P.
			B/F.
Sir J. C. Bose's Contribution through Trust Fund No. 1. (created by him)			
As per last A/c.		37,794.54	
Add : Income, this year		3,600.00	
		41,394.54	41,394.54
Prof. S. M. Sarkar Memorial Lecture Fund			
As per last A/c.	4,138.20	—	4,138.20
Director's Discretionary Fund			
As per last A/c.	17,716.61		
Less : Advance during this year	300.00		
	17,416.61		
Add : Realisation during this year	6,800.00		
	24,216.61		24,216.61
C. D. S. Fund (Employees)			
As per last A/c.	6,529.76		6,529.76
Apparatus & Book Purchase Fund			
As per last A/c.	6,911.59		6,911.59
Darjeeling Experimental Station Development Fund			
(Created during this year)		1,00,000.00	1,00,000.00
	41,796.16	10,57,823.52	10,99,619.68

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.1990

	Bose Institute Rs. P.	Governing Body Rs. P.	Total Rs. P.
SCHEDULE NO. VII			
House Building Advance Fund			
As per last A/c.	14,03,560.00		
Add : Transfer from Non-Plan Recurring Grant this year	3,00,000.00		
Add : Interest received on loan	NIL		17,03,560.00
SCHEDULE NO. VIII			
Excess of income & expenditure of Governing Body Account		27,095.34	
Less : Adjusted during the year		3,541.11	23,554.23
SCHEDULE NO. IX			
Excess of Receipts over expenditure in respect of different grant-in-aid schemes (Net)	78,93,145.38		78,93,145.38
SCHEDULE NO. X			
Deposit & Other Liability			
Goods and Expenses	9,32,968.75		
Earnest Money deposit	2,14,918.72		
Party Income-Tax	220.02		
Fire Damage Compensation	10,520.00		
Cumulative Time Deposit	176.50		
Postal Recurring Deposit	572.80		

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.90

	Bose Institute Rs. P.	Governing Body Rs. P.	Total Rs. P.
SCHEDULE NO. X (Contd.)			
Professional Tax	100.00		
Provident Fund Suspense	1,139.65		
Co-operative Society	5,670.30		
P. M. Drought Relief Fund	113.00		
P. F. Payable	6,86,886.67		
Suspense	2,63,461.00		
Short Term Technician Course	1,99,750.00		
Symposium on Radiation Physics	7,932.77		
R. S. I. C.	4,36,170.29		27,60,600.47
SCHEDULE NO. XI			
Investment & Properties			
Fixed Deposit with SBI			
As per last A/c.	12,74,193.75		
—Do—	1,50,000.00		
—Do—	1,00,000.00		
—Do—	1,00,000.00		16,24,193.75
Fixed Assets :			
As per last A/c.			
Land at Calcutta	1,26,613.00		
Land at Darjeeling	16,000.00		
Land at Falta (On leasehold land)	56,832.16		1,99,445.16

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.1990

	Bose Institute Rs. P.	Governing Body Rs. P.	Total Rs. P.
SCHEDULE NO. XI (Contd.)			
Building at Calcutta		2,89,620.25	
Building at Darjeeling		27,566.00	
Building at Falta (On leasehold land)		49,992.00	3,67,178.25
Furniture & Fittings :			
As per last A/c.		27,481.39	27,481.39
Apparatus :			
As per last A/c.		78,816.94	78,816.94
Books & Journals :			
As per last A/c.		28,667.62	28,667.62
			23,25,783.11
SCHEDULE NO. XII			
Fixed Assets from Non-Recurring Grant :			
As per last A/c.			
Building at Calcutta	8,74,350.09		
Building at Shyamnagar	92,647.99		
Building at Madhyamgram	5,89,767.27		15,56,765.35
Apparatus and Equipments :			
As per last A/c.	1,61,82,827.87		
Add : During this year	1,93,187.41		1,63,76,015.28

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.90

	Bose Institute Rs.	P.	Governing Body Rs.	P.	Total Rs.	P.
SCHEDULE NO. XII (Contd.)						
Transfer from terminated Schemes :						
As per last A/c.	69,02,452.75				69,02,452.75	
Workshop Apparatus :						
As per last A/c.	6,07,719.09					
Add : This year	4,641.89				6,12,360.98	
Air Conditioning (Cent. Building)						
As per last A/c.	1,79,225.56				1,79,225.56	
Furniture & Fitting :						
As per last A/c.	14,55,578.38				14,55,578.38	
Laboratory Remodelling : (Built Dark & Cold Room)						
As per last A/c.	11,68,735.36				11,68,735.36	
Books & Journals :						
As per last A/c.	1,16,28,730.48					
Add : This year	16,10,157.33				1,32,38,887.81	
Electrical Installation at Cent. Bldg. (including S. D. Rs. 39000/- with C.E.S.C.).						
As per last A/c.	10,44,329.38				10,44,329.38	
Renovation works at Main Campus :						
As per last A/c.	17,84,473.72					
Add : During this year	4,589.00					
	17,89,062.72					
Less : Adjusted this year	21,828.42				17,67,234.30	

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.90

	Bose Institute Rs.	P.	Governing Body Rs.	P.	Total Rs.	P.
SCHEDULE NO. XII (Contd.)						
Tubewell :						
As per last A/c.	2,43,170.01				2,43,170.01	
Fire Damage Lab. Equipment :						
As per last A/c.	65,000.00				65,000.00	
Motor Car : (including a Car received from DST valued at Rs. 70,000/-).						
As per last A/c.	2,89,785.17				2,89,785.17	
Gas Plant :						
As per last A/c.	46,256.00				46,256.00	
Glass House :						
As per last A/c.	14,432.46				14,432.46	
Boundary Wall at Madhyamgram :						
As per last A/c.	2,85,737.27				2,85,737.27	
Hostel Building : (Work in progress)						
As per last A/c.	31,19,270.00				31,19,270.00	
Internal Telephone :						
As per last A/c.	466.75				466.75	
SCHEDULE NO. XIII						
Sir J. C. Bose Cent. Bldg. : As per last A/c.						
Ground & 1st Floor			46,30,736.51			
2nd Floor			13,84,459.23			
3rd Floor (work in progress)						
As per last A/c.	22,55,449.40					
Add : This year.	1,55,119.92		24,10,569.32			
Annexe :						
As per last A/c.			8,48,864.55		92,74,629.61	

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.1990

	Bose Institute Rs.	P.	Governing Body Rs.	P.	Total Rs.	P.
SCHEDULE NO. XIV						
Acharya J. C. Bose Cent. Lab. Madhyamgram Expt. Farm :						
As per last A/c.			3,09,461.50			
C.I.T. Land on lease of which Rs. 10,45,268.40 transferred from Non-Recurring Grant			11,88,994.21			
Lease Deed Registration Cost :						
As per last A/c.			23,735.50			
Boundary wall, Plan cost, etc. :						
As per last A/c.			74,493.98		15,96,685.19	
SCHEDULE NO. XV						
Land at Salt Lake :						
As per last A/c.			14,46,213.80		14,46,213.80	
SCHEDULE NO. XVI						
Special Fund Investment :						
Sir J. C. Bose Scholarship Fund.						
Fixed Deposit with SBI.						
As per last A/c.			50,000.00		50,000.00	
Sir J. C. Bose Medal Fund :						
Fixed Deposit with SBI.						
As per last A/c.			1,06,750.00		1,06,750.00	
Sir J. C. Bose Endowment Fund :						
Fixed Deposit with SBI.						
As per last A/c.			5,00,000.00		5,00,000.00	
Richard Marry Keating Fund :						
As per last A/c.			98,500.00			
Fixed Deposit with SBI £ 500						
Prof. Shares (CESC)			[illegible]41.67			
			1,04,541.67		1,04,541.67	

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.90

	Bose Institute Rs.	P.	Governing Body Rs.	P.	Total Rs.	P.
SCHEDULE NO. XVI (Contd.)						
Birla Scholarship Fund :						
As per last A/c.						
200 Nos. 15% Non-convertable Debenture of Birla Jute & Industries Ltd.			20,000.00		20,000.00	
Urmila Devi Benevolent Fund :						
As per last A/c.						
8% Conversion loan lodged with Govt. of W. Bengal			8,800.00		8,800.00	
Sir Nilratan Sarkar Prize Fund :						
Fixed Deposit with SBI.						
As per last A/c.			15,000.00		15,000.00	
Sir J. C. Bose's Contribution through Trust Fund No. 1.						
Fixed Deposit with SBI						
As per last A/c.			36,000.00		36,000.00	
Samir Sinha Memorial Prize Fund :						
Fixed Deposit with SBI.						
As per last A/c.			10,000.00		10,000.00	
Prof. S. M. Sarkar Memorial Lecture Fund :						
Fixed Deposit with SBI.						
As per last A/c.	4,000.00				4,000.00	
C. D. S. Fund with P. F. Commissioner :						
As per last A/c.	6,213.96				6,213.96	
	10,213.96		8,51,091.67		8,61,305.63	

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.1990

	Bose Institute Rs.	P.	Governing Body Rs.	P.	Total Rs.	P.

SCHEDULE NO. XVII

House Building Advance :

As per last A/c.	10,02,060.00		
Add : Loan Sanction during this year	7,06,500.00		
	17,08,560.00		
Less : Recovery during this year	97,840.00		16,10,720.00

SCHEDULE NO. XVIII

Workshop Stores :

As per last A/c.	62,037.65		62,037.65

SCHEDULE NO. XIX

Security Deposit :

Electric & Telephone	18,169.00	75.00	18,244.00
Other	250 00		250.00
Gas Cylinder	4,600.00		4,600.00
Petrol	5,000.00		5,000.00
Telex	10,000.00		10,000.00
Electric (WBSEB)	2,160.00		2,160.00
Regional Computer Centre	1,000.00		1,000.00
	41,179.00	75.00	41,254.00

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.1990

	Bose Institute Rs.	P.	Governing Body Rs.	P.	Total Rs.	P.

SCHEDULE NO. XX

Receivable Account :

Special Advance	1,650.00		
Advance	2,84,407.00		
Income Tax Staff	115.02		
Festival Advance	1,29,787.03		
D. M. Bose Birth Cent. Celebration	6,558.53		
Insurance	8,564.64		
Course Committee—Dr. P. Gupta	9,493.76		
International Conference—			
Prof. P. Chakraborty	1,436.44		
Governing Body	23,554.23		4,65,566.65

SCHEDULE NO. XXI

Cash & Bank Balances :

In Hand	11,766.85	230.00	11,996.85
With United Bank of India.	30,34,447.00	—	30,34,447.00
With Union Bank of India. (On Savings Account)	1,87,512.77	—	1,87,512.77
With on Guarantee Margin A/c.	52,959.00	—	52,959.00
With Grindlays Bank plc.	57,42,575.46	—	57,42,575.46
With State Bank of India.	—	1,33,064.29	1,33,064.29
	90,29,261.08	1,33,294.29	91,62,555.37

Sd/-
T. K. Ghorui
Dy. Registrar
Bose Institute

Sd/-
A. J. Datta
Registrar
Bose Institute

Sd/-
Prof. S. K. Sen
Actg. Director
Bose Institute

Bose Institute

CALCUTTA-700 009

Summary of the Grants-in-aid Scheme Accounts for the year 1989-1990

Sl. No.	Name of the Project	Balance Receivable (3) Rs. P.	Balance Payable (4) Rs. P.
(1)	(2)		
1.	A. E. R. B.—Prof. S. C. Roy		16,569.13
2.	Burn Standard No.—1 Prof. A. K. Mishra		1,03,483.61
3.	Burn Standard No.—2 Prof. A. K. Mishra		34,326.50
4.	DBT-Burn Standard—Prof. A. K. Mishra		1,10,575.85
	C. S. I. R.—Projects		
5.	Dr. P. C. Sen	739.91	
6.	Prof. A. C. Ghosh	3,798.40	
7.	Dr. Bharati Ghosh (old)		21,644.51
8.	Dr. Bharati Ghosh (New)	9,922.64	
9.	Dr. Swati Sen Mandi		31,540.88
10.	Dr. Asoke Banerjee (old)		315.12
11.	Dr. Ashoke Banerjee (New)		14,548.15
12.	Dr. Susweta Biswas		21,166.82
13.	Dr. Amita Pal		2,996.72
	C. S. I. R.—Project		
14.	Dr. Siddhartha Roy	8,707.62	
15.	Dr. Bhabatarak Bhattacharyya	48,313.70	
16.	Prof. N. K. Sinha		5,831.53
17.	Dr. Monisha Bose		3,180.35
18.	Dr. Dolly Ghosh		8,330.65
19.	Dr. T. B. Samanta	83,668.53	
20.	Dr. Manas Chakraborty		38,822.54
21.	Prof. S. Ghosh		36,830.00
22.	Prof. B. B. Biswas		14,735.00
23.	Prof. S. K. Sen		76,400.00
24.	Dr. Pratima Sinha		58,518.40

(Contd.)

Bose Institute

CALCUTTA-700 009

Summary of the Grants-in-aid Scheme Accounts for the year 1989-1990

Sl. No.	Name of the Project	Balance Receivable (3) Rs. P.	Balance Payable (4) Rs. P.
(1)	(2)		
	C. S. I. R.—AD-HOC Fellowship		
25.	Smt. Sumita Seal	16,639.15	
26.	Sri Santanu Roychowdhury		2,913.06
27.	Sri Utpal Dutta		25,923.88
28.	Smt. Sucheta Chanda	4,132.78	
29.	Smt. Pritilata Nayak		6,482.12
30.	Smt. Debjani Dutta		13,643.93
31.	Sri Prankrishna Dutta		5,238.67
32.	Smt. Swati Gupta	19,447.89	
33.	Smt. Alo Pal	19,219.80	
34.	Sri Narayan Ch. Mondal		4,223.11
35.	Smt. Dipta Bhattacharya		3,876.25
36.	,, Suchitra Banerjee	—	—
37.	,, Sadhana Bhattacharyya		7,924.00
38	Sri Utpal Basu		3,850.00
39.	,, Bidyut Ghosh	19,314.97	
40.	,, Sri Amit Kr. Maity	24,509.19	
41.	,, V. S. Reddy	534.25	
42.	Smt. Sadhu Leelavati		32,924.07
43.	Sri Chinmoy Nandi		129.30
44.	Smt. Aparna Pal		27,369.12
45.	Sri Susanta Kr. Dey	14,108.35	
46.	Sri Sagar Sona Jash		10,435.01
47.	Smt. Monikuntala Kundu		1,729 31
48.	Smt. Joyoti Basu		1,155.98
49.	Sri Tapas Kr. Sengupta		856.53
50.	,, Ashim Kr. Mondal	29,347.26	
51.	,, Dulal Panda		1,285.38

(Contd.)

Bose Institute

CALCUTTA-700 009

Summary of the Grants-in-aid Scheme Accounts for the year 1989-1990

Sl. No. (1)	Name of the Project (2)	Balance Receivable (3)	Balance Payable (4)
		Rs. P.	Rs. P.
	C. S. I. R.—AD-HOC Fellowship		
52.	,, Thakurdas Saha		5,004.68
53.	Smt. Neena Ghosh Dastidar		518.16
54.	Sri Mahadeb Pal	723.91	
55.	Smt. Sujata Saha	747.56	
56.	Sri Soumen Chottopadhyay		6,260.08
57.	,, Goutam Biswas (Bio-Physics)		1,177.90
58.	,, Shyamal Kr. Raha		17,806.67
	C. S. I. R.—Fellowship		
59.	Sri Samir Kr. Roy		1,697.14
60.	,, Samir Ranjan Sikdar		359.93
61.	,, Goutam Biswas (Chem.)	21,669.60	
62.	Smt. Durba Bondhapadhyay		207.64
63.	,, Sampa Pain		2,198.70
64.	Sri Ramaballav Roy	155.12	
65.	Smt. Rita Sikdar		300.65
66.	,, Rama Srinivasan		3,275.62
67.	,, Sadhana Majumdar	7,294.00	
68.	,, Tista Bhattacharyya		217.85
69.	,, Sumita Bondhapadhyay		221.00
70.	Sri Nandan Kr. Jana	379.83	
71.	,, Sudip Kr. Ghosh	2,073.79	
72.	,, Subrata Sau	1,169.60	
73.	,, Umesh Ch. Haldar	318.53	
74.	,, Indranil Biswas		2,428.00
	C. S. I. R.—Fellowship		
75.	Sri Mrinal Kanti Maity		560.00
76.	,, Bisendu Choudhury		195.45

(Contd.)

Bose Institute

CALCUTTA-700 009

Summary of the Grants-in-aid Scheme Accounts for the year 1989-1990

Sl. No. (1)	Name of the Project (2)	Balance Receivable (3)	Balance Payable (4)
		Rs. P.	Rs. p.
77.	Smt. Chaitali Bhowmik		18,876.30
78.	Sri Subir Kr. Nag Das		643.45
79.	,, Subrata Mazumdar		19,073.10
80.	,, Pradip Kr. Sarkar		115.72
81.	Smt. Anushree Bhattacharyya	23,215.83	
82.	Sri Biswajit Bera		40,546.00
	C. S. I. R.—Pool		
83.	Dr. Anuradha Lohia		143.92
84.	Dr. Mrinal Kanti Guha	354.15	
85.	Dr. Manik Ch. Das		5,355.06
	D. S. T.—Project		
86.	Prof. B. B. Biswas		40,110.10
87.	Prof. S. K. Sen	2,52,894.93	
88.	Dr. Bharati Ghosh	19,321.44	
89.	Dr. Bimalendu Mitra	85,897.69	
90.	Prof. D. P. Chakraborty	14,299.51	
91.	Prof. S. K. Sen (Dr. T. B. Jha)		3,431.25
	D. N. E. S.		
92.	Prof. Parul Chakraborty	722.91	
	D. B. T.—Workshop		
93.	Prof. R. K. Mondal/Dr. Pravakar Gupta	3,80,545.20	
	D. I. C.		
94.	Prof. M. H. Engineer		5,15,613.11
	Dept. of Environment		
95.	Dr. Kalyani Sen		3.08

(Contd.)

Bose Institute

CALCUTTA-700 009

Summary of the Grants-in-aid Scheme Accounts for the year 1989-90

Sl. No. (1)	Name of the Project (2)	Balance Receivable (3)	Balance Payable (4)
		Rs. P.	Rs. P.
96.	Dr. Parimal Sen	71,901.48	
97.	Prof. A. C. Ghosh		79,418.46
	D. A. E.—Associateship		
98.	Sri A. S. Rishi	4,172.59	
99.	DST/Post-Doctoral Training Course		53,00,000.00
	Govt. of West Bengal Project		
100.	Prof. S. K. Sen		17,765.73
101.	Dr. B. B. Mukherjee	20,141.93	
102.	Dr. Bharati Ghosh (New)		23,400.00
103.	Dr. Bharati Ghosh (Old)		11,603.77
104.	Dr. Sukumar Gupta		1,15,000.00
	Hindusthan Lever Projects		
105.	Dr. Bharati Ghosh		1,937.59
106.	Prof. S. K. Sen	1,832.37	
	I. C. A. R.—Projects		
107.	Dr. S. Biswas	1,92,078.10	
108.	Dr. Swati Sen Mandi		21,038.89
109.	Prof. D. P. Chakraborty	0.20	
110.	,, S. K. Sen	3,30,202.36	
111.	,, S. K. Sen No. 1	24,745.58	
112.	,, S. K. Sen No. 2	98,197.64	
113.	,, S. Ghosh (Old)	96,548.71	
114.	,, S. Ghosh (New)		4,34,951.35
115.	Dr. Bharati Ghosh	15,232.99	
116.	Dr. Pravakar Gupta		8,29,600.00

(Contd.)

Bose Institute

CALCUTTA-700 009

Summary of the Grants-in-aid Scheme Accounts for the year 1989-90

Sl. No. (1)	Name of the Project (2)	Balance Receivable (3)	Balance Payable (4)
		Rs. P.	Rs. P.
	I. C. M. R. Project		
117.	Prof. Parul Chakrabarti		30,450.29
118.	,, S. Ghosh	14,086.62	
119.	,, J. Dutta (Old)	13,228.60	
120.	,, J. Dutta (New)	5,214.81	
121.	,, A. C. Ghosh		36,934.32
122.	,, A. K. Barua		55,938.45
	I. C. M. R.—Fellowship		
123.	Sri Subha Manna		3,281.94
124.	Smt. Mitali Pramanik	9,173.19	
125.	,, Sharmila Chottopadhyay		3,982.25
126.	,, Subhra Lahiri		774.56
127.	,, Debjani Dutta		2,514.90
128.	,, Rupali Sarkar		850.43
	I. S. M.—Project		
129.	Prof. A. K. Mishra—3		19,954.02
130.	—do— —5	23,379.13	
131.	—do— —6	10,789.90	
	Indo-US—Projects		
132.	Prof. Parul Chakrabarti (NIH)	28,468.26	
133.	,, A. K. Barua (Bioactive)		6,19,342.14
134.	,, S. C. Roy (PL—480)		7,70,519.18
	I. N. S. A.		
135.	Prof. S. Chanda	4,233.00	
	Nat. Bio. Technology		
136.	Dr. Gurupada Sarkar		1,348.20

(Contd.)

Bose Institute

CALCUTTA-700 009

Summary of the Grants-in-aid Scheme Accounts for the year 1989-1990

Sl. No. (1)	Name of the Project (2)	Balance Receivable (3)	Balance Payable (4)
		Rs. P.	Rs. P.
	Rockfeller Foundation		
137.	Prof. S. K. Sen	31,943.70	
	Teack and Papiya, Govt. of W. B.		
138.	Prof. S. K. Sen	—	—
	Usda-Ferro-Project		
139.	Prof. S. K. Sen	1,44,107.31	
	U. G. C. Associateship		
140.	Smt. Urmila Dev	2.83	
141.	Smt. Lina Bhattacharyya	—	—
142.	Sri Amitava Chottopadhyay	9,404.62	
	U. G. C. Teacher's Fellowship		
143.	Smt. Uma Bhattacharyya	0.04	
	U. G. C. Fellowship		
144.	Sri T. Anoopkumar		18,488.44
145.	Smt. Mousumi Mondal		32,340.00
146.	Sri Nilam Sanjib Banerjee		32,100.00
147.	Sri Sudip Chatterjee		26,547.64
	UNDP—Projects		
148.	Prof. Parul Chakraborty/Dr. A. Banerjee/ Prof. N. C. Mondal (Leprosy)		53,325.49
149.	Prof. S. Ghosh/Prof. R. K. Mondal/ Prof. B. B. Biswas/Prof. S. K. Sen		1,16,895.30
	Net balance payable in respect of Grants-in-Aid Projects transferred to Balance Sheet	78,93,145.38	
		10,096,419.38	10,096,419.38

Sd/-
T. K. GHORUI
Dy. Registrar
Bose Institute

Sd/-
A. J. DATTA
Registrar
Bose Institute

Sd/-
Prof. S. K. SEN
Actg. Director
Bose Institute

Bose Institute

AUDITORS' REPORT
ON
GENERAL PROVIDENT FUND ACCOUNT

We have audited the attached Balance Sheet of the Contributory Provident Fund of the Bose Institute as at 31st March 1990 and the annexed Income & Expenditure Account for the year ended on that date which are in agreement with the books of account and records produced to us.

In our opinion and to the best of our information and explanations given to us, the Balance Sheet gives a true and fair view of the state of affairs of the Fund.

The 30th August, 1990

Sd/-
RAY & RAY
Chartered Accountants

Bose

93/1, Acharya Prafulla Ch. Road

GENERAL PROVIDENT

Balance Sheet

FUND AND LIABILITIES	Rs.	P.	Rs.	P.	Rs.	P.	Rs.	P.
P. F. Accumulation A/c.								
G. P. F. A/c.								
Balance b/f (As per last account)			67,53,430.93					
Add : G.P.F. Subscription during 1989-90								
Council	9,84,058.00							
D. I. C. Project	1,200.00							
R. S. I. C.	70,792.00		10,56,050.00					
			78,09,480.93					
Add : Interest Paid @ 12% for 1989-90			7,33,864.28					
			85,43,345.21					
Less : Withdrawal during 1989-90			5,17,015.21		80,26,330.00			
C. P. F. A/c.								
Balance b/f (As per last A/c.)			4,51,917.71					
Add : **Council**								
Subscription	19,508.00							
Office Contribution	19,508.00							
Voluntary Contribution	10,802.00							
Interest on Advance	925.00		50,743.00					

Contd.

Institute

Calcutta-700 009

FUND ACCOUNT

as at 31st March, 1990

PROPERTY AND ASSETS	Rs.	P.	Rs.	P.
Investments				
Fixed Deposit with State Bank of India (As per last A/c.)	1,11,69,961.81			
Less : Matured during the year 1989-90	17,53,304.80			
	94,16,657.01			
Add : Addition during the year 1989-90	22,53,304.80		1,16,69,961.81	
Income Tax Recovarable A/c.			3,460.00	
Loan to Members			13,08,668.00	
Amount Receivable				
Council	6,86,886.67			
R.S.I.C.	1,130.00		6,88,016.67	
Interest Accrued A/c.			21,54,714.40	
Bank Balance with State Bank of India				
Savings Account	1,47,040.18			
Less : Current Account (As per Reconciliation Statement)	37,500.00		1,09,540.18	
			1,59,34,361.06	

Contd.

Bose

93/1, Acharya Prafulla Chandra Road,

GENERAL PROVIDENT

Balance Sheet

FUND AND LIABILITIES	Rs.	P.	Rs.	P.	Rs.	P.	Rs.	P.
B/F.								
R. S. I. C.								
Subscription	3,414.00							
Office Contribution	3,414.00							
Voluntary Contribution	4,800.00		11,628.00					
			5,14,288.71					
Add : Interest Paid @ 12% for 1989-90			40,482.00		5,54,770.71			
Office Contribution								
Balance b/f (As per last account)			65,12,701.90					
Add : During the year 1989-90			2,92,355.29		68,05,057.19		1,53,86,157.90	
Undistributed Income A/c.							5,48,203.16	
							1,59,34,361.06	

Sd/-
T. K. Ghorui
Dy. Registrar
Bose Institute

Sd/-
A. J. Datta
Registrar
Bose Institute

Institute

Calcutta-700 009

FUND ACCOUNT

as at 31st March, 1990

PROPERTY AND ASSETS	Rs.	P.	Rs.	P.
B/F.				
			1,59,34,361.06	

This is the Balance Sheet referred to in our report of even date.

Sd/-
Prof. S. K. Sen
Actg. Director
Bose Institute

Sd/-
Ray & Ray
Chartered Accountants

Bose

93/1, Acharya Prafulla Ch. Road

GENERAL PROVIDENT

Income and Expenditure Account for the year ended

EXPENDITURE	Rs.	P.	Rs.	P.
To Interest paid to members @ 12% p.a.				
G. P. F.	7,33,864.28			
C. P. F.	40,482.00		7,74,346.28	
To Balance C/d			4,02,811.00	
			11,77,157.28	
To Balance carried over to Balance Sheet for 1989-90	5,48,203.16			
			5,48,203.16	

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Bose Institute

Sd/-
Prof. S. K. Sen
Actg. Director
Bose Institute

Institute

Calcutta-700 009

FUND ACCOUNT

at 31st March, 1990

INCOME	Rs.	P.
By Interest on Fixed Deposit	11,77,157.28	
	11,77,157.28	
By Balance brought forward from last years account	1,45,392.16	
By Balance brought down	4,02,811.00	
	5,48,203.16	

This is the Income & Expenditure referred to in our report of even date.

Sd/-
RAY & RAY
Chartered Accountants

REGIONAL SOPHISTICATED

Managed by

Calcutta

Balance Sheet as at

FUNDS & LIABILITIES	1989-90 Rs.	P.	1989-90 Rs.	P.	1988-89 Rs.	P.
Grant-in-Aid Account :						
As per last account	2,33,28,387.78				2,28,72,909.18	
Add : Non-Recurring Grant, received from DST.	4,80,000.00				4,11,374.00	
Add : Interest on Savings Bank Account	44,133.25		2,38,52,521.03		44,104.60	
Sundry Creditors :						
For Goods	3,29,207.36				3,29,207.36	
For Professional Tax	30.00				—	
For P. F. Contribution	—		3,29,237.36		1,300.00	
Advance From Customer :						
For Sample Testing			27,847.25		9,082.25	
Co-operative Account :						
For Loan Realisation			410.22		375.22	
Bose Institute Account :						
For Salary M. J. and etc.	—		—		2,53,775.42	
Total :			2,42,10,015.86		2,39,22,128.03	

NOTE : Bank Guarantee Rs. 81,968.00

Sd/-
T. K. GHORUI
Dy. Registrar
Bose Institute

Sd/-
A. J. DATTA
Registrar
Bose Institute

Sd/-
Prof. S. K. SEN
Actg. Director
Bose Institute

INSTRUMENTATION CENTRE

Bose Institute

700 009

31st March, 1990

ASSETS & PROPERTIES	1989-90 Rs.	P.	1989-90 Rs.	P.	1988-89 Rs.	P.
Fixed Assets :						
Equipment :						
As per last Account	1,91,10,244.58				1,90,90,169.24	
Add : Addition during the year	7,589.00		1,91,17,833.58		20,075.34	
Spares 'Plan' :						
As per last Account	27,62,520.13				19,82,158.43	
Add : Addition during the year	5,19,290.00		32,81,810.13		7,80,361.70	
Furniture & Air-Conditioner :						
As per last Account	3,13,773.20				3,13,773.20	
Add : Addition during the year	NIL		3,13,773.20		NIL	
Current Assets, Loans & Advances :						
Cash & Bank Balances in hand	7,080.06				11,674.76	
With Schedule Bank :						
On Savings Bank Account	3,77,643.59				6,26,920.38	
On Guarantee Account	16,400.00		4,01,123.65		16,400.00	
Advances recoverable in cash or in kind or for value to be received :						
Festival Advance	12,000.00				9,480.00	
Bose Institute	4,12,902.50		4,24,902.50		—	
Suspense for F.T.N.M.R. :						
As per last Account			1,26,353.00		1,26,353.00	
Accrued Grant Account :						
Receivable from DST			1,80,000.00		9,30 000.00	
Income & Expenditure Account :						
As per last Account			3,64,219.80		14,761.98	
Total :			2,42,10,015.86		2,39,22,128.03	

This is the Balance Sheet referred to in our report of even date.

Sd/-
RAY & RAY
Chartered Accountants

REGIONAL SOPHISTICATED

Managed by

Calcutta

Income & Expenditure Account for the

EXPENDITURE	1989-90 Rs. P.	1989-90 Rs. P.
To **Staff Remuneration and Benefits :**		
,, Basic Pay (including arrear of Rs. 36017.40)	7,06,385.40	
,, Dearness Pay	—	
,, Addl. Dearness Allowance	2,18,403.00	
,, Interim Relief	—	
,, House Rent Allowance	1,32,681.00	
,, Medical Assistance	27,600.00	
,, City Compensatory Allowance	24,648.00	
,, P. F. Contribution	3,414.00	
,, Overtime Allowance	—	
,, Bonus	6,351.00	11,19,482.40
,, **Travelling Expenses :**		742.00
,, **Consumable/Laboratory Expenses ;**		
,, Contingency Expenses	31,411.91	
,, Laboratory Expenses	47,959.30	
,, F.T.N.M.R. Expenses	59,637.12	1,39,008.33
,, **Other Expenses for Laboratory :**		
,, General Charges	1,062.58	
,, Labour Charges	84.26	
,, Books & Periodicals	—	
,, Bank Charges	1,599.00	
,, Advertisement	—	
,, Workshop & Seminar	1,850.00	4,595 84
To Maintenance Expenses :		
,, Repairs & Service Contract		1,83,484.25
		14,47,312.82
To Excess of Expenditure over Income for this year brought down.		3,49,457.82
To Excess of Expenditure over Income from last years Account brought forward		14,761.98
	Total :	3,64,219.80

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Actg. Director
Bose Institute

INSTRUMENTATION CENTRE

Bose Institute

700 009

year ended at 31st March, 1990 (Non-Plan)

INCOME	1989-90 Rs. P.	1989-90 Rs. P.
By **Source of Income :**		
,, Grant Received fro n D.S.T., Govt. of India. (including transferred of Rs. 3.00 lakhs from 'Plan' A/c.)		10,50,000.00
,, Consultancy Fees (Sample Testing)		47,855.00
,, Excess of Expenditure over income for this year carr ed down		3,49,457.82
		14,47,312.82
,, Balance transferred to Balance Sheet		3 64,219.80
	Total :	3,64,219.80

This is the Income & Expendit ure referred to in our report of even date.

Sd/-
RAY & RAY
Chartered Accountants

Bose Institute

CALCUTTA

AUDITORS' REPORT

We have audited the attached Balance Sheet of the BOSE INSTITUTE as at 31st March, 1990 and the annexed Income & Expenditure Accounts of the Governing Body and the Council for the year ended on that date which are in agreement with the books of account and records produced to us.

In our opinion and to the best of our information and explanations given to us, the Balance Sheet read with the Notes given seperately in Schedule XXII and subject to our following observations, gives a true and fair view of the state of affairs of the Institute.

1. The requirements of Sections 16 and 17 of the Societies Registration Act 1961 in regard to holding of Annual General Meeting and filing of Returns were not complied with.

2. Sanction of the Central Government for appointment of Auditor is awaiting.

3. *Amount Receivable Rs. 4,65,566.65*

   The above amount includes Rs. 2,84,407.00 being general advance in which there is a sum of Rs. 96,635.74 brought forward from last account. Included in the brought forward amount a sum of Rs. 15,240.57 due from four parties which is outstanding for many years. These amounts should be adjusted at an early date.

4. *Security Deposits Rs. 41,254.00*

   Confirmation of receipts of deposists were not available for verification.

5. For the purpose of Income & Expenditure Account, the allocation of expenses between Plan and Non-Plan as made by the Institute has been accepted by us.

Sd/-
RAY & RAY
Chartered Accountants

The 30th August, 1990

Bose Institute

CALCUTTA

SCHEDULE NO. XXI : NOTES FORMING PART OF ACCOUNTS FOR 1989-90

1. Land :

a. *Madhyamgram* : Government of West Bengal acquired plots of land measuring 40.99 acres for Sir J. C. Bose Centenary Laboratory Building out of which a total of 18.73 acres was handed over to the Institute through certificate of posession on different dates. The balance land could not be handed over as it was disputed. The Governing Body in its meeting held on 31.7.89 has decided not to claim the balance land from the Govt. of West Bengal, considering other related factors.

(b) *Salt Lake* : Of the total land of 304.5189 Kottahs, Lease Deed for 999 years of the Land measuring 303.8193 Kottahs was executed on 14.2.1986 Supplementary Lease Deed for 0.6996 Kottah is yet to be executed.

(c) *Maniktala* : Against the leasehold land for 99 years, the Institute has paid during 1987-88 at a time balance six yearly instalments amounting to Rs. 2,47,549.44 to make full payment of premium of Rs. 12,07,262.25. The Institute has claimed rebate for early payment in terms and condition of Lease and obtained a refund of Rs. 36,888.41 from CIT and accounted for accordingly.

2. Fixed Assets :

(a) It appears that there is in adequate control in regard to maintenance of registens including identification and location, physical verification, ascertainment of damaged or unserviceable assets, etc. A Technical Committee was formed to assess condemmed items acquired during the period from 1966-85 as per list submitted by respective Departments / Sections. The Committee has submitted its report to the appropriate authority. Necessary action on the said report is still awaited. Similar steps should be taken for the remaining period.

(b) As per practice of the Institute, depreciation is not provided on the fixed assets.

(c) The Institute has not sold or otherwise disposed off or mortgaged any property acquired by it with grants given by Central Government for Capital Expenditure.

3. **Grant-in-Aid Schemes :**

(a) The above Scheme accounts are treated usually on cash basis except for terminated schemes where all outstanding income and expenditure are taken into account.

(b) Unutilised portion of Grant-in-Aid Schemes, sponsored by various Bodies is included in cash and bank balance of the Institute for which separate Bank Accounts are not maintained.

(c) Steps are being taken for recovery of the receivables in respect of the terminated Grant-in-Aid Schemes. In case any amount is not recoverable as per the opinion of the Council, these are written off.

4. As per practice, consistently followed over the years, the Institute is following cash basis in a number of items e.g. (a) Pension, (b) Gratuity (c) Leave Salary, (d) Interest on Bank Deposits, etc.

5. Consistent with the practice followed, generally all expenditure incurred from recurring grant have been treated as revenue and expenditure from non-recurring grants have been capitalised.

6. In respect of House Building Loans given to the employees, interest becomes receivable after recovery of the principal amount in full. Interest will be accounted for when the same becomes receivable.

7. There is a difference of Rs. 72.97 between Ledger and Schedule, which was reported earlier year also, remained to be located and adjusted accordingly.

8. In suspense Account (Rs. 783.54 net) an amount of Rs. 5,734.00 (Cr) is lying in the name of M/s. Ajodhya Prasad as retention money for over 11 years which needs to be settled and dealt within the accounts accordingly.

9. Bank Reconciliation Statements-A/c. Grindlays Bank.

(a) In absence of relevant advices Bank Debits amounting to Rs. 15,561.40 has not been entered in Cash Book.

(b) A cheque of Rs. 880/- issued on 21.11.89 but not cleared till 30.6.90 has become satale.

(c) A cheque of Rs. 4,230/- deposited on 4.7.89 but not credited by Bank till 30.6.90.

Necessary steps may be taken in respect of these items.

10. An amount of Rs. 2,63,461.00 is credited to suspense account in respect of different Grant-in-Aid fellowships (CSIR). These amount will be adjusted with respective fellowships in subsequent years.

11. There is a difference of Rs. 23,267.79 between the accounts of Bose Institute and RSIC which is in the process of reconciliation.

12. Contracts remaining to be executed in Capital Accounts—Rs. 30.00 lakhs.

13. **Contingent Liability**

(a)	Letter of Credit	Rs. 3,49,147.00
(b)	Bank Gurantee	Rs. 2,64,713.00

Sd/-	Sd/-	Sd/-
T. K. Ghorui	A. J. Dutta	S. K. Sen
Dy. Registrar	*Registrar*	*Actg. Director*
Bose Institute	Bose Institute	Bose Institute

Sd/-
RAY & RAY
Chartered Accountants

Dated : 30 August, 1990

Regional Sophisticated Instrumentation Centre, Calcutta

AUDITOR'S REPORT

We have audited the attached Balance Sheet of REGIONAL SOPHISTICATED INSTRUMENTATION CENTRE as at 31st March, 1990 and the Income & Expenditure Account for the year ended on that date which are in agreement with the books of account and records maintained.

The Balance Sheet gives a true and fair view of the state of affairs of the Centre as at 31st March 1990 and Income & Expenditure Account gives a true and fair view of the deficit of Income and Expenditure Account for the year ended on that date subject to the following observations :

(1) The Centre had purchased an equipment included in Fixed Assets from M/s. Spectrospin AG of Switzerland, the price of which includes commission payable to their Indian Agent M/s. Systronics included in liability account for Rs. 2,70,768.00. As against the same, the Centre has claimed a sum of Rs. 1,26,353/- for demurrage paid recoverable from M/s. Systronics. The matter is under dispute and necessary adjustment will be carried out on the final settlement.

(2) Details of Fixed Assets were not available for verification.

(3) No depreciation is provided on the fixed assets. As per condition of the grants for Capital Expenditure received from the Government of India, the Centre shall not sell or otherwise dispose of or mortgage any property acquired by it with such grants without prior approval of the Government.

(4) The entire liability of Rs. 3,29,207.37 is lying unpaid for more than 6 years Out of the above, supporting bills for Rs. 58,439.36 could not be made available to us for verification. We would suggest to scrutinise the old liabilities in order to assess whether these are required to be paid.

(5) An amount of Rs. 44,133.25 received on account of interest on Savings Account has directly been credited to Grants-in-Aid, Non-Recurring Account instead of crediting to Income & Expenditure Account.

(6) The total deficit of operating results aggregating Rs. 3,64.219.80 as shown in the Balance Sheet includes a sum of Rs. 3,49,457.82 for the current year.

Sd/-
ROY & ROY
Chartered Accountants

The 30th August, 1990