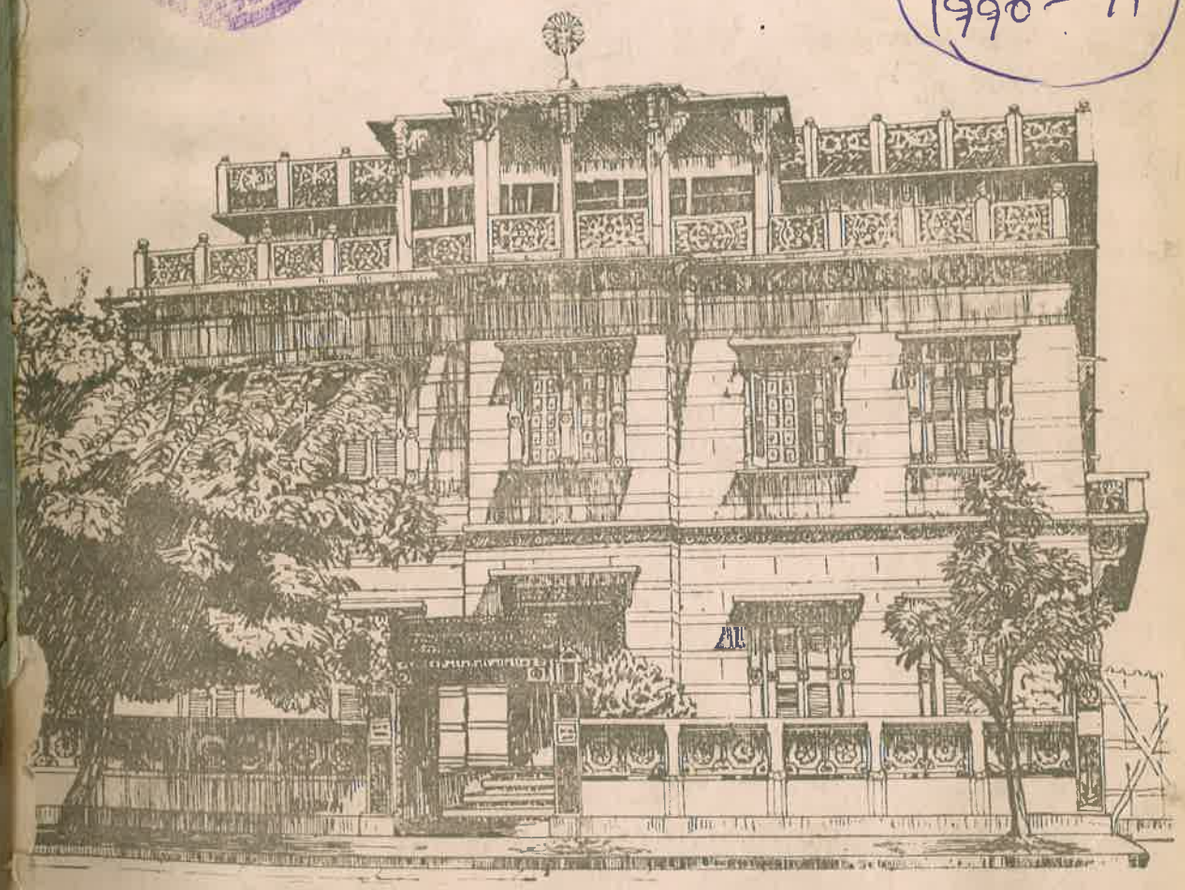
ANNUAL REPORT
OF
THE BOSE INSTITUTE
FOR
1988-89



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CORRIGENDUM

The entry at page 102, 11th line in respect of
"Research Assistant : Dr. (Mrs) S. Bhattacharya, M.Sc., Ph.D."
is deleted.

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DIRECTOR'S REPORT

It is a pleasant occasion on the 71st Foundation day of the Bose Institute that Honourable Prof. S. Nurul Hasan, Governor of West Bengal, inaugurated and presided over the function. Dr. A. P. Mitra F.R.S., the Director General, CSIR delivered 50th Acharya Jagadish Chandra Bose Memorial Lecture on "Frontiers of Atmospheric Science". Further, we have this year arranged a seminar on "Radiation Physics" which have been inaugurated by Dr. A. P. Mitra. Many distinguished participants coming from different parts of India and abroad were present to join us on this occasion.

I am thankful to the members of the Council and the Governing Body for their support in the administrative affairs. I am also thankful to the Department of Science & Technology, Government of India, for their financial support extended to the Bose Institute. As I mentioned in my last year's report about donation of a plot of land at the Salt Lake area by the Government of West Bengal for the construction of Hostel/ Housing Complex and my request to D.S.T. for allocation of funds for Scholars' Hostel, I am glad to declare that the work of construction of Hostel Complex at Salt Lake has been entrusted to the C.P.W.D., Eastern Zone. My further request to the D.S.T. is to allocate funds more liberally to the Bose Institute in the next financial year as this is indeed at present most urgently required owing to increasing difficulty in getting residential houses in Calcutta particularly for the employees from outside West Bengal. Generous and increasing support from other Grant-in-Aid Bodies such as C.S.I.R., I.C.A.R., I.C.M.R., D.S.T., PL-480, U.N.D.P., Indo-US, Government of West Bengal and other agencies is being received.

I am happy to inform you that one of our colleagues, Prof. S. K. Sen, has been elected Fellow of the Indian National Science Academy. Dr. Dipankar Home has been invited to present papers in the International Workshop on "Foundations of Quantum Mechanics" held in Bari, Italy. Prof. S. C. Roy was invited to chair one of the sessions in the 4th International Symposium on Radiation Physics held at Sao Paulo, Brazil. Prof. Parul Chakraborty was invited by the organizers to deliver talk in the International Conference "Interlec 9", held at Prague. She also attended on invitation the 14th International Congress of Biochemistry held at Prague. Prof. Chakraborty was also deputed to U.S.A., Belgium and U.K. under the W.H.O. programme. Prof. S. Chanda was invited to chair a session and present papers in the 7th International

Congress on Aerobiology held at Brisbane, Australia. Prof. S. Ghosh has been deputed to U.S.A., U.K. and Italy under U.N.D.P. programme. Dr. Siddhartha Roy was invited to present papers in the International Symposium on "Biological Magnetic Resonance" held at U.S.A. Dr. Asok Banerjee was deputed to U.S.A. on Marine Biology programme. Dr. Prabhakar Gupta attended the FEBS Workshop on Micro-injection held in Berlin. Dr. Jyoti Basu and Dr. Manikuntala Kundu attended the 14th International Congress of Bio-chemistry held at Prague and attended the 4th International Congress of Cell Biology held in Canada.

It is customary for the Director to report on the progress of the work carried out in the Institute during the year under review.

Research works were carried out in the Department of Physics with an aim to understand the ultimate truth of nature from the microscopic structure of matter studied through theoretical and experimental investigations in ultrasonics, nuclear physics and through related interdisciplinary areas. Kinetic behaviour of trapped radicals in radiation induced organic materials and viscosity controlled decay of free radicals in the high temperature icy states were studied by the method of lyoluminescence and ESR spectroscopy ; radiation induced change in viscosity of polymers was studied using differential viscometer developed in this laboratory ; diffusion coefficient in multi-component system was studied to gain insight of the structure of liquid. In atomic physics Compton scattering was employed to study Compton profile and in applied science such as to determine the effective atomic number of compounds. Analysis of degeneracy and related approximate symmetries and their applications in simple quantal systems in strong magnetic field was carried out. In nuclear physics, (α, xn) reaction using 70 MeV α-particle obtained from VECC, Calcutta was studied. In general and condensed matter physics, (i) critical behaviours of the lattice statistical model known as spiral lattice animals and spiral percolation, (ii) unusual appearance of quadratic dispersion in CeAs anti ferromagnets were investigated. Also in general physics—anholonomies in classical and quantum systems has been intensively investigated. Geometric phases and angles have been determined for spin systems and in more general quantum systems as well. A new form of the EPR paradox of CP nonconservation suggested was proposed to be tested experimentally in the experiment planned in Italy. In ultrasonics, the experiment for measuring electrooptic and elastooptic coefficients of liquids has been renovated and made more precise. Tissue characterization by ultrasonic attenuation using Emisonic 4200 diasonograph was also made.

The research investigations of the Chemistry Department are centered on the structure, function, dynamics and interactions of biomolecules from both terrestial and

marine organisms. Highlights of the investigation on terrestial organisms include the following : Structures of several novel new antifeedant and growth inhibitors from Indian plants have been worked out. Chemical investigations of some Indian medicinal plants have let to the isolation of new coumarin and quinazolone alkaloids. The optical brightener present in 'Ritha' has been traced. Besides a number of alkaloids, a diterpenoid possessing antifeedant properties has been isolated. Photochemical transformations of pyranocarbazoles involving ring expansion has lead to the formation of a new tetra and pentacyclic heterocyclic systems. In the system tube Photo-Fries rearrangement has been found to take place. A convenient method for the synthesis of organic sulfones has been developed. The method is now being utilised for the synthesis of biologically active compounds. A simple, one-pot synthesis of 4-acyloxy-α-pyrone has been achieved, which holds promise to be a general synthetic route. In experimental rats fed with diets rich in Hilsa oil eicosapentanoic acid has been found to replace arachidonic acid, a precursor of thromboxane A 2, which initiates thromb formation in thrombogenesis. The above diet also reduces blood cholesterol level as well as atherosclerotic plagues in rabbits. Fish gills contain mainly monoenoic phospholipids. In the marking fluid of tiger, a proline derivative has been detected. The postagladin synthetase enzyme complex of goat seminal vesicles has been identified in the rough endoplasmic reticular fraction. Calmodulin has been found to regulate the enzyme. A proteinase inhibitor has been isolated from the seeds of *Arbus precatorius* with a view to understanding the mechanism of proteinase-inhibitor interactions.

Investigation on biomembranes has led to isolation of a novel phospholipid transfer protein from *Neurospora crassa* and a lectin from *Mycobacterium smegmatis*, a pathogenic member of which comes leprosy. Abnormal membrane cytoskeletal structure indentified in the red blood cells of chronic myelogenous leukemia and acute lymphoid leukemic may be responsible in part, for acute anemia associated with these diseases. Vitamin E, a physiological antioxidant, has been found to impact protection against any kind of meunorhagia in women. The purification and the interaction with inhibitors, ligands, substrate and drugs of an unique Mg^{++}-independent Ca^{++}-ATPase is in progress. It has been shown that food materiale or drugs containing inhibitors of tyrosinase may precipitate conditions of amelanosis or vitiligo. From the results of tissue culture experiments tryptophan has been shown to have status similar to that of DOPA in melanogenic process. Studies on a bone marrow derived bio-immunomodulator was made A protein fraction obtained from bone marrow cell secretion has been found to reverse immuno suppression in malnutrient animals.

Investigation on the marine organisms includes the following : A biologically

active sterol has been isolated from a sea pen, *Pennatula* sp, and its structure has been established. Besides p-hydroxy-phenyl acetic acid, a plant growth regulating factor, several iodinated derivatives of the above acid and 3,4-dihydroxy phenyl acetic acid have been isolated from *Armina* sp-a marine mollusc. A marine squid *Loligo duvacelli*, has been found to contain a new sterol and good quantity of ether-lipids which play important role in many physiological phenomena. An unusual lectin from a marine gastropod mollusc has been purified which is inhibited by simple sugar like, L-fucose and 1-0-methyl-α-D-galac-topyranoside.

The Department of Botany is engaged in the following areas of research. Four promising selections of paddy and a number of potential recombinants of interspecific hybrids between *Beta vulgaris* and *Beta palonga* have been isolated. Propagation media for teak and papaya, isolation of five somaclonal lines from tobacco and purification of rice tungro viruses have been made. Polyamines are found as screening parameter in stress condition of rice and pulse crops. The metabolism and functions of polyamines in plant growth and development are studied with special reference to stress, senescence and photosynthesis. Enzymes and proteins in embryos of aged wheat seeds and pattern of cellular senescence in aged wheat and rice embryos were studied to find out the physiological and cellular events associated with germination and productivity of aged seeds. P-coumaric acid and *trans* cinnamic hormones were isolated from tea and their esters. Atmospheric bio-pollution over Calcutta and Madhyamgram with reference to occupational respiratory allergy and epidemiology of green smut disease have been surveyed. Pollen survey and immunochemistry of some allergenically potent plants have been done.

In Tissue Culture Section genetical modification of crop plants such as rice, mustard and jute have been continued to improve upon the yield potentiality and quality using tissue culture and protoplast fusion technique coupled with classical breeding programme. Improvement in the production of diosgenin from invitro cultured cells has been continued.

The Microbiology Department is engaged in researches on both basic and applied aspects of Microbiology and Immunology. Studies on the carbon metabolism of *Cicer* rhizobia established the inducibility of glycolytic enzymes in the system. Regulatory mechanisms of β-gluco-sidase and glycoamylase synthesis in different fungal strains have been studied. Fungal strains ann actinomycetes have been isolated and developed for the production and characterization of α-amylase, β-amylase, xylanase, cellulase, protease, cellogenase and keratinase.

Studies on the air-mycoflora of the Calcutta environment have been continued and a number of fungal allergens isolated. Soil microbes have been utilised for degradation of chrome-tanned leather and cellulosic wastes. Glutathione-S-transferases, a group of multifunctional detoxifying proteins, have been isolated from fungal microsomes during induction of cytochrome P-450 isozymes. An improved technique has been developed for the immobilization of fungal spores for 11-oxygenation of steroids. A lichen specimen has been isolated and successfully used for the production of litmus dye. Studies on microbial benefication of magnesite ores have been carried out on a pilot plant scale with encouraging results. An efficient phosphate solubilizing strain of *Rhizobium* has also been developed. Further, bacterial strains have been exploited for the enhancement of oil recovery. Studies have been continued on the anti-tumor activity of the enzyme L-asparaginase, the toxicity and immunotherpeutic potential of the enzyme are being evaluated. Researches on some of the pathogenic bacteria and parasite have been initiated for the better understanding of the infection and immunity related problems.

The investigations in the Biochemistry Department are primarily concerned with the mechanism of gene expression and its regulation, using *in vitro* methods and gene cloning. Prokaryotic and eukaryotic organisms are being used for these studies with both basic and applied interests. With a view to generate improved mung been plant variety with better protein quality, the storage protein gene from Brazil nut enriched in methionine and cysteine is being introduced into *Vigna radiata*. To introduce the improved modified homologous or foreign gene, one should be able to generate whole plants from transformed tissue or cells. Successful regeneration of plants has been obtained from mung bean cotyledons and apical meristem. Transformation with Agrobacterium containing reporter genes are being tried. Based on the past work in plant molecular biology, a long range UNDP-supported project has been initiated in the department jointly with the Tissue Culture Section for improvement of crop plants using modern biotechnology. Catfish ribosomal RNA genes and repetitive DNA from carp cloned in the department are being used for studying evolutionary divergence in fishes. A genomic cosmid library of the associative symbiotic nitrogen fixer *Azospirillum brazilense* has been constructed to study the genetic control of nitrogen fixation and fructose utilisation. Genetic analysis of mutants affecting initiation of DNA replication in yeast and the mechanism of host killing of superkiller mutant bacteriophage lambda are also being studied. A repetitive DNA has been cloned from restriction enzyme digest of Goat DNA, that will be used in genetic organization studies in goat. Chromatin-like DNA organization and a repetitive DNA have been studied in the human protozoal parasite *Entamoeba histolytica*.

In continuation of Acharya J. C. Bose's work on plant movement, a high molecular weight actin-depolymerising protein has been characterized from Balsam plant, with implication in the movement of the contractile pods on maturation for seed dispersal. Myoinositol-2,4,5-triphosphate generated from myoinositol hexaphosphate by phytase action during germenation of mung bean seeds have been implicated in Ca^{+2} regulation, similar to inositol-1.4.5-triphosyhate in animals. The structure-function relationship of animal tubulin and a high affinity repressor of bacteriophage lambda has been studied by ligand binding and using fluorescent probes.

The Department of Biophysics has made substantial progress and contribution in the programme of eluciation of structure, functions and dynamics of molecules in crystalline, semicrystalline and in solution by biophysical and biochemical techniques. Topological transition characteristics of DNA has been elucidated in detail and a generalised DNA model has been projected. Structures of potential drug and drug analogs have been solved and a correlation between structure and function is continuing. Considerable progress on understanding of lambda opressor and operator interaction by using fluorescently labelled repressor has been done. Substantial progress in the molecular graphics on B-Z phase transition of DNA has clarified and rationalised solution and solid state data. Further work is in progress.

The research works of Animal Physiology during the year under review were primarily concentrated on the thyroid hormone-receptor interactions, vitellogenin synthesis under the influence of zinc treatment and estrogen=progesterone interaction in the production of cyclic AMP in fish liver/brain. Influence of estrogen on the metabolism and growth of gonad of prawn was investigated, and also the neuroendocrine organs of silkworms. High affinity low capacity triodothyronine binding receptors midiating the hormone action at the molecular level have been identified in fish liver nuclei. Thyroglobulin immunization in rabbit produces hypothyroidism and significantly alters the thyroid hormone receptor concentration in liver. Zinc, an environmental pollutant, inhibits vitellogenin synthesis in fish liver. Estrogen and progesterone have some influence on the production of cyclic AMP in fish brain. Estrogen also induces marked changes in protein and nucleic acid metabolism in hepatopancreas and ovary of prawn. In silkworms, Vitamin B_{12} induces the enhancement of silk and egg production partly through its influence on the neuroendocrine organs.

The Bose Institute Library is one of the best Science Reference Libraries in Eastern India. It is frequently used and consulted by many research workers and teaching staff of the seven Universities of West Bengal, including STM, Medical

College, Indian Institute of Chemical Biology, Central Glass & Ceramic Research Institute, Saha Institute of Nuclear Physics, Indian Institute of Technology (Kharagpur), BHU, BSI, ZSI and other educational organisation and institutions.

A number of rare and costly Journals and periodicals have been subscribed along with annual and serial (foreign) publications. Library contain 24,833 volumes of books, bound journals (16,281 journals, 8,598 books and 4 maps upto 31.3.88). During the period under report (1988) 856 journals, 498 books and 14 theses were added to the library stock. The total number of periodicals received was 394, out of which 236 were subscribed (201 foreign and 35 Indian). Computer facility has been added to the Library.

The Workshop, as before, has taken keen interest in the fabrication of Instruments, repair and maintenance of equipments, building and electrical installations and the services have been extended to Farm stations and Scholars' Hostel. Some Instruments designed by Acharya J. C. Bose have been replicated and reproduced in the Workshop.

In order to set up the J. C. Bose Museum with best possible available documents both inside the Institute as well as from other organizations within the country with which Acharya Bose was closely associated have been collected. In this connection Visva-Bharati was approached with an exchange programme of documents, photographs, manuscripts, etc. related to Acharya Bose and Gurudev Rabindranath. Birla Industrial & Technological Meseum has been contacted for their valuable suggestions with regard to display of materials in the J. C. Bose Museum. The Archaeological Survey of India, Bengal Circle, was approached to restore the historical wooden gate installed at the entrance of the Main Campus of the Institute. Replica of one Compound Lever Crescograph was made, as mentioned in the last year's report, has finally been donated to Tamil Nadu Science & Technological Museum. Large number of visitors both from abroad and within the country visited the Museum. A film serial on the history of science & technology on the Indian subcontinent under the auspices of Nehru Centre, Bombay, specially mentioning the works of Acharya Bose and the necessary shooting was made in the Bose Institute. Mention may be made of the work rendered by Shri M. L. Chatterjee.

The R.S.I.C. continued to provide analytical instrumentation services to users in the region. The installation of the FT-NMR was completed for services on ^{1}H, ^{13}C, ^{31}P spectra. Trial runs on these nuclei were provided to Institute users.

Routine services are yet to commence. The X-ray diffractometer commenced user services lately.

Distributed Information Centre for Bioinformatics has been set up at the Bose Institute and the Centre has started functioning after installation of a Micro Vax II Computer.

Twelve Research Scholars completed their research work and submitted thesis for the award of Ph.D. during this year.

The Chemistry Department organized a Workshop on "Bioactive Substances from the Indian Ocean" at Port Blair and a symposium "Developing Drugs/ Pharmaceuticals from the Sea" in Callcutta. The Physics Department organized an International Seminar on Radiation Physics. The Biochemistry Department organized a Workshop on "Cloning, sequencing and chromosomal localization of animal genes".

With deep sense of sorrow I like to mention that Shri Chinmay Nandi, Scholar in the department of Botany, Sri Narsingh Bhuiya, Mali, and Sri Aurobinda Bose, Ex-worker, passed away during this year. Condolence resolutions were conveyed to the bereaved families after holding the condolence meetings in their memory.

An unfettered charter for science is that "The true scientist is the sage unattached to life and the fruits of action ever seeking truth wheresoever this quest might lead him". This estimation of quintessence of what science is all about at present seems sadly dated, if the current plight of science in India is to be taken as the term of reference. The cultivation of science and the nourishment of research are not amenable to anything more than a broad direction set by those seeking instant evaluation of the contributions of the Indian scientists to the overall stock of knowledge. In this context, the contributions in scicnce from the Bose Institute starting from its inception are not insignificant.

Contribution of Acharya J. C. Bose on the discovery of microwave gave the world a new direction, the application of which we find now in different areas of science and technology. It is unfortunate that the Nobel Committee missed the chance of conferring the honour to this illustrious scientist. Next, we find an exciting invention of meson like particle by Dr. D. M. Bose. However, later Noble Prize was awarded on this area of research to Dr. Powel. Even today, one of our youngest colleagues has given a new twist to the EPR paradox in presence of CP nonconserva-

tion to be tested experimentally. A new class of compound, i.e., carbazole and various other compounds from plants have been discovered in the Bose Institute. Pioneering work using the radioactive compounds yielded altogether a novel metabolic pathway in the energetics of plant and new type of plants by mutation. Similar in the case with cholera toxin discovered by Prof. S. N. De which paved the path for production of vaccine today. This Institute has also shared the exciting breakthrough in the information flow from DNA to RNA and at present culminating in construction trangenic plant and animal applying genetic engineering techniqxes. This is not all inclusive but a mere glimpse of potentiality which existed or exists in this Institute to undertake research in frontier areas of seience and to contribute significantly One thing emerges that the Bose Institute has not been given the attention/award that it deserved or deserves even today. Not to repeat the same state of affair my fervent appeal to the Government as well as to the public is to support and nurture the potentiality of the Institute very carefully and to declare this Institute as an Institution of National Importance without further delay and I hope that the Bose Institute Council should take necessary steps to implement this proposal.

A. PHYSICS

Institutional Project No. III. Investigations on the interaction of nuclear and other radiations with matter and studies in structure, function and dynamics of bio-molecules.

A. Physical Acoustics, Microwaves and Solid State Physics

(i) *Investigations on Biological tissue using Emisonic 4200 Ultrasound Scanner* (DIASONOGRAPH) : B. Roy and S. C. Roy.

To gain insight into the mechanisms of interaction of ultrasound with tissue materials, ultrasonic velocity in three mammalian tissues (liver, kidney, cardiac muscle) were measured as functions of frequency. No significant velocity dispersion was observed within the range of 2·5 MHz to 10 MHz at room temperature.

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

The component materials for the development of the Photoacoustic Spectrometre are being procured. The power supply for the recently purchased 450 W Xenon lamp is being developed with help of Electronics Division of VECC, Calcutta. We have got one PZT-element prepared in National Chemical Lab., Puna. It will be poled by applying a field of 25KV/cm. available in High Voltage facility at VECC.

(iii) *Tangential Instabilities at the Interface of flowing liquids :* M. H. Engineer, B. Roy and B Chatterjee.

There has recently been an upsurge of interest in the viscous fingering phenomenon, a system in which the properties of transverse instabilities at the flowing interface between pairs of liquids reveals itself. The questions of *Tangential Instabilities* at interfaces between comoving liquids then naturally arises. We have decided to look into a small aspect of this vast problem by studying the interface dynamics for two liquids of almost equal densities, but unequal viscosities, at low IFT's. Preliminary experimentation has shown a remarkably rich spectrum of surface dynamical behaviour, both chaotic and orderly. Better equipment is being built to study the problem in detail.

B. Nuclear Physics

(i) *Measurement of Compton Profile :* A. K. Chatterjee, Santa Bandyopadayay and Aruna Chatterjee.

We measured the Comton profile of aluminium single crystal and copper polycrystal. The same measurement has been continued with CuO powder sample. The objective of the last measurement is to find the effect of oxygen binding in CuO.

(ii) *Investigations with 14 MeV neutrons :* A. K. Chatterjee and D. K. Mitra.

Our programme is to study nuclear reactions with NE-213 Liquid Scintillator and Solid State Nuclear Track Detector. The standardization of both the detectors were done with 14 MeV neutrons and Am—Be neutron source. The track processing and recording was done by the conventional method of detection by optical microscope and scanning electron microscope. The track detector will also be utilized for measurement of neutron radiation dose.

(iii) *Utilizaiion of Variable Energy Cyclotron :* Measurement of (∝, xn) reaction : B. Mitra (retired from Bose Institute in 1987), A. K. Chatterjee, S. N. Changdar, Aruna (Bose) Chatterjee, D. K. Mitra and B. B. Baliga (Collaborator from Saha Institute of Nuclear Physics).

The analysis of experimental data on neutron pulse height spectrum for 70 MeV alpha particle interaction with Silver and Bismuth are being done at the computer facility of VECC. The program FERODOR is being utilized for evaluatian of neutron energy spectrum.

C. Radiation and Tracer Technique

(i) *Tracer Techniques and Liquid Dynamics :* S. N. Changdar, Haimanti Chakrabarti (Guest Worker) and Aparna Das.

Work is being continued in our laboratory for the measurement of diffusion coefficients in multicomponent systems using sliding cell techniques employing radioactive tracers. The work on the transport phenomena in Phosphoric acid solutions has been completed to study the possibility of hydration effects in this system.

D. Radiation Physics

(i) *Measurement of change in Viscosity of Polymers under ∝-particle irradiation :* L. Santra, K. Chakrabarty and S. C. Roy.

Although a great amount of work studying changes in polymer viscosities under gamma-irradiation has been done, not much activity on irradiation with charged particles has been reported. Since the nature of interaction of matter with ∝-particles is different from that with gamma rays, we expect different and interesting physics to emerge. One of the reasons, as we noted, is the significant uncertainties involved in measuring small change in viscosities near threshold by two independent measurements, one with an irradiated sample and other with the control sample. To obviate this difficulty, we have used a differential viscometer developed in our laboratory which is capable of measuring the small expected changes in viscosity in one go.

Preliminary experiments using ∝-particles show that the viscosity decreases with dose contrary to the increase when irradiated with gamma rays. This might be explained from the point of view that ∝-particle being a high LET radiation deposits a large amount of energy and irreversible breakage of polymer chains occurs. In one typical experiment using 30 MeV ∝-particles and irradiating silicone fluid of viscosity 1000 centi-stokes with doses in the range 30 to 300 rad, we noted almost the same reduction in viscosities. In order to check whether the effect is equivalent to heating, we performed test experiments by heating the fluid at different temperatures and measuring the viscosities after they attain room temperature. No change was observed. On the basis of the above observations, more systematic investigations using different samples, with varying beam current and energy have been planned.

(ii) *Rayleigh Scattering from Ions near Threshold :* S. C. Roy (In collaboration with University of Pittsburgh).

Theoretical studies of Rayleigh scattering of photons from neon atom with different degrees of ionization, for energies both near and above K-edges have been done. It has recently been realized that some structures predicted near threshold may have a non-physical origin and are due to the limitation of independent particle model and also to the use of a Coulombic Latter tail. Use of a K-shell vacancy potential in which an electron is assumed to be removed from the K-shell in calculating

K-shell Rayleigh scattering amplitudes removes some of the structure effects near threshold. A comparison of angular distribution and scattering cross sections computed using vacancy potentials and with other potentials has been made.

(iii) *Studies of radiation-induced free radicals in organic compounds by the methods of lyoluminescence technique and ESR spectroscopy :* Tuktuk Sur, H. Kundu (GSI), B. Mitra (ex-Bose Instt., Physics Deptt.) and S. C. Roy.

The kinetic behaviour of the long-lived trapped radicals in gamma irradiated tissue equivalent organic substances has been studied by lyoluminescence technique and ESR spectroscopy. Both methods have been used to study the viscosity-controlled decay in the high temperature organic icy state in different type of lyoluminescent phosphors by LL technique and ESR spectroscopy. Nature and concentration of free radicals trapped in gamma-irradiated saccharides (Sucrose, Raffinose, Melezitose etc.) and amino acids (L-Glutanic acid, Glycin etc.), subjected to the post-irradiation heat treatment at different temperature approaching the melting point, has been investigated by the lyoluminescence technique. ESR studies have also been undertaken to correlate the LL yield with the nature and concentration of free radicals produced in them.

(iv *Measurement of percent composition of compounds using Compton scattering :* K. Chakrabartty, S, C. Roy.

Percent composition of C_3HO and CH_3OH water solution were measured using Compton scattering. Also effective atomic number of compounds were estimated. Scattered counts at 90 degrees were observed. Results are in good agreement with the predicted values. Radioactive source with low energy ($\sim$ 145 kev) γ-rays is expected to be received by May, '89. Experimental set-up with more modification will be used to study bone mineral density, fatty acid contents in liver to help in understanding the causes of osteoporesis, atrophia cirrhosis of liver etc.

E. Condensed Matter and Theoretical Physics

(i) *Investigations of Rydberg atom in strong magnetic field :* D. Bhaumik and Kumkum Bhattacharyya.

Studies on the solution of the problem of Rydberg atom in strong magnetic field is continuing. Singular perturbation theory and near field approaches were used. It seems that an universal picture is emerging from all these methods. Search for approximate constants of motion is continuing. Treatment of the problem

using action-angle variables when the motion of the guiding center gets isolated has been started.

(ii) *Investigations concerning the Einstein-Podolsky-Rosen (EPR) Paradox :* Dipankar Home, A. Datta (Jadavpur University) and A. Raychaudhuri (Calcutta University).

As a sequel to our earlier work pointing out a new form of the EPR paradox involving neutral pseudo-scalar mesons like $K^\circ - K^{-\circ}$, $B^\circ - B^{-\circ}$, we have made further studies in response to criticisms and comments made on our work in various published papers on it. In particular, we have clarified the precise rale of CP Violation in such examples. We have also formulated Bell-type inequalities in these cases which can be experimentally tested to discriminate between quantum mechanics and local realism (Einstein's locality condition). Relevant experimental groups abroad are examining the feasibility of snch experiments.

(iii) *Study of the time-dependent Aharonov-Bohm (AB) Effect :* Dipankar Home and R. A. Brown (Macquaire University, Sydney, Australia).

The earlier work on a rigorous mathematical treatment of the time-dependent AB effect (using Feynman's path integral approach) has been improved upon and its implications have been studied in depth. New features of the dynamic AB effect have been pinpointed and preliminary interactions as regards their empirical corroboration are being pursued with A. Tonomura *et al.*, Central Research Laboratory. Hitachi Ltd., Tokyo.

(iv) *Quantum Non-local Effect in Scattering and Absorption :* Dipankar Home and P. Ghose (British Council Division, Calcutta).

We have investigated the possibilities ot interesting quantum mechanical non-local effects in phenomena involving scattering and absorption. We are examining the feasibility of experimentally studying such effects using neutron interferometry, such as the one available in India at BARC.

(v) *The Quantum Measurement Problem :* Dipankar Home and M. A. B. Whitaker (Queen's University of Bel fast, Northern Ireland).

A comprehensive analysis of the quantum measurement problem is being attempted taking into account the studies already initiated on the significance of SQUID ring experiments related to macroscopic quantum coherence.

(vi) *Critical Phenomena in lattice statistical models :* I. Bose

Polymers in dilute solutions are represented by lattice animals. It is well-known that the asymptotic cluster properties of lattice animals are not affected by the presence of loops or cycles tn the animals, i.e., animals with loops and animals without loops belong to the same universality class. This is true for both unconstrained and directed lattice animals. We have shown that for rotationally-constrained animals, loops have a non-trivial effect on animal statistics, i.e., animals with loops and without loops belong to different universality classes. The results have been obtained by exact enumeration followed by extrapolation to the asymptotic limit.

(vii) *Low-dimensional Magnetism :* I. Bose

The effects of magnetic field on the statics and dynamics of order-parameter-preserving antiferromagnets has been studied. The spectrum of bound states in the absence of magnetic field has been obtained and the contribution of the bound states to the thermodynamics of the system investigated. Some model two-dimensional antiferromagnets have been proposed for which the ground state and excitation spectrum can be determined exactly upto fourth order in the interchain coupling constant, in perturbation theory.

(viii) *Berry's Phase and Hannay's Angles :* M. H. Engineer, G. Ghosh (SINP) and N. Dutta (SINP).

The two-state, time-dependent quantum problem in its full generality, has been explored in a new way. The motive was to evolve rapidly-convergent scheme for calculating *corrections* to Berry's phase. Such corrections are required for making contact with experiment. That apart, the calculation of non-adiabatic corrections to the phase of an evolving eigen-state is a hazardous task, since it seems that any standard perturbative scheme for calculating it, which neglects transitions, must diverge.

The new approach casts the problem into a Hamiltonian form. This allows one to apply that powerful formalism to the quantum system. A new invariant has emerged, calculation of leading corrections to the Berry phase have been completed. Further investigations are under way.

Preliminary investigations have been made on the general behaviour of the Hannay angle for these parameter space circuits that approach and enter into regions in which the Hamiltonian system is known to be chaotic.

B. CHEMISTRTY

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

A. (i) *Chemical Investigation of a Sea anemone (Paracondylactis indica) :* Manas Chakrabarty & A. K. Barua (Supervisor).

The extract of a giant sea anemone collected from Digha sea .coast was found to have hypotensive activity. For this reason detail chemical investigation of this sea anemone was undertaken to isolate the active principles.

During this chemical study an interesting lipid has been isolated in a pure crystalline state, mp. 89°. Its UV, IR, ^{1}H NMR, ^{13}C NMR, COSY, HETCOR and Mass spectral studies clearly indicated it to be an interesting ceramide type of compound. It appears to be a N-nonadecanoyl derivative of a C_{15}-amino alcohol bearing a 4, 8-diene system. Further work to confirm its structure and biological function is in progress.

This work is being done in collaboration with Dr. A. Patra, Dept. of Chemistry, University College of Science and Technology, Calcutta.

(ii) *Chemical investigation of Sepia aculeata :* Prantosh Bhattacharyya, Manas Chakrabarty, Anup Kumar Ray and A. K. Barua (Supervisor)

Earlier the isolation of two interesting amides having phenylalanine moiety was reported. The structure of one of these amides has been determined. Progress has been made towards its synthesis to confirm the structure and also to find its biological activities.

(iii) *Chemical investigation of some algae :* A. K. Barua (Supervisor), Sarmila Ray, Debasis Ghosal, Bikash Baran Ghosh Kalyan Basu and B. B. Mukherjee (Dept. of Botany).

Four brown algae were collected from Waltair. Preliminary chemical examination showed the presence of steroid and terpenoid type compounds. Further work is in progress.

(iv) *Chemical investigation of a soft coral (Nephthys sp.):* A. K. Barua (Supervisor) & Anup Kumar Roy.

Earlier the isolation of a new aromatic compound from a soft coral (*Nephthys sp.*) was reported. Its structure was determined as 1, 3 dihydroxy-1, 3 diphenyl-propane. Progress has been made towards elucidation of a structure of an interesting sterol now isolated from the same source. Further work is in progress. This work is being carried out in collaboration with Dr. A. Patra.

(v) *Chemical investigation of a starfish—Stellaster equestris (Retzins):* A. K. Barua (Supervisor) and P. K. Dutta.

The starfish *Stellaster equestris* was collected from Gopalpur on sea. The extract of the starfish has been sent to CDRI, Lucknow for biological screening and the report is awaited: Preliminary chemical examination of the extract showed the presence of sterols and glycosides. Further work is in progress.

(vi) *Chemical investigation on Sphenopus (steenstrup) sp.:* A. K. Barua (Supervisor) and P. K. Dutta.

The above species was collected from Digha. Its extract has been sent to CDRI, Lucknow for biological screening and the report is awaited. Preliminary chemical investigation indicated the presence of sterol and terpenoid type compounds. Further work is in progress.

(vii) *Biological screening of marin organisms:* A. K. Barua (Supervisor).

Twentyone extracts of marine animals and plants have been sent to CDRI, Lucknow for biological screening and results are awaited.

(viii) *Lipid composition of Loligo duvacelli:* Anoop Kumar and Parul Chakrabarti (Supervisor).

Loligo duvacelli, a cephalopod molluse, has been studied for its lipid composition. The percentage of various lipids were as follows phosphatidyl choline (32·8%), phosphatidyl ethanolamine (42·8%), sphingomyelin (11·4%), lyso phoaphatidyl choline (2·8%), phosphatidyl inositol plus phosphatidyl serine (9·7%), sterol (21·0%), triglyceride (6·0%), diglyceride (2·5%), monoglyceride (1·0%), free fatty acids (1·0%), sterol ester (3·0%), squalene (2·0%) and carotene (1·0%). Fatty

acid analysis of phospholipids showed high concentration (34·3%) of 22 : 4ω 6 and 21 : 5ω 3 in phosphatidyl inositol. The organism has been found to contain PGB_2. This was confirmed by chromatographic and spectroscopic studies. Other eicosanoids like PGE_2 and PGF_2a are also present in this species. Therefore the organism is a good source of prostaglands and other eicosanoidins. Role of these highly biologically active substances in this animal is being studied.

(ix) *Studies on marine turtle egg yolk:* Anoopkumar and Parul Chakrabarti (Supervisor).

Composition of the egg yolks of a marine turtle, *Caratta caratta* has been analysed. Phosphatidyi choline (87%) and triglyceride (68%) were the prominent lipids. A sterol has been isolated in pure form by crystallization. Chromatographic (GLC) and spectroscopic data (Mass, NMR and IR) reveals that it is different from cholesterol. Further studies to establish the structure are in progess.

(x) *Ether lipids of marine organisms:* Aloke Hazra, Subhashis Chattopadhyay and Amitabha Ghosh (Supervisor).

Ether linked lipids from the hepatopancreas of two species of horseshoe crabs, viz, *Carcinoscarpins rotandicande* and *Tachypleus gigas*, from Sundarbands ecosystem, were isolated, purified and characterized. Presence of 1-0-alkyl diglycerides in the neutral lipid fractions were confirmed by chemical and spectroscopic techniques. Alkyl chains were found to be of C-14, C-16 and C-18, normal and saturated. Acyl chains were found to be composed of typical polyunsaturated marine fatty acids, particularly rich in eicosapentaenoic acid. Phospholipid fractions were particularly rich in plasmalogens, viz., 1-0-alk-1′—enyl-2-acyl-phosphatidylcholine. Similar study was also extended to a marine gastropod mollusc, viz. *Telescopium telesocopium*, with similar results.

(xi) *Lipids of a filter feeder bivalve:* Amitabha Ghosh (Supervisor).

This study was specifically designed to ascertain the transmission of lipids and its precurssors from planktons to the bivalvia *Macoma burmanic*a. Animal samples and the planktons on which these bivalves feed were collected at various seasons and lipids compositions were determined. Results show that major (n-3) series of polyunsaturates were biosynthesised in plankton and were transmitted to the bivalve.

Institutional Project No. III : Structure, Funtcion and Dynamics of Biomolecules.

A. Physical, Chemical and Structural studies on proteins

(i) *Studies on basic trypsin-subtilisin inhibitor from turtle eqgwhite :* N. K. Sinha (Supervisor) and P. Sil.

The inhibitor contained independent reactive sites for trypsin and subtilisin. Chemical modification showed that its reactive site for trypsin was lysine. Its reactive site for subtilisin was determined by converting virgin inhibitor to modified one by limited proteolysis with subtilisin at pH 3·7. The modified inhibitor contained an amino terminal arginine residue and its carboxy terminal residue is being determined.

(ii) *Studies on trypsin inhibitor from Abrus precatorious :* N. K. Sinha (Supervisor) and S. Saha.

Two acidic trypsin inhibitors were isolated from the seeds of *Abrus precatorius* and were purified by gel filtration through Sephadex G-75, ion-exchange chromatography on DEAE-Cellulose and finally by HPLC using a reverse phase column. Their homogeneity was checked by polyacrylamide gel electrophoresis in presence and absence of SDS. Their amino acid compositions were determined and molecular weights were found to be 10,000 and 13,500.

(iii) *Studies on protein folding :* N. K. Sinha (Supervisor) and T. K. Chaudhury.

Protein folding is a complex process. A basic trypsin-subtilisin inhibitor of turtle eggwhite which contained 110 amino acid residues and three disulphide bonds in a single chain has been chosen with a view to elucidating its folding pathway.

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

Earlier the isolation of β-sitosterol and friedelin from this orchid was reported. It has now been possible to isolate a deep violet coloured quinonoid compound m.p. 206-8°. Spectral analysis (UV, IR, ^{1}H-NMR, ^{13}C-NMR, Mass and decoupling experiments) indicated the most probably its structure is 5-Hydroxy-3 (or 2) methoxy-phenanthra-1, 4 quinone.

Another red compound has also been isolated which appears also to be a phenanthraquinone derivative. Further work is in progress.

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

C. (a) *Phytochemical studies on phylogenetically related members of the Angiosperms* : D. P. Chakraborty (Supervisor), Shyamali Roy, Lina Bhattacharyya, Uttara Das, Sarbani Santra.

(i) The structures of two new phenolic growth inhibitors of aquatic angiosperms have been completely established with phenolics with butnone residue.

(ii) The structure of coriandiol from *Coriandrum sativum* has been shown to be a steroid with a double bond at 16 : 17 position.

(iii) The chemistry of some terrestrial algae is being studied (collaborative work with Botany Department of Calcutta University).

(iv) Structural studies of various small molecules of plant origin is reported earlier are being persued.

(b) *Synthetic studies in relation to phytochemicals and some newer synthetic methods and synihetic studies in relation to phyto-chemicals.*

(i) Continuation of work on aminocarbonylation with enolisabte newer ketones and diketones have resulted into interesting aminocarbonylated ketones and their transformation products. In attempts to aminocarbonylate some phenols interesting polymeric products have been formed. Newer quinazolones of potential biological activities have been synthesised.

(ii) Studies on iodine catalysed Beckman rearrangements have resulted into an interesting heterocyclic system.

(iii) Synthesis of heterocyclic compounds using $AICI_3$ catalysed diazocoupling is being continued.

(iv) Photochemical transformation of pyranocarbazoles have yielded new 2, 5-dihydrooxepinocarbazoles and bicyclo [4, 1, 0] oxepino carbazoles. In such transformation the participation of the nitrogen-lonepair of carbazole has been demonstrated.

(v) For the first time the Photo-Fries rearrangement of N-substituted carbazole using N-sulphonyl carbazoles has been demonstrated.

(vi) A new convenient access to the synthesis of bis-carbazoles of C-18 carbons have been accomplished.

(vii) Photochemical synthesis of 4-phenyl coumarin has been accomplished. This provides a support for Seshadri's hypothesis of the biogenesis of 4-phenyl coumarins.

(viii) The synthesis of the phenolics with butenone residue isolated from aquatic angiosperms have been accomplished.

D. (*a*) *Structure of small malecules :* P. Bhattacharyya (Supervisor), S. S. Jash and G. K. Biswas.

(i) The carbazole alkaloid isolated previously from a Rutaceous plant has been identified as 2-methoxy 3-formyl carbazole.

(ii) Further chemical investigation of *Murraya exotica* has led to the isolation of several crystalline constituents. Work is in progress to characterize the constituents.

(b) *Synthesis of hetcrocyclic compounds :* P. Bhattacharyya (Supervisor), S. S. Jash and G. K. Biswas.

(i) Ketotetrahydro carbazole has been synthesised in one step using montmorrilonite clay.

(ii) A simple and rapid method for the synthesis of organic sulfones has been developed. The method is now being utilised for the synthesis of other heterocyclic compounds.

E. *Chemical investigation of Poiyalthia longifolia :* Manas Chakrabarty (Supervisor).

(i) *Non-basic part :* As stated in last year's Annual Report, a diterpenoid has been isolated from the non-basic fraction of the petrol extract of the bark by repeated column chromatography. This compound and the derived acetate were subjected to UV, IR, ^{1}H-NMR (including homodecoupling). ^{13}C-NMR (PND and DEPT 135) and mass spectral analysis. A carefull study of the resulting data and by comparison with those reported for various classes of diterpenoids revealed that the diterpenoid bears three tertiary methyls. one of which is olefinic, one

secondary methyl, one hydroxyl and a β-substituted butenolide moiety, and thus a clerodane skeleton was suggested for it. The structure was finally deduced as 16α-hydroxycleroda-3, 13 (14) Z-dien-15, 16-olide. In view of its structural resemblance to the well known antifeedants ajugarins I, II and III, it is expected to possess similar activity. Possibilities are being explored to screen this diterpenoid and the corresponding acetate for a broad spectrum of insecticidal and antifeedant properties. With the help of availabre data and results of homo and hetero-nuclear 2D-NMR experiment, viz.. H-H COSY and XHCORR spectra, a complete ^{13}C-NMR assignment of both the diterpenoids has been made possible.

(ii) *Basic fraction* : A systematic chemical invetigation of the combined basic fractions of the petrol and chloroform extracts of the bark has resulted in the isolation of one tetrahydroprotoberberine and three azafluorenone alkaloids. On the basis of spectral data UV, IR, ^{1}H-NMR (including homodecoupling and H, H-COSY), ^{13}C-NMR (PND and DEPT 135) and mass spectra, the former has been identified as (—)-stepholidine and the latter as onychine (i.e., 1-methyl-4-aza-9-fluorenone), darienine (i,e., 5, 6-dimethoxy-7-hydroxyonychine) and the new alkaloid 6, 7-dimethoxyonychine.

It is worth mentioning that the present investigation not only culminated in the isolation of a new azafluorenone alkaloid but also constitutes the first report of the occurrence of this class of alkaloids in the genus *Polyatthia* and consequently also the first report of the co-occurrence of a tetrahydropotoberberine and azafluorenones in this genus. The latter finding is of biogenetic and taxonomic significance.

This work was done in collaboration with Dr. A. Patra, University College of Science, Calcutta.

F. (i) *Investigation on the lipid of aquatic animal* : *Lipids of hilsa fish* (*Hilsa ilisa*) : Ishani Bandopadhyay, Sagarmay Saha, Aniruddha Aich and Jyotirmoy Dutta (Supervisor).

The major fatty acids of the flesh of hilsa fish have been found to be palmitic—32%, stearic—8%, palmitoleic—17.7, oleic—30%, eicosapentaenoic—4.9% arachidonic—7% and docosahexaenoic—1.5%. In this respect this lipid resembles the dietary fat of the Greenland Eskimos who are known to be much less prone to heart attack than average Europeans or Americans. The flesh lipid in fish without egg, contains15% lipid, composed of 88.5% neutral, 5% phospho and 6.5% glycolipids. Analysis of

flesh lipid of fish with increasing extent of egg formation, indicated that the energy required by this fish for unstream upstream migration for spawning is supplied by the oxidation of the flesh lipid, without any preference for any particular lipid class.

(ii) *Fatty acid of specific structure and heart diseases* ; *effect of hilsa fish oil rich diet on atherosclerosis* : Ishani Bandopadhyay, Sagarmoy Saha and Joyoritmoy Dutta (Supervisor).

The method developed in this laboratory for the induction of atherosclerosis in rabbits has been brought to a dependable level of standardization.

Feeding these experimentally induced atherosclerotic rabbits with a hilsa oil rich diet, decreased the atherogenic plasma cholesterol level from ca, 1330 mg/dl to ca 159 mg/dl in 70 days, a value very near to the normal one of ca, 120 mg/dl. This was not a cholesterol withdrawal effect became the hilsa oil diet contained 1,1% cholesterol, almost equal to that in the atherogenic diet. The ratio, HDL-cholesterol/total cholesterol increased from the atherogenic value of 0.02 to 0.22. This tenfold increase in this ratio indicated effective removal of cholesterol from different tissues.

This cholesterol removal phenomenon, due to the feeding of hilsa oil became apparent in the histochemical observations. Prominent cholesterol plaques observed in atherosclerotic animals were either absent or much smaller in the treated ones.

(iii) *Siudies on the pheromones of tigers and leopards* : An interinstitutional project, Joint Supervisors, J. Dutta, Bose Institute and R. L. Brahmachary, Indian Statistical Institute.

The marking fluids (pheromones) of tigers and tigresses were found to contain varying proportions of short chain fatty acids (chain length upto 8 carbon atoms). At least 20 such fatty acids could be detected by gas chromatography. The components identified out of these acids are formic, acetic, n-butyric, isobutyric, n-valeric, isovaleric, n-caproic, isocaproic and n-caprylic. Identification and estimation of other components are at hand.

G. (i) *Subcelluiar localization of cyclo-oxygenase prostaglandin E_2 synthetase complex in goat-vesicular gland by catalytic activity* : Eli Mukherjee and Dolly Ghosh (Supervisor).

The multi enzyme complex, cyclo-oxygenase hydroperoxidase isomerase synthetase responsible for prostaglandin biosynthesis has been shown to exist in a particulate form bound to microsomal membrane i.e., endoplasmic reticulum (ER) of the cell, both by catalytic activity analysis and immunocytochemical analysis. But the other sub-cellular organelles like nucleus, plasma membrane, mitochondria and further subfractions of ER have not been tested for PGE_2 synthetase activity. We have subfractionated the goat vesicular gland in different subfractions by discontinuous sucrose density gradient technique and assayed for PGE_2 synthetase activity. The purity of the subcellular organelles have been checked both by marker enzyme assays and by Electron microscopic visualization of their ultra structures. The PGE_2 synthetase activity has been found to be located mostly in the rough endoplasmic reticulum (RER) and partly in the nuclear membrane ; comparatively very little activity could be detected in the smooth endoplasmic retuculum (SER). There is no detectable activity of PGE_2 synthtase in the plasma membrane. The presence of prostaglandin synthetase activity partly in the nuclear membrane may be due to cross-contamination, as ER is continuous with nuclear envelope.

Although it has been known for longtime that microsomal pellet of vesicular gland is extremely potent for PG biosynthesis *in vitro*, it was not known previously where exactly the cyclo-oxygenase PGE_2 synthetase is localized inside the microsomes. These studies indicate its location mainly in the rough endoplasmic reticulum.

(ii) *Effect of calmodulin and Ca^{2+} on the prostaglandin synthetase complex* : Eli Mukherjee and Dolly Ghosh (Supervisor).

It hass been reported earlier by us that *in vitro* presence of high concentration (4mM) external Ca^{2+} in the goat vesicuar microsomes modulates the prostaglandin synthetase initially by inhibiting the enzyme activity over a period of 0-10 min. and finally stabilizes the enzyme system and stimulates the PGE_2 formation upto about 40%. The presence of calmodulin at low concentration (μg) in the above in the above enzyme system stimulates the enzyme activity and the PGE_2 formation to the same extent as in the presence of Ca^{2+} (4mM), however, no initial inhibition of enzyme activity has been observed. Further addition of external calcium in in presence of calmodulin does not alter the enzyme activity. But the addition of EGTA inhibits the stimulatory activity of calmodulin as well as Ca^{2+} indicating that this enzyme complex may be calmodulin or calcium dependent.

Presence of Ca^{2+}(4mM) inside the microsomal vesicles of goat vesicular gland

modulates the enzyme complex by stimulating the enzyme activity as in the case of external calcium but without any initial inhibition. However, the preincubation of the above microsomal vesicles with the calcium channel former, i.e., ionophor A23187, the appearance of the inhibition of the enzyme system could be observed.

(iii) *Studies on prostaglandin I_2 synthetase in goat-aorta* : Eli Mukherjee and Dolly Ghosh (Supervisor).

The prostaglandin I_2 (PGI_2) synthesis in goat aorta has been studied. Using aortic microsomes as enzyme source, prepared by the method reported earlier and a rachidonic acid as substrate, hardly any 6 keto $PGF_{1\alpha}$ (the stable form of PGI_2) could be detected. However, when the cyclo-oxygenase part of the enzyme has been supplemented to the aortic microsomes through goat vesicular microsomes a perceptable amount of 6 keto $F_{1\alpha}$, 16-20 n moles/mg protein/hour could be detected in the reaction mixture. Detail studies with this enzyme system are in progress.

(iv) *Fatty acid composition of different sub-cellular organells of goat vesicular gland and other vital goat tissues.* Eli Mukherjee, Anirudha Aich and Dolly Ghosh (Supervisor).

It was reported earlier by us that in goat vesicular gland considerable amount of eicosatrienoic acid (20 : 3n-6), 5-5·5% is present comparable to eicosatetraenoic acid (20 : 4n-6) 4·5-6·5%. This eicosatriennoic acid (20 : 3n-6) is not common in mammalian system. Continuing this finding we studied the fatty acid composition of the total lipid of the different sub-cellular organelles of the goat vesicular gland and found that eicosatetraenoic acid (20 : 3n-6) is distributed in all sub-cellular fractions like microsomes, nucleus, plasma membrane etc. to an amount comparable to eicosatetraenoic acid (20 : 4n-6). The percentage of eicosatrienoic acid (20 : 3n-6) microsomes is 6-7%, in nucleus 4-4. 5% and in plasma membrane 4-5% compared to arachidonic acid (20 : 4n-6) 5·5-6·5%.

H. *Chemical and Biological Studies on Biomembranes.*

(i) *Abnormalities in erythrocyte membrane band 3 in chronic myelogenous leukemia* : M. Kundu., J. Basu, M. M. Rakshit and P. Chakrabarti.

Band 3, the major integral membrane protein in human erythrocytes has a transmembrane domain responsible for anion transport and a cytoplasmic domain responsible for anchorage of the cytoskeleton to the bilayer. The anion transport

activity of erythrocytes from patients suffering from chronic myelogenous leukemia (CML) was not altered compared to normal erythrocytes. However, the number of ankyrin-binding sites was reduced in CML. erythrocytes. This may, possibly, be related to partial loss of anchorage of the cytoskeleton to the bilayer, increased lateral mobility of band 3 and increased heat sensitivity of CML erythrocytes as previously reported. The rearrangement of band 3 into clusters provides the recognition site for antibodies against senescent cells. These antibodies bind and remove aged cells from the circulation. It may therefore be speculated that clustering of band 3 in CML erythrocytes leads to their removal from circulation, accounting in part, for the anemia associated with the disease.

(ii) *Liposome-trapped systatin in growth inhibition of Aspergillus niger* : C. Mazumder, J. Basu, M. Kundu and P. Chakrabarti (Supervisor).

Liposome-trapped nystatin caused growth inhibition of the wild type *A. niger* and its nystatin-resistant-mutant at concentrations at which the free drug or free drug plus empty liposomes were significantly less effective. In the case of the mutant, negatively charged liposomes made from PC : PE : DCP (1 : 1 : 0·22) showed the highest efficiency (75%). However, neutral liposomes made from PC : PE (1 : 1) caused 68% growth inhibition of the wild type and were most effective in this system. Growth inhibition studies as a function of time and increasing concentrations of nystatin entrapped in the above respective liposome systems, showed significantly greater inhibition of both the wild type and the mutant. This indicates that superior efficacy is due to entrapment of nystatin in liposomes. The increased efficiency of negatively charged liposomes in the case of the mutant may be due to electrostatic attraction favouring the interaction between the liposomal membrane and the fungal cell surface in this case.

(iii) *Studies on human uterine tumor* : Subhansu Roy, Anoop Kumar and P. Chakrabarti (Supervisor).

Human uterine tumor collected from the N. R. S. Medical College Calcutta has been analysed for its lipid composition. The phospholipid profile showed the presence of phosphatidyl ethanolamine, phosphatidyl choline, N-methyl phosphatidyl ethanolamine (the intermediate metabolite of phosphatidyl choline), phosphatidyl serine and phosphatidyl inositol. But there were variation in the concentration of phosphatidyl ethanolamine from patient having fibroid tumor.

The non saponifiable part of phospholipid has revealed the presence of ether lipids in significant amount. In view of the role of ether lipids in tumor oncology the above result may provide a further approach in combating the problem.

I. *Macromolecules—Studies on Transport Enzymes.*

(i) *The interactions of chloroquine with transport enzymes in different organs of rat in vivo :* D. K. Bhattacharyya, G Adhikary and P. C. Sen (Supervisor).

Chloroquine, an antimalarial drug has been found to inhibit transport enzymes like Na^+-K^+-ATPase, Ca^{2+}-ATPase and acetylcholine esterase activities in the microsomal membranes of rat *in vivo* on time and concentration dependent manner. To examine if the inhibition of the enzyme activities could be reversed back to normal level when the drug is withdrawn, we continued the withdrawal study upto two weeks so far after ceasation of drug injection. The activities of some of the enzymes have been observed to be reversed partly and we expect that the effects would be reversed completely. The study got very important pharmacological significance since chloroquine which adversely affects some of the enzyme activities could be reversed if the drug is withdrawn.

(ii) *Effect of soluble protein (s) on transport enzyme activities :* S. Chandra and P. C. Sen (Supervisor).

A protein fraction obtained from 1,00,000 g. post supernatant of rat brain homogenate is found to inhabit Na^+-K^+-ATPase in the microsomal membrane from rat brain. The fraction stimulates Ca^{2+}-ATPase isolated from goat spermatozoa. The inhibition is neither due to disulphide group(s) or protein(s) nor due to the presence of any divalent metal ion(s) in the fraction. The inhibition of p-nitrophenylphosphatase by the inhibitor protein(s) indicate that the inhibitory properties may be comparable to ouabain, a specific inhibitor of Na^+-K^+-ATPase. However, stimulation of Ca^{2+}-ATPase by the same inhibitor(s) is very interesting. The purification of the protein(s) and subsequent mechanism of interaction with the transport enzymes are in progress.

(iii) *Partial purification and characterization of a novel Ca^{2+}—ATPase from goat spermatozoa :* Rita Sikdar and Parimal C. Sen (Supervisor).

The microsomal membranes isolated from goat spermatozoa was treated with a non-ionic detergent Octaethylene glycol dodecyl monoether ($C_{12}E_8$) followed by

discontinuous sucrose density gradient is found to be enriched in Ca^{2+}-ATPase which does not not need Mg^{2+} ion, which is the case with Mg^{2+}-dependent Ca^{2+}-ATPase isolated from different sources. SDS-gel electrophoresis study reveals about 7-8 proteins of which major protein of molecular weight of approx. 90-95 KDa is expected to be this Ca^{2+}-ATPase. The ATPase in inhibited by trifluoroperazine and lanthanum chloride like $Mg^{2+}-Ca^{+}$-ATPase. This Mg^{2+}-Independent Ca^{2+}-ATPase differs from Mg^{2+}-dependent Ca^{2+}-ATPase in different ways like buffer specificity, I_{50} for inhibitors, K_M of ATP and $CaCl_2$ etc. The work whether this Ca^{2+}-ATPase plays any role in Ca^{2+}-transport is in progress.

Institutional Project No. IV : Environment, Pollution and related health problems.

A. (i) *Immunisation and brain enzyme response in normal malnutrient animals* : A. K. Barua (Supervisor), Debasis Ghosal in collaboration with P. C. Sen.

Na^+-K^+-ATPase and Ca^+-Mg^{2+}-ATPase of the brain microsomal membrane of the immunized deficient mice/rats showed a suppression in enzyme activity compared to control. Studies on saturated to unsaturated fatty acids were carried by G. L. C. of the microsomal membrane of the normal and deficient immunized animal. A change in the ratio of saturated to unsaturated fatty acids was observed but this change could not be correlated with the change in enzyme function.

(ii) *Filed survey for vaccine failure State* : A. K. Barua (Supervisor), Debasis Ghosal in collaboration with Goutam Ghosh, R. Mazumder and U. S. Sarkar of the Institute of Child Health, Calcutta.

A programme to assess the effectiveness of vaccine in normal, subclinical and clinical malnutrient babies of age group 3 months—2 years has been undertaken.

B. *Studies on biochemical function of phytochemicals* : D. P. Chakraborty (Supervisor), Shyamali Roy, Lina Bhattacharyya, Mala Ray and K. K. Mohanty.

(i) Studies on the growth inhibitory and germination inhibitory properties have been carried out with various plant extracts including some terrestrial algae.

(ii) Structures of two steroids with C-21 and C-28 carbon skeletons have been arrived at. The C-21 steroid is growth inhibitory while C-28 steroid is a powerful antifeedant.

(iii) Antifeedant constituent of *E. coronenia* has been indentified.

(iv) Insecticidal and antifeedant properties of several plants and some constituents of known structures have been examined.

(v) Growth inhibitory property of a plant constituent against mosquito lavvae has been compared with that of ABAC, a commercial mosquito killer. The results appears encouraging.

C. *Studies in relation to vitiligo* : D. P. Chakraborty (Supervisor), Shyamali Roy, Alokananda Chakraborty, A. K. Chakraborty (collaborator from Japanese laboratory).

(i) The status of tryptophan in melanogenic process has been shown similar to that of DOPA.

(ii) From our studies on tryptophan participation in melanogenic process, Raper Manson-Powelek hyphothesis of melanin formation has further been modified.

(iii) Further studies with several phytochemicals affecting enzymic parameters of melanin synthesis have been carried out.

(iv) Role of lead in melanogenic process in amphibian end mammalian systems have been examined. The results show that lead has some roles to play in the overall melanogenic process.

Institutional project No. V : Studies on microbes for medical and industrial application.

Studies on mycobacteria :

A. (i) *Characterization of a lectin from Mycobacterium smeimatis* : J. Basu, M. Kundu and P. Chakrabarti (Supervisor).

We have previously reported the presence of hemagglutinating activity in the culture broth of *Mycobacterium smegmatis*. A lectin has now been purified from the culture broth of *M. smegmatis* by 0-80% ammonium sulfate precipitation and subsequent fractionation on DEAE-Sephadex. The lectin was found to be homogeneous on polyacrylamide gel electrophoresis. The molecular weight of the

protein was found to be 12,000 by SDS-PAGE and gel filtration. It agglutinated rabbit and human A, B and O erythrocytes non-specifically. Agglutination could not be reversed by the simple sugars D-glucose, D-galactose, D-fucose, N-acetyl-D. galactosamine, N-acetyl-D-glucosamine, N-acetylneuraminic acid or by fetuin, bovine submaxillary mucin and hog gastric mucin. Weak reversal was obtained with D-arabinose and D-mannose. Attempts were then made to determine whether agglutination could be reversed by sugars which are unique constituents of the outer surface of *Mycobacteria*. Arabinogalactan isolated from *M. smegmatis* was found to reverse agglutination. However, arabinogalactan isolated from larch wood did not show any inhibitory activity. This was particularly interesting, since mycobacterial arabinogalactan contains both glucosyl residues in the unusual furanose form. Reversal was also obtained with yeast mannen.

In the light of the present findings. the role of this lectin in mycobacterial cell-cell interaction is being investigated. Attempts are also being made to determine whether this lectin is present in pathogenic strains of *Mycobacteria*.

(ii) *Studies on penicillinase and penicillin-binding proteins of Mycobacterium smegmatis* : M. Kundu, J. Basu and P. Chakrabarti (Supervisor)

Wild type *M. smegmatis* is insensitive to β-lactam group of antibiotics. On treatment with a chemical nutagen, N-methyl-N′-nitro-N-nitrosoguanidine, a penicillin-sensitive mutant of *M. smegmatis* has been isolated by us. Labeling with ^{35}s-benzylpenicillin reveals the presence of similar membrane-bound penicillin-binding proteins both in the wild type and the mutant. However, high penicillinase activity has been detected only in the wild type. This explains the resistance of the wild type towards penicillins. D-D carboxypeptidase activity has also been detected in the wild type.

Penicillin-sensitivity of the mutant may be also due to altered drug permeability as a result of change in the biosynthesis of mycolic acids-a special constituent of the mycobacterial cell wall. This is the subject of further investigation.

C. BOTANY

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

1. *Performance of hybrid selection in rice with respect to photoperiod sensitivity* : A. K. Roychoudhury and R. Poddar

Prof. S. Bose, the ex-Chairman isolated two selections of paddy, namely, Meghna-1 and Meghna-2 from a cross between *IR-8* and *Badshabhog*. Both the selections are claimed to be photoperiod non-sensitive (Ann. Rep. 1986-87). Another selection (76/III/43) was obtained by Prof. Bose from a cross between *IR-8* and *Patnai-23*. This selection is supposed to be photosensitive (Ann. Rep. 1983-84). To testify the claim of photoperiod sensitivity or non-sensitivity, mean flowering time of three selections as well as *IR-8* was studied on four dates of sowing, namely, May 15, June 1, June 16 and July 1, 1988 at the Shyamnagar Farm. Mean time of flowering based on 28 plants varies from 100 to 119 days (*i.e.*, Sept. 12 to Oct. 21) in Meghna-1, from 92 to 112 days (*i.e.*, Sept. 4 to Sept. 16) in Meghna-2, from 112 to 137 days (*i.e.*, Sept. 30 to Oct. 20) in the selection 76/III/43 and from 86 to 109 days (*i.e.*, Sept. 2 to Oct. 2) in IR-8. Mean time (days) and date of flowering of each selection vary considerably for four dates of sowing covering a period of one and half month. These results do not substantiate the earlier claim and it needs repetition of the experiment with large number of plants.

In another experiment at the Madhyamgram Farm four agronomical characters like grain yield, panicle number, panicle length and plant height of Meghna-1 were studied along with five varieties of paddy, namely, *Ratna*, *Rupsail*, *IR-8*, *Radhuni-pagal* and *Badshabhog*. Though Meghna-1 gives the highest grain yield, the difference in yield from *Ratna* or *IR-8* is not statistically significant. Meghna-1 is taller than *Ratna* and *IR-8* but shorter than other varieties. *Meghna-1*, *Ratna* and *IR-8* do not differ significantly with respect to panicle number and penicle length.

2. *Studies on rice mutants* : B. Majumder

Changed grain size mutant : There are several induced mutants in rice

with changed grain size in the variety S. R. 26 after the treatment of γ-rays (20kR). Out of these mutant S. 623 is a fine grain mutant. The grain size of the mutant is smaller in comparison with the parent S.R. 26. This mutant will be put in a yield trial in future.

One induced mutant (S. 625) with white stigma and and green tiller was isolated from Dular variety with purple stigma and purple tiller following 30kR γ-rays treatment. A similar mutant (S. 240) was obtained earlier from the same variety after 50kR X-ray treatment.

Isolation of alboviridies mutant in rice : Six rice varieties and eight mutants were irradiated with different doses of γ-rays. In the second generation some of the mutants were found to segregate less number of chlorophyll deficient plants compared to parents. In other mutants the response of irradiation was more or less equal to that of their parents. Number of alboviridies mutants were isolated from the rice variety, Dular after 15kR γ-rays treatment. It was not observed in other rice varieties,

Rate of mutability of chlorophyll character : Rice varieties were treated with different doses of X-rays, β-rays and γ-rays. The treated populations were screened for chlorophyll mutants in the R_2 generation. It was found that albino and Xantha mutants are higher in frequency than the lutescent and maculata mutants in rice.

Analysis of the chlorophyll pigment : Leaf chlorophyll pigments of the rice varieties CB-1 and CB-2 were analysed. It was observed that CB-2 has lower chlorophyll pigment than CB-1. The segregation of the albino seedlings under field conditions also coroborates this finding. A higher percentage of albinos had segregated in the variety CB-2.

Studies on rice hybrids with double flag leaf : Many hybrid lines of rice are maintained. One hybrid of a cross CHDG × MB had unextra flag leaf in panicle. This hybrid line (CM-5 df) was made pure for this character. This hybrid was found to be monogenic recessive in nature. The grain yield of this hybrid is higher than that of the parent, Marichbati.

Yield trial of hybrids : There are many hybrids of rice obtained from the crosses, Jaya × DMI-52, Jaya × CHDG, Dular × IR-8, Dulobij × IR-8/1, Dulobij × IR-8/2 and two selections, namely, Pandu-1 and Pandu-2 obtained from the cross,

Patnai × Dular. These hybrids were put in a yeild trial in a RB design with six replications. The mean grain yield of one hybrid obtained from Jaya × DMI-52 and selection Pandu-1 were significantly higher than the other hybrids and the standard rice variety, Pankaj.

Inheritance of internode number : Rice plants with low number of internodes (3) and high number of internodes (5) were crossed to understand the inheritance of this character in rice. The crosses were made between IR-8 × Dulobij and IR-8 × CBI. The hybrid rice plants were studied in the F_1 population. The observed results in the F_1 progeny indicate that higher internode number is dominant over the lower number. The segregation of F_2 population indicate that two recessive genes are responsible for the lower number of internodes in rice.

Salt resistant mutant and hybrid : Rice variety S.R. 26 was irradiated with γ-rays. After treatment of 30kR several mutants were isolated and they were maintained for generations. Out of these mutants S. 605 was found to be salt resistant than the parent S.R. 26.

Rice hybrid DMI-49 (Mota × IR-8) was put in a yield trial at the Canning Experimental Station. The grain yield of the hybrid is better than some or equal to the standard salt resistant varieties of rice used in the experiment.

Analysis of rice seed protein : Protein contents of rice seeds were analysed in a number of hybrids, mutants and their parents. The results indicate that the protain content is high in the rice variety CHDG (13·5%) and low in the mutant S. 221 (8.0%).

3. *Cellular events in rice during saline stress* : Rina Basu and Bharati Ghosh

In previous years we reported salt induced metabolic changes during early germination of rice seeds cv. Rupsail. Whether these laboratory induced changes can be expressed in nature during stress condition, we chose several saline resistant and sensitive cultivars supplied by International Rice Research Institute (IRRI) and Central Salinity Research Institute (CSRI). From our screening data, it is revealed that M-1-48 strain was most salt sensitive sps. showing lowest putrescine level as well as its enzyme arginine decarboxylase and highest polyamine oxidases activity. CSRI-1 strain was proved to be the most resistant one with the highest putrescine level and ADC activity and the lowest oxidase (DAO and PAO) activity. At

10^{-3}M NaCl conc. for 6 hr., an increase in PA content with high ADC activity was observed in M-1-48 but not significant changes occurred in CSRI at high salinity. An enhanced incorporation of C^{14} arginine into PA in M-1-48 and retention of more or less same radio level in CSRI during stress condition supported the above observation. The above parameters were studied in three other cultivars of rice, *i.e.*, Dular, Rupsail and Assam Getu. We came to the conclusion that Dular is supposed to be more resistant than Rupsail which in turn is proved to be more resistant than Assam Getu. Studies on the response of these cultivars in relation to membrane permeability showed that resistant cultivars having higher putrescine level leached lesser metabolites and electrolytes. Further work on membrane protein is in progress. However, it is inferred that putrescine can be used as marker of stress tolerance at least in seedling stage.

4. *Studies on polyamines in relation to source and sink organ senescence in plants* : Soumen Chattopadhyay and Bharati Ghosh.

Previously we reported that polyamines could inhibit the primary component of source and sink organ photosynthesis in rice and pea, and it appeared that this inhibition might be due to increase of polyamine mediated metal ion efflux or the synthesis of high molecular weight chloroplastic protein in both the plants. It is now established that endogenous polyamine titre is positively correlated with known senescence parameters *viz.*, chlorophyll, nucleic acid, protein and hydrolizing enzymes like RNase, acid and basic protease, α-amylase and polyamine oxidases activity during source and sink organ development in rice and pea. The exogenous application of tetramine spermine retards the chlorophyll and soluble protein loss and inhibits acid and basic protease activities during senescence in source organ, but in sink organ these parameters do not response equally by spermine. Further investigation is being carried out to elucidate why polyamine affects differentially on the source and sink organ senescence in plants.

5. *The regulation of ornithine decarboxylase in jute seeds* : Malabika Pandit and Bharati Ghosh.

In some higher plants two pathways for polyamine biosynthesis are operative which is also established during germination of jute seeds. The rapid increase in PA concentration along with their active biosynthetic enzymes leads to the suggestion that PAs are essentially required for differentiation, growth and development. The ODC has been purified about 773 fold with the recovery of 33%. In the final

purification step, two active fractions were obtained and by SDS gel electrophoresis it is established that fraction A is tetramer of fraction B. It inhibited typical Michaelis Menton Kinetics with K_m of 10^{-4}M. PAs inhibit the enzyme under *in vivo* and *in vitro* conditions. DFMO, a suicide inhibitor of PA metabolism, does not inhibit the enzyme even at 1-10 mM conc. The exogenous PA induces the synthesis of an inhibitory protein termed as antizyme which inhibits the enzyme activity. Antizyme which was partially purified showed that it is heat labile and trypsin sensitive. The inhibition is stochiometric ; the enzyme inhibited non competitively with a $K_1 = 1.5 \times 10^{-8}$M which proved that regulation of ODC is under the control of antizyme (The project is ended here).

6. *Nodule senescence in leguminous plants* : Sakuntala Chatterjee, Kajori Lahiri Bharati Ghosh.

The changes in polyamine titre with their enzymes during nodule senescence had been established in last year. In the reported year, we tried to establish the above facts using hot arginine. Maximum polyamine turnover using ^{14}C arginine as precursor is noted during active growth, *i.e.*, flowering stage which declines with age. Studies with specific inhibitors of polyamine metabolism DFMA (Difluromethyl arginine) and DFMO (Difluromethyl ornithine) and their combinations also support our previous findings. Tetramine spermine, an antisenescence agent, had been tried *in vivo* on detached nodules with the idea whether spermine could regulate nodule senescence just like excised leaf senescence in monocots and dicots. Our results showed that spermine at low conc. not only inhibits the activity of the degradative enzyme but also increases the activity of synthetic ones specially nitroginase (main tool of N_2 fixation). Major emphasis has now been given on whether spermine could regulate the leghaemoglobin, major nodule protein. Attempts are going on to purify leghaemoglobin from ageing nodules by conventional ways.

7. *Identification of salt stress protein* : Bharati Ghosh and Sankar Das.

Attempts are being made to identify salt stress proteins in mustard and rice seedlings germinated under various saline conditions.

8. *Growth performance of naturally aged versus artificially aged (hot-water-dip treated) wheat embryos* : Smritimala Ganguli and Swati Sen-Mandi.

Growth performance of deteriorated wheat embryos in cultural conditions

depends largely on the method of ageing treatment. Low viability embryos obtained by different ageing methods behave widely differently when grown on sucrose media. The ability of badly deteriorated embryos to utilize sucrose for rejuvenation was found to be much lower in naturally deteriorated seed stocks than in hot-water-dip artificially deteriorated ones.

9. *Scutellar amylase activity and its response to GA in unaged and aged wheat seeds* : Gitali Das and Swati Sen-Mandi.

Biochemical assay of scutellar amylase in unaged and aged (both naturally and artificially) seeds showed the presence of long lived α and β amylase in dry embryos that increase in association with germination. Activity of these enzymes were found to be reduced in aged seeds.

Histochemical localization and biochemical assay studies of amylase activity showed stimulation of amylase activity in presence of GA in unaged embryos and in high viability stocks (upto 50%v) of artificially aged embryos. No stimulation in enxyme activity due to GA could be observed in the naturally aged seeds.

10. *Effect of GA on germination and growth of fresh, naturally aged and artificially aged wheat seeds :* Gitali Das and Swati Sen-Mandi.

GA induced enhancement of growth could not be detected around 12-13 h of incubation in fresh (99% v) stock. No significant enhancement could be observed beyond this time. In artificially aged stocks the time of initiation of GA stimulation was delayed upto the 50%v seeds. In lower percentage viability stocks the enhancement effect was absent. In the naturally aged stocks GA stimulation could not be observed in any of the viability stocks studied.

11. *Possible alternative source of utilizable substrate for germinating wheat seeds/embryos during early times of imbibition* : Gitali Das and Swati Sen-Mandi.

Germination associated increase of free fatty acid content in unaged and aged wheat embryos indicated an increase in lipase activity during early times of germination. Biochemical assay of isocitrate lyase enzyme also showed an increase of enzyme activity. This suggests that in wheat, the free fatty acid released (probably lipase activity) is subsequently utilized through glyoxysomal cycle (β-oxidation) to generate

energy that is needed by germinating embryos. The increase in the activity of these enzymes could be detected earlier than the time of increase in amylase activity.

12. *Comparative study of field emergence of naturally aged and artificially aged wheat seeds :* Gitali Das and Swati Sen-Mandi.

Field emergence of artificially aged and naturally aged seeds were found to be lower than the laboratory germination percentage in high viability seeds (99%v, 70%v and 50%v). This loss of field emergence ability was found to be proportionately reduced in more deteriorated (artificially aged prolonged hot-water-dip treatment) stocks.

13. *Establishment of seedlings raised from sucrose-induced germination of extensively aged wheat embryos :* Gitali Das and Swati Sen-Mandi.

Sucrose induced seedlings of 1%v artificially aged embryos were planted in the field and found to establish into successful plants. The seeds raised from these seedlings were viable.

14. *Study of phosphohydrolases in artificially aged rice seeds :* Selva Meena Dass and Swati Sen-Mandi.

Artificial ageing (by hot-water-dip treatment) has been standardised in rice. The pattern of ageing has been found to be similar to that observed in wheat. Preliminary experiments with such accelarated embryos indicate change in activities of acid phosphatase and alkaline phosphatase and with progression in seed deterioration. Activity of these enzymes is now being studied in naturally aged seeds.

15. *Germination characteristics of aged (naturally aged and artificially aged) groundnut seeds* : Nupur Roy and Swati Sen-Mandi.

Studies with groundnut include characterising groundnut seed lots by TTC stainability test and correlating stainability with germination ability of fresh and aged stocks. The performance of isolated embryos under controlled cultural conditions is now being studied.

16. *Study of minor changes in the genomes of fungal pathogen by using the technique of RFLP analysis :* Swati Sen-Mandi, Smritimala Ganguli, Gitali Das, Selva Meena Dass and Nupur Roy.

Isolation, characterization, identification and maintenance as pure culture of

Alternaria triticini from diseased (leaf blight) wheat (Triticum aestivum var Lal Bahadur) leaf has been achieved. Preliminary experiments for isolation of fungal DNA, restriction fragmentation of the DNA and agarose gel electrophoresis have been done in this respect.

17. *Micropropagation of Teak and Papaya* : Sunitibala Debi, Mousumi Das (nee Mondal), B. B. Mukherjee and Sukumar Gupta.

Root induction was obtained by culturing *in vitro* propagated shoots of teak plant in White's liquid medium supplemented with the IAA, IBA or IPA individually or in combination. Rooting was less when auxins were added individually, but it was profuse when auxins were in combination. Treatment time for root initiation was 72 hours ; and then on transfer to the hormone free basic medium roots showed further growth and elongation.

Rooted plantlets were allowed to grow in hormone free medium before a transfer in field condition. Plants were carefully removed from medium, washed in tap water, and then transplanted directly to the manured soil. 90-95% survivality were observed when transplantation was made on rainy season and if reduced to 80-85% during winter transplantation.

To induce photoautotrophic adaptation in *in vitro* grown plantlets of papaya before transplanting to the field, an experiment was done by gradually reducing the sucrose concentration of the medium. Chlorophyll content of leaf was taken as the index of photoautotraphism. It was found chlorophyll content increased with the increase of sucrose in the medium and 10 g/l sucrose was the lower limit, below which the growth and vigour of plantlets declined.

A medium for the initiation of callus from roots of *in vitro* grown plantlets was standardized to study its growth, nature and papain content. Half concentration of salts of MS medium supplemented with different concentration of IBA and BAP were tested. A combination of 3 mg/l IBA and 1 mg/l BAP was suitable for high rate of callus growth. Callus growth increased upto a certain period after which its growth become static.

Root culture of *in vitro* grown plantlets was developed to have an alternate source of regeneration of plants. Differentiated root (1-1·5 cm) when transferred on MS medium supplemented with 2 mg/l NAA and 0·5 mg/l BAP shoot regeneration occurred

through callus formation. Two to three shoots regenerated per culture. Regenerated shoots when transferred to rooting media roots initiated within 12 days. Papain activity in the *in vitro* grown calli was primarily detected and estimated to be very low.

18. *Field trial and performance of somaclonal line* : Sujata Saha and S. Gupta.

Two cell lines (S & R) were isolated from callus derived from infected leaves. These lines were named as (1) 'S' line which produced only infected plants, and (2) 'R' line which produced 67% uninfected plants and 33% infected plants. The seeds of the uninfected plants of the somaclonal lines were collected and sown in the field again to check whether the somaclonal lines were maintaining their uninfected nature in the successive generations. It was observed that they are maintaining their uninfected character in the second generation also.

Phenol content and protein banding pattern of seeds of somaclonal variants were studied. No significant difference was observed in the protein banding pattern but the phenol content differed in the somaclonal lines. Total phenol content in leaves of infected plants was less than that of uninfected plants.

19. *Effect of water, salt and freezing stress on callus of Brassica juncea (var. 85-89)* : S. P. Mukherjee, S. N. Banerjee, S. Gupta and B. B. Mukherjee.

The levels of certain metabolic traits of *Brassica juncea* (variety 85-89) callus treated under water, salt and freezing stress were studied with an objective to identify the markers of different stress. Callus of *Brassica juncea* were used for such study. The following observations were made :

(1) In all tissue subjected to different stresses relative to water content decreased and proline content increased.

(2) These calli subjected to freezing stress was different from these subjected to water stress and salt stress because protein content declined in tissue due to water stress but remained unaltered in those treated in freezing stress. But ascorbolic acid content increased in tissue under freezing stress and its content declined due to water and salt stress.

20. *In vitro regeneration of mustard plants* (*Brassica juncea* var. 85-89 and 351) *on Hypocotyl & Cotyledous explants* : S. N. Banerjee, S. P. Mukherjee, B. B. Mukherjee and S. Gupta.

Shoot buds were induced directly in hypocotyl and cotyledous segments of *Brassica juncea* (var. 85-89 & 351) on MS medium supplemented with different hormonal combinations *viz.*, IAA+BA and NAA+Kinetin). Similarly, profuse rooting was induced in cotyledonous segments in NAA or IAA supplemented media. The media supplemented with only BA or kinetin augmented callus development. Both the varieties showed similar morphogenetic responses.

21. *Tissue culture of rice in stress condition (NaCl environment)* : Sabita Bhattacharya, B. B. Mukherjee and S. Gupta.

Cell line tolerant to 1% NaCl was isolated from the callus tissues of the cultivar 'Badshabhog'. Similarly 0.5% NaCl tolerant lines in Meghna and IR-8 were also isolated. Tolerant cell lines of 'Badshabhog' showed regeneration of plantlets when cultured in N_6 medium supplemented with IAA. Regeneration in tolerant lines of 'Meghna' was also obtained in N_6 medium containing NAA and kinetin whereas in tolerant line or IR-8 regeneration occurred only in the basal N_6 medium.

Proline content in NaCl tolerant as well as in control lines of Badshabhog was estimated and it was observed that it was three fold more in NaCl tolerant cell lines than that in the control.

22. *Proteins and phenols in Nigella sativa tissue grown in different cultural conditions* : Aditi Chatterjee and B. B. Mukherjee.

Leaf calli of *Nigella sativa* were grown in culture media containing different growth hormones like NAA, IAA, kinetin, BAP under light and dark condition. Total phenol content, phenolic, profiles, total protein content and protein banding pattern in gel electrophoresis were studied in tissues grown in different media under light and dark conditions. Total phenol in all light grown tissues was more than that in dark grown tissues. Also, the variations were observed in phenolic profiles in tissues grown in different media. Similarly, changes were observed in protein banding pattern in those tissues in different culture cycles. Investigations on the enzymes like peroxidase and α-amylase have been initiated in tissue stated above and standardized.

23. *Quantitative estimation of GA aud IAA in different stages of maturation in Shorea robusta seeds* : P. K. Saha (Supervisor) and Amita Bhattacharya

Gibberellin A_3 was estimated spectrofluorometrically from the alcoholic extract

of mature viable seeds of *Shorea robusta*. It was found that the amount of GA_3 in the mature viable seeds is 0.0046 μgm/gm of seeds.

Quantitative estimation of IAA in different stages of seed maturation was carried out using *Shorea robusta* seeds. The immature seeds had the highest amount of endogenous IAA, 0.0075 μgm/gm of seeds. The amount of endogenous IAA declined considerably and only 0.0019 μgm/gm of seeds of IAA was found in the mature viable seeds (5 days after harvest). No IAA could be detected in seeds which were stored for 10 days after harvest and no IAA could be detected in the non-viable seeds also.

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

The studies (SEM) on ultrastructure of seed coat of *C. tora* revealed distinct differences between germinating and non-germinating seeds. The germinating seeds are swollen, their epidermal cells are wide apart the micropyle, hilum and strophiole are open whereas the non-germinating seeds have sealed micropyle, hilum and strophiole and their epidermal cells are compact. The function of micropyle, hilum and strophiole for the entry of water during germination was confirmed.

25. *Ultrastructure and water relation in germination of three species of Cassia :* P. K. Saha (Supervisor) and Amita Bhattacharya.

SEM studies on ultrastructure of seed coat of *C. occidentalis*, *C. fistula* and *C. sophera* were carried out. Water absorption patterns of the seeds of all the three species were studied. It was found that water absorption and germination of all three species are also correlatable to the structures (hilum, micropyle and strophiole) of the seed and they are dependent on the opening of seeds that facilitated water entry.

26. *Salt tolerance in Rice (Oryza sativa)—Field Experiment (First trial) :* P. K. Saha, B. B. Mukherjee, S. N. Ganguly and S. Gupta.

The results of screening at germination level indicated that the seeds of cv. Meghna were most tolerant to salinity. So in the kharif season (1988) an experiment on seedling establishment and productivity (in terms of grain yield) was done in Canning Salinity Research Station with Meghna as meterial. Seedlings showed similar response in soil upto tillering stage when transplanted in soil from the culture

media with different salinity level (control, 0.25%, 0·50%, 0.75% and 1.0% NaCl) was tested.

Transplanted seedlings initially raised in media containing 0.5% salinity showed maximum yield of grains in comparison to others raised in media containing lower or higher level of salinity.

The soil salinity was monitored during the period of grain filling stage and ripening stage. The salinity levels were 4·4 ECE and 3·9 ECE respectively in soil of 0-6″ depth. The salinity level was 6·4 ECE and 5·2 ECE respectively in soil at 6-12 inches depth.

The seeds collected from kharif harvest was further screened for trial in pre-monsoon season.

27. *Chemicul examination of the leaves of Rhizophora mucronata :* Malabika Ray, Tapan Das and S. N. Ganguly.

A new triterpene ketone, $C_{32}H_{50}O_3$ (M^+482) m.p. 272° was isolated from the methanolic-extract of the leaves of *Rhizophora mucronata*. On the basis of physical and chemical evidences the structure of the compound was established and can be represented as 3-keto-6-acetoxy-hop-22(29)-ene.

28. *Investigation on Camellia sinensis :* Malabika Ray and S. N. Ganguly.

In an attempt to find out a relationship between the endogenous hormones in pluckable leaf of *Camellia sinensis* and quantity of pluckable leaf during different season, we are able to isolate an indole compound, $C_{11}H_{11}O_2N$, crystallised from petroleum ether, m.p. 56° from the methanolic extract of the leaves of *C. sinensis*. From the spectral measurement and also by chemical degradation the compound was identified as indole-3-methylethanoate. This is the first report of natural occurrence of this compound. The wheat coleoptile bioassay showed that the compound had a growth promoting activity.

29. *A hypnotic barbitone from Sphaeroides oblongus :* S. K. Mitra, B. Sanyal, Biswapati Mukherjee and S. N. Ganguly.

Chemical investigation of major source of poison of *S. oblongus*, collected from coast of Bay of Bengal, afforded shining white needles, m.p. 195-96°. On the

basis of physical and chemical evidence the above compound was identified as 5, 5-diethyl barbituric acid (barbitone). This is the first report of isolation of barbitone from natural source. The occurrene of barbitonce was monitored for two years ; its appearance was found to be seasonal probably related to the breeding term.

30. *Cytogenetical and chemical investigations of naturally occurring diploid and hexaploid Chenopodium album* : B. Bera and K. K. Mukherjee (Supervisor).

In continuation of our chemical investigations on different ploidy levels of naturally occurring *C. album*, two growth regulating compounds were isolated from the seeds of the broad leaved diploid cytotype of *C. album*. The compounds are 8-acetoxycryptomeridiol and cryptomeridol. In addition, three more compounds were isolated and crystallised. The biological activity as measured through rice second leaf seath bioassay showed better growth promoting activity of crytamaridiol over 8-acetorycriptomeridiol.

31. *Cytogenetical investigations on interspecific hybridization in Beta* spp. : K. K. Mukherjee.

Mean chiasma frequency of four inbreed lines, their hybrids and populations of *Beta* spp. showed reduction in the mean chiasma frequency in the inbreeds compared to the hybrids and populations. The mean chiasma frequency of the hybrids and the populations are comparable. It is evident from this study that chromosome pairing is concomitant with the mating system of the species.

32. *Cytogenetical investigation in Trichosanthes* spp. : A. K. Sardar and K. K. Mukherjee (Supervisor).

Chromatographic analysis of seed phenolic compounds of two monoecious species of *Trichosanthes*, namely *T. anguina* and *T. cucumerina* and two dioecious species, namely, *T. diocea* and *T. palmata* revealed that the seed phenolic profile of both the monoceious species namely, *T. anguina* and *T. cucumerina* are closely similar. *T. dioeca* although manifested certain similarities with *T. anguina* but have distinctive spots of its own. On the other hand *T. palmata* showed strikingly different seed phenolic profile from both the monoecious species and dioecious *T. diocea*.

Studies on the seed fatty acid profile of the monoecious and dioecious species revealed that there are close similarities within the monoecious species. Only quantitative variations of fatty acid between the two monoecious plants namely, *T. anguina* and *T. cucumerina* was recorded. Dioecious *T. diocea* and *T. palmata* manifested qualitative variation in seed fatty acids compared to the monoecious ones.

Institutional Project No. II : Chemical and biological studies of marine organisms.

1. *Studies on mangrove of the Sunderbans* : S. N. Ganguly.

Insect grazers from *Rhizophora mucronata* growing in the mangrove forests of Sunderbans were collected in two forms. In one form the insects were immediately fixed and in the other form the insects were allowed to survive for about 15 days after collection and then fixed. These two forms were separately extracted and analysed. It was observed that the insects which fixed immediately after collection contained 13 compounds (TLC) of which Gibberellins A_3, A_5 and A_9 ; α-amyrin, ursolic acid were identified whereas the insects fixed after 15 days contained only four compounds, viz. amyrenone, ursonic acid, Gibberellins A_3 and A_1. It is interesting to note that the original plant when extracted showed the presence of Gibberellins A_3, A_5 A_9 ; β-amyrin and ursolic acid are in much less yield than insect extract. Insects are yet to be identified.

Institutional Project No. IV. Studies on ecology, environmental pollution and related health problems.

1. *Investigations on the minerals in leaves of some mangrove and in the soil of Sunderbans* : Somnath Matilal and B. B. Mukherjee.

Investigations were made to examine whether there is any influence of the nutrient content of leaves of dominant plants of mangroves on those in soil where they grow. *Excoecaria*, *Avicennia* and *Ceriops* were identified as dominant plants. NPK, Ca and Mg content in leaves of three plants were analysed and soil where they grow was analysed. It was observed that there was a positive correlation between the nutrient content in leaves of *Avicennia* and *Exoecaria* and that in soil but no such correlation was observed in mineral content of leaves of *Ceriops* and the soil where *Ceriops* is dominant.

2. *Investigations on field capacity in mangrove soil and the vegetation in Sunderban in Bangladesh* : Ansarul Karim and B. B. Mukherjee.

Field capacity of soil at different areas dominated by *Heritica*, *Ceriops* and

Excoecaria were studied. It was found that field capacity of *Heritiera* dominated soil was maximum. Such soil was dominated by silt. Field capacity in *Excoecaria* dominated forest was intermediate and that in *Ceriops* dominated forest was minimum. In *Ceriops* dominated forest, sand content was more. *Heritiera*, *Excoecaria* and *Ceriops* occurred in three stages in succession.

3. *Volumetric airborne pollen survey of Central Calcutta :* Sunirmal Chanda (Supervisor) and Swapna Banik.

A total of 71 atmospheric pollen types were identified for the year July 1985 to June 1986 where *Trema orientalis* pollen showed the highest airborne frequency followed by grasses and Cyperaceae. Quantitatively March showed highest pollen frequency followed by April and February. Qualitatively however, highest concentration was recorded in May followed by September and August. The volumetric mean concentration of pollen grains in the atmosphere of Central Calcutta for the year 1985 to 1986 has been 0.0045/litre, *i.e.* 10,000 litre of air contained 45 pollen grains.

4. *Clinical investigation with dominant airborne pollen types :* Sunirmal Chanda (Supervisor), Swapna Banik and Indrani Kundu (Institute of Child health, Calcutta).

Clinical tests using skin and prick tests were done at the Institute of Child Health, Calcutta with antigenic extract of pollen grains of twenty species which have been recorded in the atmosphere of Calcutta ; out of which pollen of *Areca*, *Azadirachta*, *Cocos*, *Delonix*, *Saccharum*, *Peltophorum*, *Shorea*, *Eucalyptus*, *Minusops*, *Leucaena*, *Carica*, *Terminalia*, *Moringa*, *Albizia*, *Vinca*, etc. were found to be allergenically significant. Pollen of *Borassus* and *Trema*, though dominant in air, were clinically less potent.

5. *Aerobiological studies in the Salt Lake City, Calcutta :* Sunirmal Chanda (Supervisor) and Swati Gupta.

An aerobiological survey using Burkard automatic volumetric sampler was done in Salt Lake City, Caltutta. A total of 35 types of pollen grains and 48 types of fungal spores were trapped along with some unidentified types. Frequency of grass and cyperaceous pollen grains were fairly high throughout the year followed by *Trema*. The dominant fungal spores came from *Ganoderma*, *Aspergilli*, *Cladosporium*, *Beltramia*, *Nigrospora*, etc.

6. *Eco-floristic survey and aerobiology of Cooch Behar District :* Sunirmal Chanda (Supervisor) and Manas Ranjan Majumder.

Eco-floristic survey of Cooch Behar District was done using gravitational sampler depicting the nature of vegetation with their habit, habitat, mode of pollination, flowering periods, etc. The flora showed a heterogenous assemblage of both tropical and subtropical plants, which is probably due to the easy entrance of subtropical/temperate plants from the upper elevations of Bhutan and Sikkim Himalayas. A continuous aerobiological survey for three consecutive years was done in the Cooch Bihar town to study the nature and concetration of airborne pollen spores of that area. Seventy pollen and spore types were trapped and identified, of which grasses showed the highest frequency. Some other dominant pollen types came from *Caryota urens*, *Azadirachta indica*, *Samanea saman*, *Casuarina equisetifolia*, *Terminalia* sp., *Syzygium* sp., etc. The occurrence of pollen grains of *Pinus*, *Alnus*, *Betula*, *Ilex*, *Quercus*, *Duabanga* etc., essentially temperate suggested long distance transport from the adjacent Himalayas. Fungal spores were represented by *Alternaria*, *Corynespora*, *Curvularia*, *Drechslera*, *Pithomyces*, *Torula*, etc.

7. *Quaternary Palaeoecology and Palaeoenvironment of Chilka Lake, Orissa :* Sunirmal Chanda (Supervisor), Kashinath Bhattacharya (Dept. of Botany, Visva-Bharati), Subhas Chandra Santra (School of Environmental Science, Kalyani University) and A. B. Goswami (Geological Survey of India, Eastern Region).

The studies on the past life forms of Chilka Lake showed almost identical spectrum of the aquatic vegetation which provided some information about the palaeo-expanse of the lake as well as past environmental condition. In the past, the salinity of water of the lake was low, as a result fresh water aquatic species like *Utricularia* could grow in abundance as reflected by the high incidence of *Utricularia* pollen.

Apparently with the rise of salinity, fresh water aquatic species disappeared. In addition, pollen grains of *Najas Potamogeton*, *Typha* and species of Hydrocharitaceae also occurred in the sediments. The present aquatic vegetation of the lake consists, among others, of *Potamogeton pectinatus*, *Scirpus articulatus*, Hydrocharitaceae, etc., along with a large number of shallow water algal flora namely, *Gracilaria confervoids*, *Exteromorpha intertinalis*, *Cladophora glomerata*, *Polysiphonia subtilissima*, *Grateloupia filicina*, *Dyngbaea aestuarii*, *Ceramium elegans*, *Chaetomorpha linum*, *Oscillatoria laetevirens* var. *minima*, etc.

8. *Chemical analyses of some allergenic pollen grains :* Sunirmal Chanda (Supervisor) and Swati Gupta.

Total protein was estimated from the pollen grains of *Solanum sisymbrifolium, Lantana camara, Cassia fistula, Shorea robusta, Trema orientalis, Vinca rosea.* The amount varies from 10·2% to 26·8%. Method for characterizing proteins by acrylamide gel elcctrophoresis was applied. Pollen of *Solanum sisymbrifolium* showed a higher percentage of soluble protein compared to the pollen of *Lantana camara* and *Trema orientalis.* This differences are also noted in the densitographs of the respective protein electrophoregrams.

INVESTIGATIONS NOT INCLUDED UNDER INSTITUTIONAL PROJECTS

1. *Studbook of white tigers in India* : A. K. Roychoudhury.

For the first time in India a complete listing of white tigers, known heterozygotes and their founders in different zoos in India has been made. This studbook contains all the information like name, sex, date of birth, parentage, owner, and date and cause of death of 431 tigers which had been brought from the wild and born in captivity. To make plan for breeding of white tigers, inbreeding coefficients of the offspring for all combinations of potential sires and dams have been determined. To get the visual idea of relationships between animals in a zoo, several genealogical charts have been constructed. From these charts one can easily understand the origin and propagation of white tigers in a zoo as well as consanguineous relationship of any pair of animals. There is also a bibliography of white tiger literature.

The white tigers in India originated from two lineages-one from Rewa and the other from Nandankanan ; they were founded by twelve and four animals respectively. As on June 30, 1988 there were 37 white tigers in India of which 13 belonged to Rewa lineage, 16 to Nandankanan lineage and the rest to mixed lineage. Though the number of founders in Rewa lineage is large compared to that of Nandankanan lineage, the average inbreeding coefficient of the white tigers is higher in former (0·402) than that in latter (0·207). In other words the white tigers of Rewa lineage are more inbred than those of Nandankanan lineage.

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

Morphology of 210 pollen types of Fabaceae were studied, which revealed a wide range of vairations regarding the number, position and character of apertures, exine statification, etc. The pollen grains of Mimosoideae are characterised by monads in *Leucaena glauca, Entada scandens,* tetrads in *Mimosa pudica* and polyads in a number of species e.g. *Samanea saman, Inga dulcis, Acacia nilotica,* etc. The pollen grains of Papilionoideae and Caesalpinoideae are invariably monads and largely colpate, colporate or colporoidate. The porate grains represented smaller numbers. The shape varied from prolate to oblate, surface ornamentation psilate, granulate, reticulate to finely reticulate.

3. *Pollen morphology of some members of Asteraceae and their significance in the taxonomical approach :* Sunirmal Chanda (Supervisor) and Aparna Pal,

The pollen morphology of some the tribes Vernonieae, Anthemideae, Cynareae and Mutisieae were investigated. Vernonieae showed a ramifying nature with various combinations of characteristics in the different taxa, but the general lophate character provided the tribe an entity of the own. Anthemideae is characterised by the tricolporate and echinate pollen form and Cynareae and Mutisieae with its wavy exine surface and expanded exine with the strata differentiated into mega and microcollumella layers.

Within the Asteraceae, the possible fundamental base was found to be Eupatorieae-Heliantheae-Anthemideae-Astereae complex, each of which evolving along parallel directions with two other evolutionary lines represented by the Vernonieae-Cichorieae Complex and the Cynareae-Mutisieae Complex.

4. *Quaternary vegetational history, biostratigraphy and ecology of Kalapanya, Sekerkot and Indranagar, West Tripnra :* Sunirmal Chanda (Supervisor) and Satadip Sarkar.

The late-Quaternary (Holocene) pollen analysis of these deposits depict the past vegetational history, biostratigraphy and paleoecology of West Tripura. The accumulated preliminary results suggest a heterogenous assemblage of spore and pollen grains similar to extant vegetations which indicate a slightly cooler climate during 17,350±500 B.P.

5. *Study of the dominant vegetational constituents with pollinating calendar of some parts of North and South 24-Parganas with the correlation of honey constituents :* Sunirmal Chanda (Supervisor) and Pabitrananda Ganguly.

About sixty dominant plant species under different families have been recorded with respective flowering periods. Honey samples from the above area demonstrated a good correlation of pollen forms originating from the dominant flora. Plants were mostly entomophilous. The results will help in locating honey yielding plants.

6. *Late-Quaternary vegetational history and palaeoenvironment of ancient relict Loktak Lake of Manipur :* Sunirmal Chanda (Supervisor) and Partha Roy.

Some subsurface samples were palynologically investigated from the Loktak Lake deposits dating back $10{,}000 \pm 210 > 31{,}000$ Y.B.P. The results revealed a mixed type of vegetation consisting of ferns, conifers and angiosperms. The profiles could not be divided into distinct pollen zones because the pollen diagrams gave more or less an unfluctuated picture. Most of the samples were dominated by grass and Cyperaceae pollen grains. The arboreal pollen types originated from *Terminalia*, Myrtaceae, Meliaceae, Mimosaceae, Rhamnaceae, Fabaceae, etc., along with non-arboreal taxa like *Justicia*, *Impatiens*, Lamiaceae, Asteraceae, etc., suggesting a tropical rain forest type of vegetation during the time of deposition.

7. *Floristic and palynological survey of Darjeeling and Midnapore :* Sunirmal Chanda (Supervisor) and Abhaya Prased Das.

A pollen flora of the herbaceous and arboreal angiosperms from the Darjeeling hills has been prepared in order to facilitate correlation with airborne types.

A recent floristic survey of the Midnapore town area has recorded nearly 300 species of angiosperms. A pollen flora of the same reflects presence of all dominant palynomorphotypes.

8. *Late-Quaternary vegetational history, biostatigraphy and Palaeoecology of Bengal Basin :* Sunirmal Chanda (Supervisor) and N. C. Barui.

The Late-Quaternary pollon analysis of different deposits from both sides of the River Hooghly were carried out to depict the vegetational history, biostratigraphy, palaeoecology of the Bengal Basin during 2640 to 7030 Y. B. P. The accumulated

results confirm earlier results showing a typical mangrove vegetation somewhat resembling the present day vegetation of the Sunderbans. The occurrence of fern spores probably indicated a different ecological condition at that time and now a near-absence of ferns in the western part of Sunderbans is probably due to the increase of salinity. Occasional mild tectonic movements and increasing biotic interference might have induced the migration of the forest towards the south.

A floristic survey of the extant vegetation has also been made depicting their habit, habitat, nature of plant community and successional pattern.

D. MICROBIOLOGY

Institutional Project No. I. Plant improvement using modern biological techniques.

1. *Studies on mechanism of Azospirillum root association and effect of insecticides and pesticides on Azospirillum :* Satya Ranjan Saha and A. K. Mishra (Supervisor).

Attachment of *Azospirillum* with root of *Pennisetum* sp. grown in liquid culture under laboratory conditions was studied. No bacteria were found inside the root tissue. Studies are still going on in this field, as others have reported *Azospirillum* root association in plants which are growing in soil.

Studies with insecticides and pesticides (Thiodane, Metacid and Demicron) applied to rice plants revealed that no inhibitory effect on growth and nitrogenase activity of *Azospirillum* was observed. So this bacteria can safely be applied to the rice cultivation in presence of insecticides and pesticides.

2. *Enzymes of carbohydrate metabolism in the members of Azotobacteraceae grown on hexoses versus succinate or acetate :* S. Jana, P. K. Chakrabartty and A. K. Mishra (Supervisor).

Operation and regulation of the EMP, ED and PP pathways and the TCA cycle were studied in two strains of *Azotobacter* and two strains of *Azomonas* grown on hexoses or succinate or on acetate. The data suggested that enzymes of ED and EMP pathways are inducible in nature and are present only when grown on hexoses. Presence of the enzyme 6-phosphogluconate dehydrogenase even in succinate—or acetate-grown cells of *Azomonas macrocytogenes* indicated a possible constitutive synthesis of the enzyme in this organism. In the other strains, however, the enzyme is inducible in nature.

The activities of the ED enzymes and the enzymes of the EMP pathway were several-fold higher in the strains of *Azomonas* than in the strains of *Azotobacter* when the cells were grown on hexoses ; as such help to demarcate between species of *Azotobacter* and *Azomonas* providing an enzymatic basis.

3. *Nitrogen-fixation capacity by Azotobacter chroococcum* BI_2 : S. Jana, P. K. Chakrabartty and A. K. Mishra (Supervisor).

Azotobacter chroococcum BI_2 fixed nitrogen *in vitro* within a pH range of 7-9 and optimum being 7·3. The temperature range for N_2-fixation was 25-37°C and the optimum range being 28-32°C. The strain could tolerate salinity upto 0·12% for N_2-fixation and was resistant to several metal ions. Maximum N_2-fixation was observed in the presence of low concentration of KNO_3 and $(NH_4)_2SO_4$. Pesticides, e.g., Rogor, Metacystox and Thioda were inhibitory to nitrogen fixation by the strain even at very low concentrations.

4. *Solubilization of phosphate and silicate by strains of Rhizobium and Bradyrhizobium* : Anup Kumar Halder, A. K. Mishra and P. K. Chakrabartty (Supervisors).

In continuation of our study of solubilization of phosphate and silicate, we surveyed a large number of strains of *Rhizobium* and *Bradyrhizobium* for the purpose. Almost all the strains were capable of releasing phosphate from either hydroxyapatite or tricalcium phosphate and silicate from either magnesium trisilicate or calcium silicate. Besides strains of *Rhizobium*, strains of *Bradyrhizobium*, which meet an alkaline end point in yeast extract mannitol medium, also produced 2-ketogluconic acid and gluconic acid in the medium used and solubilized phosphates and silicates. Among *Rhizobium*, one strain from lentil and one each from *Cicer arietinum* and *Aeschynomene aspera* were assessed to be potent phosphate solubilizers. Some strains of *Bradyrhizobium* from *Cicer arietinum* could solubilize phosphate very efficiently. Metal chelators like EDTA and EGTA when added to the fully grown cultures enhanced the process of solubilization very effectively. Calcium, on the other hand, decreased the rate of solubilization.

Several strains of *Rhizobium* and *Bradyrhizobium* were also used to solubilize phosphate from four different samples of Mussoorie and Purulia rock phosphates used as low and supergrade variety of phosphatic rocks. All the strains could solubilize phosphate from the rocks to a varying degree. Strains of *Rhizobium*, in contrast to the strains of *Bradyrhizobium*, were observed to be better solubilizers. The strain from lentil was highly efficient in solubilizing phosphate consistently from all the samples tested and could release as much as 54% of phosphate in the soluble state after 72 hours of incubation. Initial presence of soluble phosphate in the form of Na_2HPO_4 did not affect this process.

5. *Expression of nitrate reductase in Rhizobium meliloti* : Anup Kumar Halder, A. K. Mishra and P. K. Chakrabartty (Supervisors).

In continuation of our study of nitrate reductase in *Rhizobium*, assimilatory nitrate reductase in *R. meliloti* was observed to be inducible in nature. The enzyme was expressed in GTS-glutamate medium in the presence of nitrate and the synthesis was inhibited in the presence of ammonia or glutamine. Chloramphenicol was inhibitory to the induction of the enzyme.

Dissimilatory nitrate reductase in *R. meliloti* was observed to be constitutive. Cells grown on complex medium exhibited high activity of the enzyme at the end of exponential growth phase. Presence of ammonia or glutamine was also inhibitory for the synthesis of this enzyme.

6. *Regulation of carbon metabolism in Rhizobium* : N. C. Mandal and P. K. Chakrabartty (Supervisor).

In continuation of our study of the regulation of carbon metabolism in *Rhizobium*, it was observed that upon carbon starvation the levels of glycolytic enzymes including those of ED and PP pathways decreased significantly, whereas, the activity of isocitrate lyase, an enzyme of glyoxylate pathway and is absent in cells growing on hexoses, increased dramatically. The findings indicate an altered carbon metabolism during carbon starvation. The activity of malic enzyme for gluconeogenesis increased several-fold over the control although the activities of TCA cycle enzymes remained unchanged.

Many strain of free-living rhizobia and *Bradyrhizobium* have the ability to catabolize 2-, 3-, and 4-carbon alcohols as sole carbon source. With an increase in alcohol concentration a decrease in growth rate was observed indicating that the substrate may be toxic for the organism. During growth on alcohol enzymes of carbohydrate metabolism attained a level similar to those during carbon starvation. Alcohol, however, induced the synthesis of alcohol dehydrogenase presumably for detoxification.

Institutional projeet No. IV. Studies on ecology, environment pollution and related health problems.

7. *Airborne fungal spores in urban Calcutta in relation to occupational area and population density :* Tilak Banerjee, A. K. Roychowdhury and R. Chakraverty (Co-supervisors) and K. Sen (Supervisor).

Survey of fungal air spora from seven different areas, coverings fifty sites in Calcutta has been reported earlier. During the period under report the data for various fungi collected have been analysed statistically.

In all the areas, among the two common saprophytes, *Aspergillus* and *Penicillium*, the former occured at a higher percentage (mean incidence %14.15 $\pm$1.41 – 27.73$\pm$1.91) than the latter (mean incidence %7.68$\pm$1.06 – 12.65$\pm$1.11). Among the seven areas, mean insidence percent of *Aspergillus* was highest in Commercial area (27.73$\pm$2.01) followed by slum area (27.55$\pm$2.01) and area with population 1000/hectare (26.43$\pm$1.99). Highest incidence of *Penicillium* occured in area with population 1000/hectare followed by slum area (12.65$\pm$1.11) and storage and transport area (12.26$\pm$0.84).

Among the plant pathogenic fungi, the three genera, *Curvularia*, *Alterneria* and *Helminthosporium* occurred more or less regularly, but at a significantly lower percentage than the two saprophytic forms mentioned above. Again among the three plant pathogenic fungi, *Curvularia* showed significantly higher incidence in the open green area (18.13$\pm$1.97) and in area with population 250/hectare (13.82$\pm$1.08).

The high incidence of *Aspergillus* in summer, *Cladosporium* in winter and the sterile forms during the rainy season, indicated the effect of climatic fectors on the occurrence of fungal types in air.

A number of uncommon fungi have been identified as *Trichnrus spiralis*, *Botryodiploidia theobromae*, *Memnonella echinata* and *Pestalotiopsis* sp.

8. (a) *The mycoflora of home environments* : Roma Chakraverty.

The urban residents spend most of their time indoors and such environments are important in air pollution. Hence the present study deals with the survey of the air mycoflora of home environments with the culture plate method. It was observed, that the fungal concentration was significantly high in the bed rooms, followed by bathrooms, drawing rooms and kitchens respectively. The effect of TV was not significant. The ceiling fan, while on, was found to increase the fungal concentrations significantly as against still air, in various rooms.

Aspergillus and *Penicillium* were the predominant genera, followed by *Curvularia*, *Alternaria* and some sterile forms. *Aspergillus* was represented by *A. niger*, *A. fumigatus*, and *A. parasiticus*. *A. niger* was the most dominant species. *Penicillium* was represented by five species. Further study is in progress.

(b) *The phyllosphere mycoflora of some medicinal plants :*

The phyllosphere mycoflora of some common medicinal plants like, *Occimum sanctum* and *Azadirechta indica* has been studied. It was observed that very few fungal isolates were recorded, as compared with the common weeds (mentioned in previous report). Besides, *Azadirechta indica* showed some antifungal properties.

Further study is in progress.

9. *Structure, Function and Multiplicity of Cytochrome P_{450} in Fungi :*

(a) Role of inducers on benzo (a) pyrene metabolism by *Aspergillus ochraceus* TS *in vivo* and *in vitro* : Debjani Datta and Timir B. Samanta (Supervisor).

In continuation of our work on benzo (a) pyrene (BP) metabolism attempts were made to resolve BP-metabolites produced by microsomes of *Aspergillus ochraceus* TS induced by agents of diverse chemical structure. The HPLC profile of the metabolites revealed that there was a coordinate induction of epoxide hydrolase along with Cytochrome P_{450} linked monoxygenase. The induction of epoxide hydrolase had good influence on the level of dihydrodiols produced under the conditions used. The production of BP-*trans*-4, 5-dihydrodiol (K-region diol) for the first time in fungal microsomes is considered to be a good possibility for isolation of newer product(s) which are yet to be isolated as mammalian metabolite(s) thereby establishing the role of these reactions in fungi for management of PAHS in ecosystem.

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

The involvement of cytochrome P_{450} and NADPH-cytochrome P_{450} reductase in metabolism of benzo (a) pyrene by *A. ochraceus* TS had been reported earlier. By way of investigating other detoxifying protein, glutathione-S-transferase (GST) was detected in microsomes of *A. ochraceus* TS. It was observed that the enzyme is located in microsomes only and is involved in conjugation of 1-chloro-2, 4-dinitrobenzene (CDNB) with glutathione (GSH). The level of the enzyme could be increased preferably by carcinogenic substrates. However, treatment with 3-methylcholanthrene (3-MC) produced basic isozymes as envisaged by the results of inhibition studies (I50) with N-ethyl maleimide. Further characterization is in progress.

10. *Reduction of hexavalent chromium by a soil streptoycete :* Sumana Das and A. L. Chandra (Supervisor).

The 1500 μg ml $K_2Cr_2O_7$ tolerant *Streptomyces* sp. 5M, when incubated in yeast extract malt extract broth in the presence of $K_2Cr_2O_7$ resulted in a decrease of the chromate in the culture filtrate. Incubation of the chromate with different cell fractions in the presence of NADH and NADPH caused a decrease of Cr^{6+} in the reaction mixture. This decrease was maximum with the $105,000 \times 1h$ centrifuged sediment in the presence of NADH. The reduction of the hexavalent form into the trivalent form of chromium by the cell fraction was estimated spectrophotometrically. The formation of Cr^{3+} was also noted in electron paramagnetic resonance spectrum.

Institutional Project No. V. Studies on microbes and parasites for industrial and medical applications.

11. *Studies on the lichen dye* : Kalyani Sen.

Pilot plant production of litmus has been done. Commercial production of litmus dye is cost effective.

12. *Search of new fungi for industrial chemicals* : Kalyani Sen.

Fungi collected from diffcrent depths of soil (10 ft – 500 ft) have been purified. Further studies on their metabolites for plant growth chemicals are in rapid progress.

13. *A streptomycete collagenase :* R. P. Mukhopadhyay and A. L. Chandra (Supervisor).

A soil streptomycete designated as *Streptomyces* sp A_{11} produced an extracellular, inducible collagen hydrolysing enzyme that appeared to be a "true collagenase" as it degraded native collagen under physiological conditions and cleaved the synthetic hexapeptide 4-phenylazobenzyloxycarbonyl-L-prolyl-L-leucyl-glycyl L-prolyl-D-arginine into 2 tripeptides. The enzyme was purified by $(NH_4)_2SO_4$ precipitation and DEAE cellulose chromatography. The molecular weight of the enzyme was found to be 74,000 by SDS-polyacrylamide gel electrophoresis. The enzyme was homogeneous, no subunits could be detected. Ca^{2+} enhanced collagenase activity EDTA inhibited the activity.

14. *Studies on β-amylase activity of Emericella nidulans 45 :* Banhisikha Chattopadhyay and Arati Das (Supervisor).

In *Emericella nidulans* 45 using starch as carbon source in fermentation medium exocellular β-amylase activity was found to be very negligible upto 4th day of

incubation. On further incubation, the activity was increased and attainded maximum (8·0 U/ml) on 6th day and then declined.

A study of exocellular protease activity of the strain revealed the presence of proteases (mainly neutral) in the culture filtrate. The enzyme level gradually increased with increase in the incubation period. The decrease of exocellular activity may be due to the accumulation of increasing protease level in the culture filtrate after 6 days of incubation. During fermentation in medium containing a combination of starch and sorbose as carbon sources, appreciable exocellular enzyme activity was observed on the 2nd day of incubation (17·3 U/ml) and the maximum yield (26·0 U/ml) was found on 6th day suggesting that sorbose helps to release the cell bound β-amylase leading to increased accumulation of the enzyme in culture filtrate.

Experiments on mutagenic treatment with the wild strain was continued using the mutagens in 3 steps according to the scheme : UV→NTG→UV. A mutant was finally obtained producing the enzyme to the level of 395 U/ml against the perental level of 80·4 U/ml.

The enzyme produced by the mutant was then partially purified (22·7 fold) following different chromatographic techniques. Work is in progress to characterize the enzyme.

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

In course of stepwise mutagenic treatment to successively improved strains of *Aspergillus terreus* 4, a mutant strain of *A.* terreus NA-170 was finally obtained by experiment with nitrous acid and it was improved over the wild strain by 170% in glucoamylase production.

The enzyme was partially purified (8·6 fold) through several steps of treatment $(NH_4)_2SO_4$—Sephadex G-100—CM-cellulose. The specific activity of the partially purified enzyme was 137·5 U/mg protein. The optimum activity of the enzyme was observed at pH 4·5 and temperature 60°C. The enzyme was activated by Ca^{2+}, K^+ but inhibited by Ag^+, Hg^{2+} and Cu^{2+}. Among the chemical compounds EDTA, sodium arsenate and p-CMB completely inhibited while L-cystine activated the enzyme activity.

In the attempt to improve the production of the enzyme by cultivation of the strain in media containing various types of bran samples along with minerals of Czapek Dox medium, the yield was maximum when wheat bran was used.

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

The present investigation was undertaken to search for promising fungal strains of high tyrosinase activity for the transformation of L-tyrosine to L-DOPA. Among 140 fungal isolates obtained from different sources good tyrosinase activity was observed in twenty six cultures including strains of *Aspergillus*, *Penicillium*, *Fusarium*, *Verticillium* and *Chaetomium*. Further studies of these strains indicated *Aspergillus niger* AR107 as the most active strain.

To improve the yield of L-DOPA cultural parameters were studied. Maximum transformation was observed with the culture growing in still condition at 28°C at pH 5·8. 72 h old mycelia were found to be most suitable for maximum tyrosinase activity and hence all the successive experiments were carried out with 72 h old mycelia. Further experiments showed that with L-tyrosine as the substrate, the maximum production of L-DOPA was attained when the substrate was added at 1·0 mg/ml concentration in 4 intermittent feeding at 15 min intervals to the assay mixture, incubated at 45°C for 60 min in shaking condition and the presence of L-ascorbic acid (2·0 mg/ml) as an antioxidant in the assay mixture helped to improve the transformation rate.

For isolation of improved L-DOPA mutant strains multistep mutagenic treatments are in progress.

17. *Breeding by protoplast fusion :* Arati Das.

Protoplast fusion was carried out between to strains of *Aspergillus niger* of which one is fast growing and poor producer of glucoamylase enzyme, and the other is slow growing and good producer. Protoplasts were obtained by treating mycelia with a combination of Novozyme 234 and Cellulase cp and fusion was carried out in presence of polyethylene glycol. Following fusion, a number of segregants of both parental and nonparental combinations were obtained when assayed for glucoamylase activity. All these selected strains were fast growing and expressed variable enzyme activities, some even exceeding the value of the better yielding parent. Among these selected

segregants the most active strain produced about 68% more of glucoamylase than that of the better yielding parent. This indicates promising prospect of breeding improved glucoamylase producing strains by protoplast fusion technique.

18. *Enzymatic hydrolysis of wastes by Aspergillus ochraceus xylanase :* Swadesh R. Biswas and Geeta Nanda (Supervisor).

The saccharification of some alkali treated agricultural wastes by *A. ochraceus* xylanase was studied. The culture filtrate obtained after growing the strain in xylanase medium was used as the enzyme source.

The maximum saccharification was found to occur at a pH of 6·0 and a temperature of 50°C. Sugarcane baggasse was found to be the best substrate for maximum liberation of reducing sugars. The maximum rate of saccharification of rice straw, wheat straw and bagasse was 258, 21·39 and 30%, respectively. The effect of exogenous supply of β-xylosidase improve the rate of saccharification. The alkali treatment of the substrate with 1% NaOH leading to good saccharificalion rate. The main product of enzymetic hydrolysis was found to be xylose.

19. *Optimization of growth medium for production of alkaline protease by Nocardia sp. TP8.* : Ruby Dash and Geeta Nanda (Supervisor).

In continuation of studies on protease production of alkali serine protease and metalloprotease by soil isolated thermophilic strain of *Nocardia* sp. TP8 attempts were made to further increase the productivity by studying the effects of different nutrients on the enzyme system.

Among the carbon sources tested 2·5% mannitol was the optimum choice. A significant increase in protease production was obtained when 0·5% peptone and 0·2% sodium dehydrogen phosphate were used. All inorganic salts (0.2%) were inhibitory to enzyme production, although supplementation with 0·1% urea effectively increased the protease production. Under the optimum condition, the organism produced 156 unit per ml of crude enzyme at 50°C after 24 hr. incubation. Further studies are in progress to enhance the enzyme production through agricultural waste utilization.

20. *Production of cellulase by some thermophilic fungi :* Bandana Banik and Geeta Nanda (Supervisor).

Isolation and screening of cellulolytic microorganisms for quick decomposition

of cellulosic waste were carried out. Twenty-five fungal strains belonging to different genera *Aspergillus* sp., *Penicillium* sp. *Fusarium* sp. and *Mucor* sp. showed extracellular cellulolytic activity and at temperature between 28°C to 60°C. The isolates were grown in CD medium and their cultural condition for production of cellulase were standarised. Optimum yield of cellulase (FPase, CMCase and salicinase) activity was found at pH 4·8 for 7 days incubation, at 50°C temperature with 1% substrate as carbon source in growth medium. Substrates used were cellulose powder, carboxymethyl cellulose (CMC), Solka Floc SW 40 and alkali treated paddy straw. Out of 25 strains of *Aspergillus* sp., F7 showed highly cellulolytic acticity. Maximum yield observed was 65·72 U/ml, (CMCase), 0·85 U/ml (FPase) and 18.25 U/ml (salicinase). Further work is in progress.

21. *Studies on microbial conversion of phytosterol to 17-ketosteroid :* Alok Dhar and Timir B. Samanta (Supervisor).

17-ketosteroids are chemically important for synthesis of biologically active steroids. With a view to prepare steroid intermediates from sterols, six bacterial strains (G_1-G_6) locally isolated were incubated with cholesterol under liquid culture condition at 37°C. The processing of the culture filtrate of individual treatment revealed that cholesterol was oxidised to cholestenone in all the cases except G_1.

Later, the above strains were challenged with progesterone as substrate under liquid culture conditions. It was interesting to note that only the strain G_4 oxidised progesterone presumably to its hydroxy derivative. The oxidation took place at other than 11-position which remains to be settled.

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

Immobilization of spores of *A ochraceus* TS was attempted with various matrix like agar-agar, polyacrylamide, calcium alginate by single and double entrapment technique. Assay of the immobilized spores for steroid hydroxylase activity showed that calcium alginate gel furnished better results.

23. *Genetics of iron-sulfur based autotrophy in Thiobacillus* : A. Das, S. Das, A. K. Mishra and Pradosh Roy (Supervisors).

Thiobacillus has been recognised as an industrially important microorganism for

the utilization of low grade ores and removal of sulfur from coal. The species *Thiobacillus ferrooxidans* oxidises both iron and reduced sulfur compounds in its energy yielding process, the mechanism, for which is not known at the molecular level. Preliminary studies have shown that iron oxidation is inducible in nature. Attempts are being made to identify the protein/s involved in iron/sulfur oxidation. Several facultatively autotrophic *Thiobacillus* have already been isolated which are being used to study the genetics of sulfur bound autotrophy using conventional bacterial genetics which is almost impossible to study with strictly autotrophic *Thiobacillus ferrooxidans*.

24. *Development of bacteria with useful characteristics for the enhancement of recovery of oil* : Indrani Roy, C. Deb and A. K. Mishra (Supervisor).

Attempt to isolate some of the anaerobic/thermophilic bacteria capable of liquifaction of crude oil was made from different crude oil procured from O. N. G. C. Dehradun. But no such organism could be isolated from these samples. However, a strain of *Pseudomonas stutzeri* isolated from petroliferous oil was found to totally degrade crude oil. Attempts to mutate this strain for partial degradation (liquification) of oil is now being attempted so that the strain could be used for microbial enhancement of oil recovery.

25. *Removal of H_2S from oil/gas & recovery of sulfur* : Amitava Das, Subrata Das and A. K. Mishra (Supervisor).

The naturally occurring bacteria e.g., *Thiobacillus*, *Beggiatoa*, *Sulfolobus*, *Chlorobium*, *Chromatium* etc. can use reduced sulfur compounds to get energy and utilise the same to fix CO_2. These bacteria are inhibited by various hydrocarbons present in the oil. So we are trying to isolate bacteria which can tolerate hydrocarbons present in the oil and simultaneously oxidise reduced sulfur compounds i.e., H_2S.

26. *Microbial beneficiation of Magnesite ore to remove silica* : B. K. Mohanty, Suparna Ghosh and A. K. Mishra (Supervisor).

The removal of silica from salem magnesite ore by a *Bacillus* sp. was carried out at a pilot plant level (Laboratory scale). A stainless steel air-lift percolator was built for this purpose. Four different carbon sources (glucose, fructose, sucrose and commercial sugar) were used. Although a faster temoval of silica was achieved in the presence of fructose, sucrose and commercial sugar than glucose, the overall

removal of silica was same in all the cases. Besides, other parameters like effects of pretreatments of ore, particle size, pulp densities etc. were also studied, A mutant of the strain was found to remove 82% of the silica from the magnesite ore.

27. *Microbial removal of silica from chromium ore* : Suparna Ghosh, B. K. Mohanty and A. K. Mishra (Supervisor).

Several bacteria having the silica solubilising capacity and resistance to high chromium (Cr^{+3}) concentration were isolated from chromium ore body. The silica release increased from 31 μg/ml to 94 μg/ml when a modified medium was selected. The effect of different heavy metal on growth and Si release revealed that the organism was resistant to several heavy metals. However, Cd^{+2} enhances the silica solubilisation whereas, Fe^{+2} and Fe^{+3} inhibited the process. The presence of minute quantities (microgram order) of various amino adids like glycine, alanine valine, serine, p-hydroxy proline increased the silica removal from the ore.

28. *Studies on amylolytic activity of Myceliophthora thermophila D14* (ATCC 48104) : Ramkrishna Sadhukhan and S. L. Chakrabarty (Supervisor).

It was already reported that *M. thermaphila* D-14. a cellulolytic thermophilic fungus, also possesses amyloltyic activity. The expression of cellulolytic and amylolytic enzymes in the organism is very interesting. The growth of the organism is maximum at 45°C and at PH 5·5. The biosynthesis of the amylolytic enzyme is found more or less proportional to the growth of the organism. The amylase activity was greatly suppressed when grown on glucose or sucrose but it was maximum in presence of starch. Sodium nitrate and potassium nitrare were most conducive among the nitrogen sources used in the medium. Enzyme production was optimum at 60°C and at pH 5·6. The enzyme was stable for 2 hrs at 60°C and in the pH range between 3·0 to 6.5 for 12 hrs.

The enzyme was found to occur in multiple forms. The purification and characterization of these components are in progress.

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

L-Asparaginase producing bacterial strains were isolated from natural sources

like muddy soil, polluted drainage and faecal-contaminated water, sewage system, garbage etc. Out of 427 strains isolated so far, 10 bacterial strains having appreciable L-asparaginase activity were selected. Out of these, strains *MB-190*, *MB-214* and *MB-405* showed comparatively higher L-asparaginase activity. These strains were studied for proper taxonomic identity. From the observations so far made the strains *MB-190*, *MB-214* and *MB-405* exhibit much taxonomic similarities with *Vibrio*, *Escherichia* and *Pseudomonas* respectively.

Basing on the characteristics like higher specific and enzyme activity, stability of the enzyme at broad range of pH (7.5 to 10.0) and temperature (30°C to 55°C) and good growth and enzyme production in culture media, the strain *MB-405* deserves special attention and hence selected for further studies which are in progress.

30. *Purification and characterization of Vibrio cholerae-L-asparaginase :* Susanta K. Day and S. L. Chakrabarty (Supervisor).

By successive procedures of 35-55% $(NH_4)_2SO_4$ saturation, DEAE-cellulose, Sephadex G-100, Sephadex G-200 and DEAE-Sephadex column chromatography, L-asparaginase of *Vibrio cholerae* has been purified to homogeneity, The enzyme specific activity was found 76.12, 207 fold purified and 16% recovered. The MW as determined by Sephadex G-200 column was 118,000±6,000 and the subunit MW was 29,000 as carried out in 7.5% SDS-PAGE in vertical slab gel. The Km value of the purified enzyme has been established as 1.4×10^{-4}M.

The purified or even some-fold purified enzyme did not show any toxic effects on depilated rabbit skin as measured by blueing dose/ml. Also it did not exhibit any enteropathogenicity in suckling mouse model.

31. *Studies on antineoplastic activity of Vibro cholerae-L-asparaginase :* Susanta K. Dey, Amares Sinha and S. L. Chakrabarty (Supervisor).

The evaluation of the purified enzyme of *V. cholerae* strain regarding its antineoplastic activity has been carried out in Swiss mice infected with Dalton's lymphoma (DL) and Ascites fibrosarcoma (AFS) cells. It caused increase in mean survival time (24 days to 46 days), delayed tumor appearance (9th day to 26th day) and about 33% cases of complete remission as recorded through determination of LD_{50}. Marked inhibitory effects of the enzyme on DL and AFS tumor cells were also

observed by *in vitro* studies of tumor cell culture in RPMI-1640 medium. The injected enzyme showed good plasma clearance rates (16 hrs for normal mice and 26 hrs for tumor infected mice). The splenic T-lymphocyte function with SRBC was carried out for immuno-cytoadherance (Rosette formation) studies. The variation in cell surface modulation and modification of T-lymphocytes of normal and tumor bearing Swiss mice injected intraperitoneally with the enzyme was also studied under scanning Electron microscope.

32. *Outer membrane proteins and cellular adherence properties of V. cholerae* : T. K. Sengupta and A. C. Ghose (Supervisor).

(a) *Iron-regulated outer membrane proteins of V. cholerae and their role in cellular adherence properties of bacteria.*

V. cholerae organisms belonging to both 01 and non-01 serovers were found to produce phenolate-type siderophores when grown in an iron-deficient synthetic medium (Tris-buffer medium). Siderophore production was associated with increased expression of several outer membrane proteins (OMP) in the molecular weight range 66KD to 75KD. These OMP, however, appeared to be unrelated to the expression of hemagglutinating and intestinal adherence properties of *V. cholerae* as only minor variations in these properties were noted in presence or absence of iron. These results suggest that iron-limiting condition may not adversely affect the adherence and colonization potential of *V. cholerae* in the gut.

(b) *Media-dependent expression of outer membrane proteins and cellular adherence properties of V. cholerae.*

V. cholerae organisms (01 and non-01) grown in Trypticase Soya Broth (TSB) were found to exhibit higher hemagglutinating and intestinal adherence capabilities as compared to those of organisms grown in a synthetic medium (Tris-buffer medium). Interestingly, OM prepared from cells grown in TSB showed the presence of several new protein bands in the molecular weight region 14 KD to 30 KD that were not detectable in the OM prepared from cells grown in synthetic medium (Tris-buffer medium). The role of these protein bands in the cellular adherence properties of *V. cholerae* is being investigated.

33. *Characterisation of antigens of Leishmania donovani* : A. Chaudhuri and A. C, Ghose (Supervisor).

A defined liquid culture medium was developed that supported the growth of *L. donovani* promastigotes *in vitro*. The medium was composed of small molecular weight substances that were easily dialysable. Log phase cultures of *L. donovani* promastigotes, when grown in this medium, were found to excrete (or secrete materials that reacted to rabbit antisera raised against the whole promastigotes. The excretory-secretory (ES) material contained both protein and polysaccharide substances. Further studies are in progress to characterise the ES antigen(s) and to establish its relationship to the parasite somatic antigens.

E. BIOCHEMISTRY

Institutional Project I : Improvement of plant productivity, nitrogen fixation and photosynthesis using modern biotechnology and plant breeding :

1. *Storage protein from Vigna radiata and its genomic cloning :* S. Bhattacharyya and B. B. Biswas (Supervisor).

In continuation of the previous year's work the amino acid composition of purified vicilin from *Vigna radiata* has been analysed.. This vicilin contains high amount of glutamic acid, aspertic acid, phenylalanine, serine, valine and leucine but it is devoid of methionine and cysteine. It has also been shown through different experiments that the purified vicilin might exist as tetramer of one subunit of MW 52 K and the presence of two smaller polypeptides which were detected along with the 52 K protein after purification is the result of breakdown of 52 K protein during maturation.

The *EcoRI*+*Bam*HI, *Bam*HI+*Bgl*II and *Bam*HI+*Hin*dIII digests of genomic DNA of mung bean yielded signals when hybridized with vicilin cDNA or phaseolin cDNA (at less stringent condition) as probe. Those lighted fragments of DNA containing the putative vicilin gene are now being cloned and analysed.

2. *Regeneration and Genetic transformation in Vigna radiata* : Mahadev Pal, Utpal ghosh and B. B. Biswas (Supervisor) (suported by UNDP and CSIR grants).

Vigna radiata are very poor in sulphur containing amino acids in the storage proteins and are prone to stress and diseases. The aim of the present work is to make this plant with storage protein rich in methionine as well as stress and disease resistant. With this aim at the outset cell and tissue culture was started to regenerate *V. radiata*. Regeneration from the callus of leaf disc, shoot, root, cotyledon, epical meristem and nodal explants was therefore attempted. Shoot regeneration from cotyledon, epical meristem and nodal explants was successful and reproducible all with multiple shoots. The procedure of regeneration from cotyledon explants can briefly be stated as follows— 16 hrs germinated seeds were decoated and the cotyledons were taken and inoculated asceptically on MS media containing cytokinin at required concentrations. Multiple and

single shooted plantlet emerged from the cotyledons within one to two weeks. After 2-3 weeks when shoots were 1-2 cm long, the plantlets were transferred to the fresh MS medium and incubated till the shoot length grew up to 4-5 cm. This has been achieved within 6-7 weeks. Then these shoots were made colyledon free and transferred to rooting medium where roots were observed to be emerged within 2 weeks incubation. The whole plants thus obtained are now ready for field transfer.

Multiple shoot regeneration from epical meristem was done exactly by the procedure described above.

Along with the work for tissue culture vector assembly and transformation experiments were also tried. So far as the vector assembly is concerned binary vector mobilisation from *E. coli* to *Agrobacterium tumifaciens* with a helper function through triparental mating was attempted. The successful conjugation was confirmed by selection of the transformants and isolation of plasmid therefrom followed by characterization of the plasmid DNA by agarose gel electrophoresis. In this way assembly of a binary *Agrobactrium* vector was obtained.

For achieving successful transformation the cocultivation of cotyledon explants with *Agrobacterium* was done for 24 hrs on MS medium. After coculture explants were transferred to shoot inducing medium containing Kanamycin, cefotaxime and Carbenicillin, multiple shoots and single shoot from cotyledons were emerged as stated previously. But shoot induction from cotyledons was found to be significantly reduced. The shoots from cotyledon which survived about three weeks were transferred to same fresh medium with kanamycin only and kept for another 2 weeks. Most of the plants were turned brown at this stage. The few cotyledons which still survived were again transferred to suitable medium containing Kanamycin.

Control experiment (without coculture with Agrobacterium) with cotyledons were carried out simulteneously. Most of the cotyledons turned brown within 3 weeks in kanamycin containing medium. Few cotyledons produce shoots which did not survive ultimately. However, it was found that mung bean plant in general is resistant to kanamycin to a cestain extent. In that case transformation studies are to be made with other marker genes.

3. *Myoinositol phosphate metabolism in Vigna radiata* : Mau Mukherjee, Karabi Chatterjee, Susweta Biswas (Co-supervisor) and B. B. Biswas (Supervisor).

In Plant system the role of myoinositol trisphosphate IP_3 (an intermediate

product of mung bean phytase action of myoinositol hexaphosphate IP_6) as a second messenger in cellular signal transduction was studied. This IP_3 was found to be very much effective in (i) rabbit blood platelet aggregation and (ii) release of Ca from microsomes isolated from mung bean hypocotyl.

These findings indicate that above IP_3 can be accepted by the receptor in plant cell. In mung bean system IP_3 shows strong binding with the microsomal fraction isolated from mung bean hypocotyl compared to other fractions. This strongly suggest that IP_3 binds to a membrane bound intracellular receptor which is beleived to reside in the smooth endoplasmic reticulum. ^{32}P labelled IP_3 was obtained by the action of phytase on ^{32}P labelled IP_6 isolated from mung bean. IP_3 was purified by Dowex formate (200-400 mesh). Recently in animal system indirect evidence was obtained which suggests that IP_3 might control Ca entry across the plasma membrane, and IP_3 may be considered as second mesenger in its own right, acting to control cell surface Ca gates. But in plant system a very little information is available. The role of IP_3 (Phytase product) in plant system is to be tested.

Presently we are trying to identify the specific isomeric form of this IP_3 (phytase product) by NMR spectroscopy ^{32}P NMR profile of IP_3 (Phytase product) is different from that of myoinositol 1,4,5 trisphosphate. This in all probabilities turns out to be myoinositol 2, 4, 5 trisphosphate. Final identification and detailed NMR studies of this compound are in progress.

4. *Isolation and characterization of storage protein from mustard seeds* : S. Dasgupta and R. K. Mandal (Supervisor).

With a view to improve storage protein quality of cultivated mustard (*Brassica campestris*) using modern biotechnology, work on the isolation, characterization and biosynthesis of maior storage proteins have been initiated. Proximate composition (DNA, RNA, protein, lipid and residue) analysis of developing *B. campestris*, variety B-9 seeds under field conditions was determined. Following initial accumulation of DNA due to rapid cell division of embryo, the RNA content increased during the cell growth period. Accumulation of storage material (proteins and lipids) started 7 days after flowering and was maximum at the mid maturation stage. Total proteins isolated from mature seeds by SDS-mercaptoethanol extraction, and globulins fractionated by NaCl extraction followed by gel filtration were examined by SDS-polyacrylamide gel electrophoresis. Two classes (12S and 2S) of major proteins were thus characterized. The purified 2S protein will be used to raise antibody for its subsequent use in precipitating polysomes containing 2S protein-specific mRNA.

5. *Cloning and sequencing of a highly repeated DNA in Brassica* : J. Dasgupta and R. K. Mandal (Supervisor).

Total DNA isolated from germinated seedlings from three species of *Brassica* namely, *B. campestris*, *B. juncea* and *B. napus* was digested with different restriction enzymes and examined by agarose gel. In all cases ladders of repeats of short lengh monomers were observed. The *Hind* III monomer repeat of 180 bp length of one species isolated from low melting agarose hybridized with similar bands of other species, showing homology between them. The monomer unit of *B. campestris* and *B. juncea*, the species widely cultivated in India, were cloned in pUC8 vector and were completely sequenced by dideoxy sequencing method. The sequences from the two species showed considerable homology as expected. These are being compared with sequences of similar repeats in other *Cruciferae* by computer analysis.

6. *In vitro regeneration of Mimosa pudica plant from callus* : Ambalika Roy, Susweta Biswas (Supervisor) and Amita Pal (Co-Supervisor).

Callus was initiated on Linsmaeir and Skoog's basal nutrient medium supplemented with 0.5 mg BAP and 1.5 mg 2-4 D from secondary and tertiary pulvinii and leaflets. Shoot buds appeared from the calli after fourth subculture under photoperiodic condition. These shoot buds when transferred to the suitable secondary medium grew to shootlets.

Rooting media were evolved to initiate roots from the base of these shootlets. Standardization of conditions to transfer these plantlets to the field is under way.

7. *A new actin depolymerizing protein from plant* : Mita Pal and Susweta Biswas (Supervisor).

Actin binding protein from Dopati pod coat was further characterized. The polymerization of G actin isolated and purified from Rabbit muscle was monitored in either the absence or presence of 310 K DPC protein. The nucleation and the elongation steps in actin polymerization were not clearly separated by this measurement. The result shows that the increase in the absorbance due to the polymerization of G actin is dependent on the increasing concentration of 75 K DPC protein. It was also observed that there is almost no effect of DPC protein when added after 20 min of polymerization. Some effect was also observed when mung bean actin like protein was used instead of animal actin. The polymerization of G actin was monitored under the same salt conditions by viscometry using an Ostwald type of viscometer. There

is a lag of 5 min which is due to the nucleation step followed by abrupt increase in the viscosity which is regarded as the elongation step. The presence of DPC protein, did affect neither the lag period nor the rate of elongation, while the specific viscosity decreased with the increasing concentrations of DPC protein. The result indicates that this protein inhibits polymerization of G actin. Addition of sonicated F-actin to the DPC containing sample did not increase actin polymerization.

The results of amino acid analysis of DPC protein indicate the presence of higher amount of acidic amino acid like glutamic and aspartic acid swhich is also very different from other actin binding proteins reported so far from different organisms.

8. *Construction of genomic library of Brassica compestris in lambda EMBL-3* : Niranjan Das and Sudhamoy Ghosh (Supervisor).

(a) *Preparation of nuclear DNA from Brassica campestris.*

Six days' old leaves from germinating seedling of *B campestris* (Agrani variety) were processed for separation and isolation of nuclei particles. High molecular weight DNA from nuclei was prepared using standard method. After digestion of nuclear DNA partially by *EcoRI* restriction enzyme, DNA preparation was size fractionated by 10-40% sucrose gradient centrifugation and 18-22 Kb size *EcoRI* cleaved DNA fragments were isolated.

(b) *Preparation of EMBL-3 DNA and corresponding annealed arms.*

EMBL-3 DNA was prepared from the corresponding lambda phage in large scale. The DNA was fully digested with *EcoRI*, annealed according to the standard method to obtain annealed lambda EMBL-3 arms in large quantity as checked by gel electrophoresis.

(c) *Construction of Brassica campestris genomic library.*

Annealed EMBL-3 lambda arms and 18-22 Kb size *Brassica campestris* DNA were ligated by T4-DNA ligase to generate concatemeric DNA for *in vitro* lambda packaging. The above ligated phage DNA containing plant DNA inserts was packaged using our own preparation of lambda packaging extracts. The recombinant phages (which were spi$^-$phenotype) were selected on *E. coli* p2392 (P2 lysogen). Finally, genomic library has been constructed.

9. *Construction of a genomic library of Azospirillum brasilense and identification of clones containing ntr and fru genes* : Sudip Chatterjee, Ashim Mandal and Sudhamoy Ghosh (Supervisor).

(a) Construction of genomic library : Previously we reported preparation of lambda packaging mixture from two strains of *E. coli* viz. NS428 and NS433 in our laboratory which could generate *in vitro* 10^6 pfu/ug of lambda DNA. This packaging mixture, kept frozen at −80° C, was found suitable for construction of a cosmid library using pLAFRI plasmid vector and *Azospirillum brasilense* DNA. Total DNA of the bacteria was prepared following a standard method taking care that the size of the isolated DNA remaired not less than 100 kb. This bacterial DNA was further digested by EcoRI partially to obtain DNA fragments having an average size of 20-30 kb. This partially digested DNA was subjected to sucrose density gradient (10%—40% sucrose) fractionation in an ultracentrifuge and the size of DNA in each fraction was analysed by agarose gel-electrophoresis using standard DNA markers. Fractions containing 20-30 kb DNA fragments were purified and the purified DNA ligated with *EcoRI* linearize pLAFRI DNA to obtain concatameric DNA which was packagable in lambda head *in vitro* using our packaging mixture by the method of Enquist and Sternberg. Cosmid library was obtained by infecting the packaged recombinant DNA into *E. coli* 17-1 (*recA hsdR pro* RP4−2Tc : : Mu Km : : Tn7) and about 1500 Tc clones were preserved as the library as this should amply represent total genome of *A, brasilense* in 20-30 kb inserts.

(b) Cloning of *fru* operon or regulon : We reported last year the isolation and characterization of a large number of fructose utilization defective and fructose regulatory mutants of *A. brasilense*. To identify clones containing genes that code for enzyme I, enzyme II and phosphofructokinase (these are also designated as fru-enzymes) or any genes that regulate the expression of the above enzymes, we complemented such defects of the mutants by conjugal transfer of the plasmids pLAFRI containing *A. brasilense* DNA inserts using *E. coli* S17-1 library as donors and *A. brasilense* mutants (which show phenotypic defect in fructose or other carbohydrate utilization) as recipients. We were able to identify a clone in our library (clone no. 93) that could complement not only *A. brasilense* RGC2 (a mutant which could not express any fru-enzymes) but also *A. brasilense* RG C7 (defective in enzyme II synthesis) and *A. brasilense* RG C17 (pleiotropic mutant in the utilization of all carbohydrates). The plasmid pLAFRI-insert 93 was isolated from the complemented strain of *A. brasilense* RG C2, and *E. coli* 17.1 strain was transformed with the plasmid

DNA. The conjugative plasmid pLAFRI—insert 93 in *E. coli* 17-1 (the new construct) could again complement by its conjugal transfer to *A. brasilense* RG C2 for its defect in fructose utilization. The loci of *fru* operon and/or regulon in the insert 93 are now being investigated by Tn5 insertion mutagenesis.

(c) Identification of *ntr* (nitrogen regulatory) genes from the genomic library of *A. brasilense* : Previously we reported the isolation of a number of Ntr phenotypic mutants of *A. brasilense* in order to manipulate the regulatory genes to enhance nitrogen fixation. As the library was constructed in *E. coli* 17−1 which has integrated RP4 plasmid with *tra* genes and because we used pLAFRI as cosmid vector, it could be possible to identify clones in the library with insert of *ntr* genes of *A. brasilense* by complementation test. For the test we used Ntr defective *A. brasilense* as recipient and the *E. coli* 17−I (pLAFRI-insert) library as donor. Out of 200 clones from the library tested, only one could complement the nitrogen fixation defect of the mutant *A. brasilense* RGN12. From the complemented strain the plasmed pLAFRI-insert C6 was isolated (approx 22-23 kb) and tetested for its ability to complement the defects of *A. brasilense* RGN12 and *A. brasilense* RG747 after conjugal transfer of the plasmid in the usual way. Nitrogen fixation defect of both the mutants was abolished on acquiring pLAFRI-insert C6. We are in the process of identifying the loci of *ntr* genes in pLAFRI-insert C6 by Tn5 insertion mutagenesis.

Institutional Project No. III : Studies on structure, function and dynamics of biomolecules.

10. *Studies on highly repeated fish DNA* : U. Datta and R. K. Mandal (Supervisor).

The cloning and sequencing of highly repetitive 245 bp DNA from the common carp *Cyprinus carpio* were previously reported. The presence of this 245 bp repeat sequence has been studied in different fishes by Southern hybridization experiment using ^{32}P labeled pCchr-3 as a probe. Under the hybridization condition a ladder pattern of *Hind*III fragments similar to that of the *Cyprinus* was obtained from two carp fishes (*Hypophalmicthys molitrix* and *Catla catla*) and two catfishes (*Heteropneustes fossilis* and *Clarias batrachus*). Again any hybridization with this probe was absent in a catfish, *Mystus vitatus* and in a salt tolerent fish *Anabas testudineus*. This observation suggests that the fish repetitive DNA can be used as a marker to follow the evolutionary relationship among various species.

As an approach to know the minium size of the cluster of 245 bp tandem

repeat, the *Cyprinus* genomic DNA was resolved by a pulse field agarose electrophoresis after digestion with *EcoRI* and *BamHI* which do not recognize any site in the repeats. The largest *EcoRI* and *BamHI* DNA fragments (comigrating with 50 Kb uncut λ monomer) were eluted from the agarose gel. The eluted DNA fragments were redigested with *Hind*III and Southern hybridized along with the *Cyprinus* DNA digested with *Hind*III using labeled pCchr-3 as a probe. Southern hybridization result clearly indicates that the monomeric units of 245 bp are tandemly arranged in a cluster of at least 50 Kb size. Attempt to localize the repeated DNA in *Cyprinus* chromosomes by *in situ* hybridization is being made.

11. *Studies on a super killer (sk) mutant of bacteriophage lambda* : S. Maity and N. C. Mandal (Supervisor).

Earlier it was shown that a mutant of bacteriophage λ having a mutation (*sk* mutation) around *nut*R-*t*RI region causes host killing in absence of *N* gene function. This was shown to be due to increased expression of a gene or genes downstream of *t*RI-under N^- condition of the phage in presence of the above mutation. Studies with the clones carrying the segment of λ DNA containing rex, cI, cro, cII, O and P genes and half of cI, cro, cII and half of *O* gene and Pgene respectively from the above killer mutant and the wild type phage and with BglII deletion mutants of those plasmids indicate that the sk mutation causes the host killing possibly by increasing the expression of *P* gene and/or a gene located after that but not beyond *nin5*.

An attempt is being made to know (a) the mechanism by which *sk* mutation causes increased expression of the downstream genes and (b) to locate which particular gene is involved in such host killing and (c) to establish phage—host interaction at the molecular level which results in the above host killing.

12. *Studies on the high-affinity mutant repressor of bacteriophage lambda* : Rina Saha, B. Bhattacharyya, S. Roy and N. C. Mandal (Supervisor).

It was reported earlier that when the high-affinity mutant *c*I gene of lambda was cloned in multicopy plasmid and then a lacuv5 promoter was placed upstream of the above gene, the intracellular level of the repressor could not be increased beyond 15 times that in a monolysogen. So to increase the expression of cIha for preparative purposes, an attempt is being made to subclone this gene into the plasmid pEA305 (in this plasmid the expression of the wild type cI gene of lambda is under the control of *tac* promoter, and after IPTG induction of such clone, the above repressor

could be syntheisized to the extent of 30% of the total cellular protein) by replacing the segment of *c*I gene bounded by NsiI and BclI sites in pEA305 by the same segment containing the *ha* mutation from pMD102.

13. *Studies on structure, function and dynamics of λ repressor* : Rina Saha, N. C. Mandal, S. Roy and B. Bhattacharyya (Supervisor).

The repressor of bacteriophage λ is a very well studied DNA binding protein. The active form of this repressor is a dimer of a single chain acidic protein consisting of 236 amino acids, and containing 2 nearly equal size domains (namely N and C terminal domains) connected by a string of 40 amino acids. The N-terminal domain binds the operator DNA while the C-terminal domain play important role in protein-protein interactions which include cooperative binding and long range interaction. It is not known whether there occurs any conformational change or interdomain communication within the repressor molecule following its binding with operator DNA. Bis-ANS is an external fluorescent probe whose fluorescent characteristic is influenced by the hydrophobicity of the macromolecule it interacts. For this reason Bis-ANS was chosen to study the above mentioned properties of λ repressor molecule. We have found that energy transfer between trp residue of λ-repressor and bound Bis-ANS leads to quenching of the intrinsic *trp* fluorescence. The quenching is biphasic implying 2 types of binding sites. The estimated kd value for high affinity site is about 5 uM. The energy transfer data indicates that the high affinity Bis-ANS binding site is localised within C-terminal domain, because all the 3 *trp* residues present in λ-repressor (known from amino acid sequence) are known to be situated within this domain. When Bis-ANS repressor complex is subjected to proteolytic digestion with trypsin, there is still energy transfer which also precisely indicates that Bis binding takes place within the C-terminal domain. We have also found enhancement of Bis-ANS fluorescence when repressor Bis-ANS complex interacts with the operator DNA which indicates that there is either some interdomain communication or conformational change taking place within the repressor molecule following DNA binding.

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

Controlled proteolysis of goat brain tubulin by subtilisin was carried out to investigate regulatory aspects of the binding of colchicine to tubulin. Tubulin S,

obtained by the cleavage of the carboxyl termini 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 pH of 6.8, becomes independent of pH (in the range 5.7 to 8.0), (b) the colchicine binding site, which is labile at 37°C ($t_{\frac{1}{2}}$ = 4 to 5 h), becomes highly stable ($t_{\frac{1}{2}}$ > 12 h), (c) the affinity for colchicine is lowered and (d) this lowering of affinity arises from a faster dissociation (higher off rate) of the complex. The above characteristics of tubulin S were not shown by a partially digested hybrid in which the C-terminus of the beta subunit alone was cleaved. The hybrid behaved very 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-terminus of the alpha subunit of tubulin.

Possibilities of the C-termini being involved in nonbonded contacts with the main body of tubulin are also noticed from the change in conformation between tubulin and tubulin S.

15. *Physicochemical characterization of tubulin isolated from Mimosa pudica :* Asis Roychaudhuri and Susweta Biswas (Supervisor).

Sensitive plant *Mimosa pudica* tubulin isolated from callus cells as well as from leaflets is unique regarding some of their biological properties like colchicine binding, polymerizazation, isoelectric point etc. We have polymerized tubulin from both callus cells and leaflets by self-induction as well as by taxo linduction. By electron microscopic study, we have found uniform structure of microtubule having 13 protofilaments in self assembled microtubule, the number of protofilaments vary in the microtubule induced by taxol and as a result the uniformity of microtubular structure is lost. We have also studied the effect of pH and Zn on polymerization. In both cases, different types of sheet like structures are formed as observed by electron microscopy. We also found that self assembled microtubule of *M. pudica* tubulin is cold resistant whereas the brain tubulin assembled microtubule is cold sensitive. It has also been found that the polymerization of tubulin is lowered through modification of free -SH groups by N-ethyl malemide.

16. *DNA replication in the yeast Saccharomyces cerevisiae :* Alo Pal, Amit Maity and Pratima Sinha (Supervisor).

We are identifying the genes needed for the initiation of DNA replication

in the yeast *S. cerevisiae*. In this respect a number of chromosomal mutants defective in the maintenance of yeast minichromosomes were isolated earlier. The rationale was that some of these mutants (*mcm*) might not initiate replication at yeast replication origins cloned on the minichromosomes, thus destabilising them.

One of the mutants, *mcm2*, was further characterised. This mutant is defective in the maintenance of minichromosomes depending upon the *ARS* (putative yeast rep. origin) cloned on it. It was found that the stability of a 60 kb chromosome can be increased in this mutant if an additional *ARS* is cloned in this chromosome, thereby implying that the instability of chromosomes is due to the lack of functional *ARSs* in this mutant. Yeast DNA has also been fractionated by Pulsed Field Gel Electrophoresis and the 60 kb chromosome has been isolated. Work is in progress to clone *ARSs* from this DNA and delete them from this chromosome. If *mcm2* indeed responds to *ARS* function one would expect the stability of this 60 kb chromosome to go down in the mutant.

Suppressors of *mcm2* have been isolated. We are identifying extragenic suppressors which should define other loci whose products interact with that of the *mcm2* gene product to form an initiation complex.

Preliminary experiments show that *mcm2* which was earlier shown to cause hyper-recombinogencity also causes enhanced sensitivity to kill.ng by ultraviolet radiation as compared to the wild-type.

17. *RP4 specific beta-lactamase : Lack of its expression in Azospirillum brasilense :* Sib Hari Datta and Sudhamoy Ghosh (Supervisor).

Because of our interest in the bacterium *A. brasilense*, we investigated an abnormal expression of Ampicillin (Am) resistance properties in the bacterium. We observed that when the broad host range plasmid RP4 is transferred by conjugation from *E coli* to *A. brasilense* RG (Wild type), the plasmid's beta-lactamse activity is not expressed at all in the later host. Beta-lactamase activities of *A. brasilense* RG and *A. brasilense* RG (RP4) in their crude extracts were practically the same, 0.21 and 0.20 unit/mg protein respectively, where as *E. coli* J53 (RP4) showed an activity of 12.4 units/mg protein. We did not observe any abnormal expression of other drug resistance properties of RP4 in *A. brasilense* RG ; for example Tetracyclin (Tc) and Kanamycin (Km) sensitive wild type RG strain become Tc^R and Km^R when RP4 is conjugally transferred into the bacterium from *E. coli*. In

order to prove more convincingly that *bla* gene of RP4 can not express in *A. brasilense* RG(RP4), we had to eliminate chromosomal *bla* gene activity of *A. brasilense* (RG). A mutant was isolated named *A. brasilense* RG D16 that showed practically no B-lactamase activity (0.002 units/mg protein) and was extremely sensitive to Am (MIC value of Ampicillin : 500 and <5 ug/ml for RG and RG D16 strains respectively). As expected RG D16 (RP4) strain was also extremely sensitive to Am and showed beta-lactamase activity in crude extracts about 0.002 unit/mg protein. This clearly indicates that *A. brasilense* can express its own *bla* gene and loose this property when the gene is mutated, but the bacterium is completely unable to express TEM-2 type enzyme encoded in *bla* gene of RP4.

18. *Cloning of Repetitive DNAs from farm Animals* : G. Faruk and P. Gupta (Supervisor).

Total genomic DNA was isolated from different tissues e.g. liver, kindey and testis of several individuals belonging to two locally available breeds of goat viz., Jamnapari and Black Bengal. Goat genomic DNA was digested with restriction endonucleases Hind III and EcoRI. Upon agarose gel electrophoresis and ethidium bromide staining of the gels loaded with DNA after complete digestion with EcoRI revealed a discrete band around 875 bp size. Partially digested RI DNAs showed multiple bands of increasing sizes indicating the presence of multimers of 875 bp long repeated DNA. DNA from 875bp region was eluted from low melting agarose and cloned directly in the RI site of M13 mp 18 A portion of the eluted DNA fragment was radiolabelled with 32P dCTP and used for screening the repetitive DNA containing plaques on the lawn of E. coli JM101. Five such repetitive DNA clones were identified and one of them is being sequenced following Sanger's dideoxy chain termination method. Similarily, a repetitive DNA fragment of 1.2 kb size has been identified by Sau 3A digestion of pig DNA. This fragment has been successfully cloned in M13 mp 18 BamH1 site and is also being sequenced.

19. *Chromosomal localization of Genes on Fish chromosomes :* K. Roy and P. Gupta (Supervisor).

Technique of in situ hybridization has been successfully standardized by using G6PD probes on Drosophila polytene chromosomes. Chromosomal preparation from different species Indian carps has been used for localization of two genes viz.,i) Hind-III repeated DNA isolated from *Cyprinus carpio* pCChr3 (Datta et al., 1988)

and the ribosomal DNA clone from *Heteropneutes fossilis* pHfr18 (Dasgupta et al., 1989). Results of these experiments are carefully being monitored. Further, in order to characterize individual chromosomes of various carps restriction endouuclease banding technique are being attempted.

Institutional Project No. IV : Studies on ecology, environmental pollution and related health problems.

20. *Studies with scorpion venom* : Asitava Basu and Sudhamoy Ghose (Supervisor)

The venom of scorpion *H. swammerdami* consists of several toxic and nontoxic protein constituents. It was found that both the dialysable and nondialysable fractions of lyophilised venom of this scorpion contained insect toxic activity. The toxins present in the dialysable fraction were isolated by preparative gel electrophoresis. Among them, fraction-I, the slowest moving protein band was found to be most toxic. Further electrophoresis of this fraction on PAGE confirmed that the protein was homogeneous, but SDS-PAGE of this fraction showed two bands one major and the other minor of molecular masses of 6,400 D and 6,100 D respectively. Further purification of the fraction-I by ion-exchange chromatography showed two peaks. Among them, the protein passing out in flow-through showed insect toxic activity at a dose of 1 ug/larvae. The protein is thermostable. Apart from the toxic activity of the venom it was found that crude venom caused acceleration of puparium formation of silk-worm larvae by 1-2 days as compared with normal.

Institutional Project No. V : Studies on microbes and parasites for industrial and medical application.

21. *Characterization of chromatin in Entamoeba* : Bidyut Ghosh and R. K. Mandal (Supervisor).

The nuclear basic proteins were isolated from *Entamoeba histolytica* chromatin which were found to be of higher molecular weight than that of other eukaryotic chromosomal basic proteins (histones). Micrococcal nuclease digestion of *Entamoeba* nuclei and subsequent agarose gel electrophoresis of the isolated DNA revealed the presence of distinct ladder pattern, and complete digestion yielded distinct bands at the 200-250 bp region. This is indicative of general eukaryotic chromatin organisational pattern. Micrococcal nuclease digestion also reveals that some part of *Entamoeba* DNA may be micrococcal nuclease resistant as evidenced by the presence of two sharp

bands around the 400 bp region in all samples of DNA prepared following the nuclease digestion of *Entamoeba* nuclei.

22. *Molecular Biology of Entamoeba histolytica : Organization and Characterization of the genome* : Anuradha Lohia, Nezam Haider & B. B. Biswas (Supervisor).

(A) A genomic library of *E. histolytica* NIH : 200, had been constructed previously in the yeast shuttle vector Y1P5. Fifteen recombinant clones had been selected. These clones were tested for "autonomously replicating sequence" (ARS) activity in *Saccharomyces cerevisiae*. Clone P2 was found to contain weak ARS activity in yeast. It was further subcloned in M13mp18 and m13mp19 and sequenced by Sanger's dideoxy chain termination method. About 1400 bp of the insert were sequenced and found to contain several tandem repeats of different sizes, ranging from 6 bp to 18 bp repeats. No open reading frame could be detected and no hybridization was detected with total Entamoeba RNA. Further characterization of the ARS sequence is in progress.

(B) The heat shock response was studied in *E. histolytica* and two new protein bands of 70 k and 18 k sizes were detected on SDS-PAGE after heat shock of the parasite at 43 c. Isolation of heat shock genes from the parasite is being carried out by screening genomic libraries of *E. histolytica*.

F. BIOPHYSICS

Institutional Project No. III : Investigation on the structure function & dynamics of Biomolecules.

In tune with the major objective of the Department, we have devoted attention both to understand model (a) Structural conformation & interaction mechanisms of biomacromolecules like proteins, nucleic acids and protein-nucleic acid interactions in general for defined and random sequence systems and in specific systems like (b) Plant protease Calotropin DII, (c) DNA binding protein, lamda repressor ; and a RNA binding enzyme, (d) glutaminyl tRNA synthetase by biophysical and biochemical processes. Besides experimental methodologies, we are also investigating Protein-DNA, drug DNA mechanisms via modelling and computer simulation specially bio-critical phenomena like phase transition in molecular biology.

1. *Studies on fundamentals of a few chemotherapeutic drugs at molecular level* : Goutam Biswas, A. Gomes, R. Banerjee (Jadavpur University collaboration) and Asok Banerjee (Supervisor).

The objective of this research is to identify structural & conformational features of a typical nucleoside series and a β-lactam series with antiviral, antibacterial activities and inactivities and get a correlation, if possible, in their structure-function.

A critical comparative database of the two series have been done and understanding in the interaction mechanism of these potential drugs and non-potential compounds in the same series is progressing. The interaction mechanism of potential AIDS drug AZT (Azidothymidine) in vivo is understood. As a further measure, physical testing of known antiviral drugs which are currently being used is taken into consideration & as a control, we shall be taking chemotherapeutic agents and number of antibiotics without antiviral activity. Good progress has been done (see publication list) and attempt is underway to draw a rational correlation and conclusion in structure function area in biology.

2. *Studies on specific drug-DNA complexes with planar & nonplanar drugs* : Bankim Das, A. Gomes, B. Das (Vivekananda College collaboration) and Asok Banerjee.

Studies on drug DNA complexes are augmented. The molecular modelling have

been done for planar and nonplaner drugs interacting with DNA via computer & space filling models. Results of studies both from solution and semisolid states achieved from spectroscopic techniques (UV & CD), fibre diffraction and space filling models for specific drug-DNA complexes and are being tabulated with an objective to form a database to rationalise a conclusion.

3. *Experimental and theoretical biology of critical biomolecular phenomena/nucleic acid, protein and nucleic acid protien interaction* :

(a) *DNA transition characteristics* : Bankim Das, Albert Gomes, B. Das, G. Biswas & Asok Banerjee.

The fundamental role and rule for the Watson-Crick & Hoogsteen base pairs in the transition topology of DNA is highlighted & reported. Further work is in progress to visualire B↔Z transition topology.

(b) *Protein characterisation/Singh crystallography* : Bankim Das, G. Biswas, B. Das, A. Gomes, N. K. Sinha (Chemistry), S. Biswas (Biochemistry) and Asok Banerjee.

A plant protease calotropin DII is crystallized. Photographs show good single crystals, monoclinic cell with resolution of 4.0 A°. Crystallization condition, technique improvement is continuing in collaboration with Chemistry Department for better resolution and data collection.

Set up for characterisation & crystallization of another Ca^{2+} insensitive actine binding protein of plant origin is underway in collaboration with Biochemistry Department.

4. (a) *Studies on cI repressor of Bacteriophage lambda and its interaction with operator DNA* : Utpal Banik, Rina Saha (Biochemistry), B. Bhattacharyya (Biochemistry), N. C. Mondal (Biochemistry) and Siddhartha Roy.

Lambda repressor-operator interaction has been chosen as a model system for studing protein-DNA and protein-protein interaction. We have used fluorescence probe to investigate dynamics of protein-DNA interaction. We have also used fluorescence energy tranfer studies to measure distances between protein sites. Several interesting conclusions have been drawn (i) Contrary to the previous hypothesis, N-terminal arm does not play any role in DNA binding, (ii) Apart from

the two established domains, there may be a third domain like structure, (iii) there is a major conformational change in the protein upon DNA binding which transmitted from N-terminus to C-terminus.

(b) *Mapping of active sites of glutamine tRNA Synthesis* : Anusree Bhattacharyya, Tista Bhattacharyya and Siddhartha Roy.

Glutamine tRNA synthelase have been purified to homogeneity from an over-producing E. Coli strain. We have studied reactivities of thiol residues in this enzyme using Dithiobis-2 nitro-benzoic acid.

(c) *NMR study of DNA structure and bending of DNA* : Siddhartha Roy (In collaboration with Prof. A. Banerjee ; University of Calcutta).

We are studying various synthetic oligonucleotides for their ability to undergo B-Z transition and B-Hairpin loop transition by NMR and CD. We are also developing synthetic methods to regiospecifically label oligo nucleotides with stable isotopes.

G. ANIMAL PHYSIOLOGY

Institutional Project No. IV : Studies on Ecology, Environmental Pollution and Related Health Problems.

1. Environmental Physiology and Hormonal Regulation.

(i) *Thyroid hormone status and enzyme systems in brain of Singi fish (Heteropneustes fossilis Bloch)* : Srabani De and A. K. Medda (Supervisor).

The changes in the activities of several enzymes, viz., ion-dependent ATPases cytosolic malic enzyme, mitochondrial ∝-glycerophosphate dehydrogenase, RNase, DNase, acetylcholine esterase, etc., after the administration of triiodothyronine (T_3) and also in hypothyroid condition (caused by thiourea treatment) are under investigations. The alterations in Na^+K^+-ATPase and Mg^{++}-ATPase system in different subcellular fractions are presented in this report.

The Na^+K^+-ATPase activity was detected in mitochondrial and microsomal fraction. But there was no detectable amount of this enzyme in cytosolic fraction. Microsomal Na^+K^+-ATPase was found to be enhanced with various doses of T_3 (0.012, 0.025, 0.05 and 0.10 μg/g, three injections). Mitochondrial Na^+K^+-ATPase activity was also increased with these doses of T_3, except 0.012. It appeared that mitochondrial Na^+K^+-ATPase was less susceptible than microsomal Na^+K^+-ATPase.

The Mg^{++}-ATPase activity was detected in mitochondrial, microsomal and cytosolic fractions. The mitochondrial Mg^{++}-ATPase increased with T_3 (0.025, 0.05 and 0.10 μg/g, three injections). The lower dose of 0.012 μg/g was ineffective in this respect. The microsomal and cytosolic Mg^{++}-ATPase activity was not changed by T_3.

The thiourea-treated hypothyroid fish showed reduced Na^+K^+-ATPase activity in microsomal and mitochondrial fraction and also reduced Mg^{++}-ATPase activity in only mitochondrial fraction. This reduced ATPases activities could be restored to the normal level by T_3 treatment.

(ii) *In vitro demonstration of putative nuclear 3, 5, 3, triiodothyronine receptors in isolated liver nuclei of Singi fish, Heteropneustes fossilis (Bloch)* : A. K. Dasmahapatra, A. K. Ray and A. K. Medda.

Putative thyroid hormone receptors have been demonstrated in the isolated liver nuclei of Singi fish, *Heteropneustes fossilis* (Bloch), and their binding characteristics have been examined. Nuclear T_3 saturation analyses were carried out *in vitro* at 27°. After incubation the bound and free hormones were separated by centrifugation and the nuclei were treated with Triton-X-100 (final concentration 0.25%) to reduce the non-specific binding. The binding was saturable and reached equilibrium by 20 minutes of incubation and was also stable for 2 hours. The binding was reversible and the rate of dissociation was more or less equal to the rate of association. The binding was linearly increased with the increased concentrations of the DNA (nuclei). Scatchard analyses of the equilibrium binding data revealed that only one class of binding sites for T_3 did exist in the hepatic nuclei of Singi fish. The affinity of these sites or the mean dissociation constant ($Kd = 0.1987 \pm 0.071 \times 10^{-10}$M) and the mean maximum binding capacity (MBC = 0.1689±0.042 pmol/mg.DNA) were in reasonable agreement with the values reported for other teleost fishes.

(iii) *Increase in triiodothyronine binding sites in hepatic nuclei of rabbit during thyroglobulin immunity* : A. K. Dasmahapatra, Subhra Lahiri and A. K. Medda (Supervisor).

In order to investigate the effect of thyroglobulin immunity on thyroid hormone-receptor interplay in rabbit, attempts were made to study the status of triiodothyronine binding sites in the hepatic nuclei in immunized state. It was observed from the Scatchard analysis of the *in vitro* binding of triiodothyronine to the isolated hepatic nuclei of rabbit that only one class of binding site did exist and the maximum binding capacity was increased in immunized rabbit in comparison to the control on 98th day of immunization, but the equilibrium dissociation constant remained unaltered. The significance of this increase in maximum binding capacity in immunized rabbit was unknown. It might be due to the increase in the half life of hepatic thyroid hormone receptor due to less availability of the circulating thyroid hormone.

(iv) *Responsiveness of adult toad to thyroid hormone* : Shyam Sundar Dey and A. K. Medda (Supervisor).

In continuation of the study on the responsiveness of toad liver to thyroid hormone with respect to the changes in thyroid hormone-specific enzyme systems, the present report deals with the thyroid hormone-induced changes in the activity of mitochondrial ∝-glycerophosphate dehydrogenase (∝-GPD) and mitochondrial protein content of liver, muscle and brain of adult toad, *Bufo melanostictus*. Both triiodothyronine (T_3) and thyroxine (T_4) have a marked stimulatory influence on the activity of mitochondrial ∝-GPD in liver and muscle. But brain did not show any alteration

in enzyme activity with T_3 and T_4. Muscle ∝-GPD underwent greater stimulation than liver ∝-GPD with T_3 and T_4. T_3 appeared to be more potent than T_4 and the minimum effective dose of T_3 for enzyme induction was found to be 0.1 μg/g while that of T_4 was 0.25 μg/g. The mitochondrial protein content of liver and muscle also increased with T_3 and T_4. The enzyme induction and enhancement of mitochondrial protein content could be inhibited by cycloheximide. That T_4 is a prohormone was also demonstrated by treatment with propylthiouracil (PTU), which blocked the conversion of biologically inactive thyroxine to biologically potent triiodothyronine, leading to no enzyme induction in thyroxine+propylthiouracil treated toads.

(v) *Involvement of sex steroids in the cyclic adenosine monophosphate second messenger system in brain of Singi fish :* Madhumita Ghosh and A. K. Medda (Supervisor).

In continuation of our studies on the estrogen action on brain of Singi fish investigations were made to understand the involvement of estrogen in the adenyl cyclase activity and cyclic adenosine monophosphate (cAMP) production, if any, in triggering the hormonal action. Injections of estrogen (4 μg/g) and progesterone (8μg/g) for three consecutive days caused a fall in the adenyl cyclase activity in the crude homogenate preparation of Singi fish brain. Corresponding decrease in the cAMP content in brain was also observed after estrogen and progesterone treatments. An inhibition of the cAMP second messenger system after estrogen and progesterone treatments was thus documented in the present experiment, but it needs further verification at different conditions.

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

In order to evolve means for induced breeding in freshwater prawn throughout the year, regulation of gonadal activity is under investigation as initial steps. Although estrogenic compounds have been detected in freshwater prawns the physiologic role of these compounds are not known. In order to understand the involvement of estrogenic compounds in the control of gonadal maturation and the changes in different organs, effects of injections of various doses of estrogen on the alterations in different cellular constituents in muscle and hepatopancreas, a key organ for synthesis of vitellogenin, have been investigated.

Three consecutive injections of estrogen at 1 μg/g caused increase in RNA

contents in hepatopancreas and muscle. Injections of higher dose of estrogen (2μg/g) effected to further increase in RNA and protein contents in both hepatopancreas and muscle.

A rise in the Na^+K^+-ATPase activity was observed in hepatopancreas after injections of different doses (1, 2 and 4 μg/g) of estrogen. Mg^{2+}-ATPase activity was stimulated in hepatopancreas only with higher dose (4 μg/g) of estrogen. Haemolymph protein content also increased after treatments with estrogen.

(vii) *Induction of enzyme system in brain of Singi fish by cyanocobalamin :* Uma Bhattacharya and A. K. Medda (Supervisor).

The changes in enzyme systems, viz., mitochondrial ∝-glycerophosphate dehydrogenase (∝-GPD), cytosolic malic enzyme, acetylcholine esterase, etc., in brain of Singi fish after treatment with cyanocobalamin are under investigations. The mitochondrial ∝-GPD activity increased after cyanocobalamin injection. The mitochondrial protein content of fish brain tended to increase with cyanocobalamin, but this was not significant. The induced enzyme activity was inhibited by cycloheximide treatment.

(viii) *Effect of lead, zinc. mercury and copper with and without estrogen on serum vitellogenin level in Magur fish (Clarias batrachus* L.) : Abhijit Panigrahi, A. K. Dasmahapatra and A. K. Medda (Supervisor).

The deleterious effect of some heavy metals was examined with an important physiological parameter, say vitellogenin synthesis, in Magur fish. Estrogen, which is known to induce vitellogenin synthesis in liver of fish was also used with the heavy metals. Injection(s) of lead, zinc and mercuric acetate decreased the serum vitellogenin content in Magur fish, while cupric acetate failed to cause any change in the vitellogenin level. Estrogen injections increased the serum vitellogenin level in normal and copper salt treated fish, but were totally ineffective in altering the reduced vitellogenin content in lead, zinc and mercury salts treated fish. Vitellogenin level almost restored to normal level at six week in lead, zinc and mercury treated fish, and estrogen injections on days 37, 38 and 39 enhanced the serum vitellogenin content in all groups.

(ix) *Effect of thyroxine and cyanocobalamin on phenylhydrazine-hydrochloride-induced changes in blood picture in rat :* Mitali Pramanik and A. K. Medda (Supervisor).

In order to investigate the phenylhydrazine hydrochloride-thyroxine-cyanocobalamin interactions, rats were injected with different doses of phenylhydrazine

hydrochloride (5, 7.5 and 10 μg/g, three consecutive days injections) with and without thyroxine (1, 2 μg/g) and cyanocobalamin (10 μg/g). Phenylhydrazine hydrochloride markedly reduced the the RBC count and haemoglobin content. The PCV and MCHC was also decreased. But MCV increased, MCH remained unchanged. Thyroxine was found to have a protective action on the hemolysis induced by phenylhydrazine hydrochloride (10 μg/g). The reduction of RBC count and haemoglobin content was not so marked in the animals injected with phenylhydrazine hydrochloride + thyroxine in comparison to that induced by phenylhydrazine hydrochloride alone. Other erythropoietic stimulant, viz,, cyanocobalamin, when given with phenylhydrazine hydrochloride (10 μg/g) had similar effect.

(x) *Studies on the interaction between pesticides, commonly used in agriculture, and freshwater fish :* Rama Ghosh.

(a) *Determination of LC_{50} value of carbofuran* 75 DB *technical on catfish, Clarias batrachus* (*Linn.*) and *Heteropneustes fossilis* (Bl.).

Healthy fishes weighing between 15-20g, collected from local market, were acclimatized in laboratory conditions for 15 days prior to the experiment. For the determination of LC_{50} value of carbofuran (tech.), a batch of 10 acclimatized fish was exposed to different concentrations of carbofuran for 96h at 25°C and the number of fishes died were counted.

The preliminary results show that the LC_{50} value (50% mortality) of this pesticide (a) on magur fish (*Clarias batrachus*) was found to be 2.39 ppm and (b) on Singi fish (*Heteropneustes fossilis*) was 3.5 ppm.

Higher mortality rate was observed with increase in the temperature of environmental water. Further work is in progress.

(b) *Extraction and purification of carbofuran from commercial preparation.*

Pure carbofuran is required as standard in the present study. This is not available in the market. So carbofuran was extracted and purified from commercial preparation (Carbofuran 75 DB technical) which was kindly gifted by Rallis India Ltd., Bangalore-560058. The light brown solid material was washed with double distilled water several times until a white powder was obtained. This was recrystalised treating with warm acetone. The crystalline material was washed with chilled acetone and dried in vacuum. The purity of the material was checked by melting point determination.

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

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

Estrogen has been detected in silkworms but its physiologic role in these insects is totally unclear. In order to understand whether estrogen plays a role in gonadal development and breeding in silkworms, changes in some cellular constituents in fat body (a key organ for vitellogenin synthesis) and ovary have been investigated after estrogen treatments as the initial steps.

Two injections of estrogen (1.5, 2μg/g) showed an increase in RNA and protein contents in both fat body and gonads. Higher dose of estrogen at 4 μg/g caused significant fall in protein contents of these organs. A marked rise in haemolymph protein content was observed after inter injection of estrogen at 1.5 μg/g.

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

(*a*) *Variations of protein and cholesterol content of haemolymph plasma of male and female Antheraea mylitta D. during diapause* (*pre-pupa to 90 day old pupa*).

The female *A. militta* D. pupa always maintained higher protein level in the haemolymph plasma than the male pupa. The protein level gradually decreased in both sexes from pre-pupal stage to 30 day old pupa. There after, an increase in protein content at 60 day and more markedly at 90 day old pupa was found.

As in case of protein, the female *A. mylitta* had higher cholesterol level in haemolymph than the male pupa. The cholesterol level gradually increased with the advancement of stages and reached to a maximum on day 90. It seemed that the rise in protein content is possibly contributed by the fat body for temporary storage in the haemolymph. The higher cholesterol level together with the increased protein content is supposed to be required for overall growth and development of pupa.

(*b*) *Variations of protein, RNA, DNA and cholesterol content of fat body of male and female A. mylitta D. during diapause* (*pre-pupa to 90 day old pupa*).

The fat body of female *A. mylitta* appeared to be a more active protein synthesizing organ than that of the male. This was evident from higher protein level in female fat body. Although some accumulation of fat body protein occurred

in both sexes during early pupal stage, the fat body protein content gradually decreased, afterwards, as observed on days 60 and 90. The RNA content of fat body in both sexes declined during the early pupal stages upto day 30 after which it gradually increased. The fat body DNA content of male *A. mylitta* pupa decreased from day 30 which became more marked at days 60 and 90. In female, an increase in fat body DNA content was noted on day 90.

The fat body cholesterol level markedly reduced during larval-pupal transformation in both male and female *A. mylitta*. The female pupa-showed more fat body cholesterol content from pre-pupal stage to 15 day old pupa. Surprisingly, the cholesterol content increased about 364-fold from the day 30 and this enhanced level was maintained upto day 90.

(*c*) *Variations of weight, and protein, RNA, DNA and cholesterol contents of testis and ovary of A. mylitta D. during diapause (pre-pupa to 90 days old pupa*).

During the period from pre-pupal stage to 90 day old pupa, the testis weight was higher than that of ovary. The less ovarian weight was due to no formation of ovariole. There was enhancement of protein content in both testis and ovary, testis showed higher value than ovary, except on days 60 and 90 when ovary swowed marked increase in protein content in comparison to testicular protein. The RNA content was higher in ovary than that in testis. With the advancement of pupal age, the ovarian RNA content steadily increased upto day 90 of the pupal development. This was also true in case of testis. The DNA level at larval-pupal transformation increased from 60μg to 260 μg/100 mg tissue in testis at day 90 and from 49 at 0 day to 775 μg/100mg tissue at day 90 in ovary. All these changes in protein and nucleic acids are supposed to be due to rapid preparations for the formation of eggs or sperms.

Cholesterol content of testis and ovary followed a stage-specific variations like other cellular components during the pupal development. With the advancement of pupal stages, the cholesterol centent of testis or ovary gradually increased and became maximum at day 60 or 90. The increase in cholesterol content was very sharp at day 60 in both the gonads.

H. PLANT MOLECULAR & CELLULAR GENETICS

Institutional Project : Crop improvement through use of modern biological techniques.

1. *Desirable variants of Costus speciosus through embryo culture* : Archana Roy and Amita Pal (Supervisor).

In continuation with the earlier investigations on embryo culture of *Costus speciosus* to obtain desirable variables with higher diosgenin content, considerable progress has been made. It has been demonstrated that the embryo regenerants are the possible source of variables as envisaged earlier in view of limitations of conventional sexual crossing because seeds are non-viable.

A comparative study of biomass growth rate of the regenerants and their respective donar populations was performed which further suggests importance of embryo culture in *C speciosus*.

(II) *Identification of genetic stability in Poplar regenerants* : Aparajita Mitra and Amita Pal (Supervisor).

Leaves of Poplar culture regenerants and their donar plants of same physiological age were the experimental materials. The soluble proteins were extracted with the standarized extraction buffer. Both native protein and protein subunit patterns were studied using polyacrylamide gel electrophoresis. The co-efficient of similarity values between the donar and the regenerants were determined which indicate their congruence.

The absence of good phenotypic markers to identify the cultural variants at the juvenile stage especially in tree species demands a reliable screening method to be established. As such isozyme studies are being conducted. Isozymes being the direct gene produce, the minute changes reflects in their zymogram profile and could easily be detected electrophoretically by appearance or disappearance of bands and thus through such study one can rapidly screen the genetic nature of the culture regenerants even from a small amount of tissue.

Various electrode and gel buffers were standarized to study the following

isozymy patterns. The enzyme activity staining for esterases, peroxidases, acid phosphatase produced insoluble chromogenic precipitates on the polyacrylamide gel while superoxide dismutase and aspartate amino-transferase produces achromatic bands. The persistent donar like zymogram signifies genetic stability of the regenerants and variable zymogram indicates genetic variability.

III. *Construction of molecular vehicles for transfer of alien genes to plants :* S. Das, D. Basu and S. K. Sen.

Suitability of *Agrobacterium* plasmid derived vectors often depend upon the mode of the delivery of the transfer DNA that is desired in a given situation. The effectiveness of a vector system depends primarily upon the bacteria-plant interaction, the feasibility of plant regeneration from a single presumptive transformed plant cell and the expression of the reporter gene used as the marker. We had realised that the necessity for construction of vectors exists in order to improve upon the already commercially available of a few vector systems. We have now at hand a series of vectors where the scope for a wide range of choice of border sequences, marker genes for plants and the type of virulence function can be offered to the user. The constructions have been carried out in this laboratory and would be continued as the necessity for a suitable marker gene for a plant system often turn out to be quite tricky looking into the diverse type of plant systems that our crop world possesses. Drug resistance and herbicide resistance genes have been used as markers ; border sequences with or without the overdrive sequences of T-DNA of Ti as well Ri plasmids ; and virulence functions of nopaline, octopine and super virulence of Ti plasmid characteristics as well as that of Ri plasmid form the essential components of such constructions.

IV. *Genetic analysis of the T-DNA transfer process* : S. Das, D. Basu and S. K. Sen.

The conjugative model of T-DNA transfer process as proposed by Stachel and Zambryski (1986) form the guideline of our search for the role of gene product of vir D, function of *mob* and *tra* genes as well as the border sequences and the overdrive in T-DNA transfer system. With various constructs of vector systems, the release of single-stranded endonucleolytic cuts upon induction is monitored against occurrence for transformation without the border sequences. It is believed that certain role of virulence functions will be revealed hitherto unknown in relation to the T-DNA transfer process.

V. *Search for T-DNA genes which influence plant development :* N. S. Banerjee, C. Ganguly, D. Banerjee, D. Basu, S. Das and S. K. Sen.

The socalled oncogenes contained in T-DNA of Ti plasmid as well as Ri-plasmid are known to influence the endogeneous level of auxin-cytokinin level. The role of some of them in IAA pathway and zeatin synthesis is well documented. There are some more such genes the characteristics of which are unknown. We consider along with some other workers that these genes can be quite useful as genetical tool for understanding of plant development as well in manipulation of growth of crop species to advantage for better productivity.

Identification of the product of some of these genes contained in Ri-plasmid is being carried out using appropriate genetical methodologies.

VI. *Transfer of insect resistance gene to crop plants :* D. Basu, A. S. Rishi, S. Das and S. K. Sen.

BT-endotoxin gene have been identified, cloned and restriction mapped for the structural gene component from 4 different strains of *Bacillus thuringiensis*. Their expression against suitable promoters has been monitored in *E. coil* as well as in plant. Assay for a large number of lepidopteran insect pests of jute, chickpea, castor, cotton, mustard and some other crops monitored. The effectiveness of the toxin differ in relation to the pest types. Transfer of such gene into certain crop plants has been achieved and its expression monitored. Advanced trials are underway to evaluate the effectiveness of this feat. A search for similar entomocidal genes effective beyond the lepidopteran insects is being pursued.

Work on isolation of our second candidate for insect resistance gene has been kept in abeyance for a while. The cowpea trypsin inhibitor (CpTI) gene which codes for 19 kd protein is in the pipeline of our future target. The search for a suitable promoter for its use is being continued.

VII. *Standardisation of techniques for transformation of crop plants :* S. R. Sikdar, T. Saha, P. Nayak, T. Johnson, A. S. Rishi, S. Kar, P. Mukherjee, S. Das and S. K. Sen.

In vitro plant regeneration from a single cell/protoplast is the prerequisite for making use of the genetic transformation techniques in vogue. Obviously it calls for induction of somatic embryogenesis as the basis for plant regeneration. Plant regenera-

tion for single plant cell/protoplast has not been an easy proposition in cases other than model systems such as plants like tobacco and carrot. Thus the cell cultural appropriate technique required for diverse crop species is often unknown, yet the necessity remains extremely high. Our progress on that front has been of high order. Transformants have been raised in jute and mustard establishing to the fact that the required methodology for plant regeneration exists. The exogeneous DNA delivery system through infection as well as plasmid uptake has been seen to work judiciously. Progress in rice *Paspalum*, tea chickpea and *Arabidopsis* is close to completion. Additionally, some more tropical crop plants are under active trials. The cell cultural methodology in the laboratory is undergoing tremendous pressure of development to suit to the requirement of genetic transformation and plant generation.

VIII. *Cellular manipulation for genetic engineering of crop plants* : S. R. Sikdar, S. Sen Gupta, P. Nayak, T. Johnson, S. Das and S. K. Sen.

The advanced generations of intergeneric somatic hybrids between *Brassica juncea*+*Diplotaxis muralis* and *B. juncea*+*Eruca sative* are evaluated for their genetic characters.

Cybrids between *B. juncea* and *Polima*, a cytoplasmic male sterile line have been evolved through protoplast fusion. The mt-DNA is being alalysed for the nature of the stability and transmission of the characteristic of the cms mt-DNA of *Polima*.

High plating efficiency of *Indica* rice protoplast has been observed to occur.

Electrofusion and microinjection of rice protoplast are in active state of experimentation.

Direct embryogenesis in case of jute protoplasts has been possible to induce. Plant regeneration from such embryos is yet to be achieved. Since methodologies for transformation and fusion at the protoplast level of jute have been already achieved, the study is poised for a break-through, a goal which has been cherished for so long.

INVESTIGATION NOT INCLUDED UNDER INSTITUTIONAL PROJECTS

1. *Cytotypes of red and black fruit bearing Salanum nigrum and their taxonomic relationship* : Suchitra Banerjee and Amita Pal (Supervisor).

Solanum nigrum is a potentially good source of solasodine, a steroid precursor.

It is generally referred as '*Solanum nigrum Complex*' since it consists of different ploidy levels.

In *S. nigrum*, two fruit colours are commonly seen, i.e. orange red or red and purplish black or bluish black. Dates back from 1933 till now it is believed that a particular ploidy level manifests a specific fruit colour, and that is—the diploids produce purplish black or blue-black fruits. But during the present investigation it has been noted that in each of the red and black fruit bearing groups both diploid and tetraploid cytotypes are existing and the black fruit bearing group even consists of hexaploid cytotypes. This finding suggests that a particular chromosome number does not have any directs relationship with the specific fruit colour, as claimed earlier. Moreover, since the principal identifying characteristics between *S. nigrum* and *S. sarrachoides* (please vide Annual Report B.I. 1987-88) is the fruit colour, the present findings led us to think that the two groups of *S. nigrum* (i.e. red fruit bearing and black fruit bearing) endowed with diploid, tetraploid and hexaploid cytotypes might belong to different varieties, if not to different species. If so, that further complicates the situation leaving it open to find out which group or variety (?) or species (?) is actually being used in the commonly used Ayurvedic medicine and to ascertain whether one or both of them are beneficiary. In this regard a quantitative and qualitative assay of total soluble protein and study of few isozymes was thought desirable which might help us to ascertain their genetic relationship and to assign their respective taxonomical position.

Both SDS and native polyacrylamide gel electrophoretic patters and zymogram studies of isoenzyme viz. peroxidases, esterases, superoxide dismutase, acid phosphatase and ascorbate oxidase through respective enzyme activation reactions of all the cytotypes of *S. nigrum* revealed distinctness of two groups of *S. nigrum*.

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 facilities. The Library is primarily meant for the use of its research staff, but it is frequently used and consulted by many research workers and teaching staff of the seven Universities of West Bengal including STM, Medical College, Indian Institute of Chemical Biology, Central Glass & Ceramic Research Institute, Saha Institute of Nuclear Physics, Indian Institute of Technology (Kharagpur), BHU, BSI, ZSI and other educational organisation and institutions.

The research activities 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 25637 volumes of Books, bound Journals and Maps (16722 Jrs, 8898 Books, 4 Maps & 13 Theses) upto 31.3.89. During the period under report (1988-89) 441 Journals, 300 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 Saturday). 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 published :

A. Annual Report 1987-88 : English and Hindi versions

B. Transaction of the Bose Research Institute

Vol. 49, no. 3 & 4

During this year (1988) 335 permission cards were issued to outside readers and 6,034 readers used the library for reference works.

During 1988-89 thirteen theses from the following Departments were received and duly accessioned in the Thesis Register.

Chemistry	—	8
Botany	—	2
Microbiology	—	2
Tissue Culture	—	1
		13

In 1988-89, 3,222 volumes of Books and Journals were issued to Institute borrowers.

Under Inter-Library loan system 43 volumes of Books and Journals were taken on loan and 97 volumes were issued on the same systems to other educational organisations and Institutions including INSDOC, within Calcutta. Besides, 1346 current loose periodicals were issued on overnight issue system to Institute faculty members.

During the year under report (1988-89) 78917 copies of reprographic services (Xerox) were given to faculty members and staff of the Institute.

Approved budget, for 1988-89 was Rs. 16.00 Lakhs.

WORKSHOP

In order to cope with the pace of scientific development in the Institute, Bose Institute Workshop is actively involved in this challanging 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 under review.

(a) Designing and fabrication of Instruments and gadgets.

1. Tube Gel Apparatus.
2. Slab Gel Electrophoresis Apparatus.
3. T. L. C. applicator.
4. Perpex combs.
5. Circular Electrophoresis apparatue.
6. Microscope chambers.
7. Horizontal Electrophoresis Apparatus,
8. Flesh slicing machine.
9. 4″ × 4″ Gel Electrophoresis Apparatus.
10. Flange for beam extraction from the beamline at VECC.
11. Rectification for Viscometer.
12. Part of the vibrating string Viscometer.

(b) Repair and maintenance of Instruments of laboratories :—

Stabilized regulated power supply units, various type of Centrifuges. The

Gas Chromatorgraphy line repaired very skilfully to restore the instrument in original working order located at the Chemistry Dept. Water bath, various types of shaker, 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.

(c) 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. Necessary repair and maintenance work have been carried out for the Neutron Generator Room of Physics Dept. at the Main Campus. The Capacitor Bank of both the campuses have been successfully maintained through out the year keeping power factor .95-0.99 which has specified as "Unity" as per the regulation of the C. E. SC. and obtained the rebate all through.

(d) Repair and maintenance of air conditioning plants of 4°C cold room and other controlled temperature room coolers, refrigerators and Deep freezes. conversion of water cooling system to aircooling system of 4°C cold room of New Campus has taken up for better performance.

(e) Construction of special furniture and gadgets meant for J. C. Bose Unit and base for Microwave apparatus, Crescograph & Phytograph are under process.

(f) Prepare drawing and ammonia for (i) Mechanical, Electrical and Civil works, rectification of drawing of Hostel Complex has already been done. A full size isometric view of crescograph has been done and donated to Netherlands as per request of J. C. Bose Unit, A full size drawing of Viscometer has been completed.

(ii) Graphs and drawing for thesis, research publications have complied with as per requisitions. Some complicated circuit diagrams have also been done for RSIC.

(g) Renovation and fabrication of the Acharya J. C. Bose's original Instrumants

as well as necessary drawing of Phytograph Instrument have been done. One Crescograph and 2 Microwave apparatus and 2 Phytograph Instruments are under process and expected to be completed at the earliest.

Arrangements of lectures and seminars by providing slide projectors, Overhead Projectors and public address system were made. About 500 Institute's lectures and seminars were attended 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 furniture and also maintained stock books and records of these materials. Kardex system already introduced were utilised fully with inclusion of all store materials.

The work of maintaining Asset Register has been made uptodate with location and serial numbers of the assets and were endorsed by the Central Audit. Accounts of consumble items (purchase, consumption and balance with cost) as required by the Central Audit have been furnished with full satisfaction.

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 Telecome Enterprise at Main Campus and for New Campus, as and when required.

3. Maintenance and regular check up of various Fire Fighting Equipments installed in the Institute.

4. Maintenance and repair of irrigation pumps and Engines at Experimental Station.

REGIONAL SOPHISTICATED INSTRUMENTATION CENTRE

An overall resume of services provided by the Centre for the year 1988-89 is given in the table appended :

The RSIC continued to provide analytical instrumentation services to users in the region.

The FT-NMR installation for liquid sample HR work was completed during the year and trial runs for internal users had commenced. A problem in the floppy disk unit which occured after about six months from the date of such services made the instrument inoperative once again. A new hard disk and floppy disk unit were ordered and these have just arrived. It is expected that routine services in the instrument will commence shortly.

The X-ray Diffractometer was made operational during the year and user services have been and continue to be provided.

Services on solid samples from the Mass Spectrometer were impaired because of a damage in the Solid Introduction Probe. A spare unit is being ordered shortly. Gas and Liquid samples, however, are being analysed.

Problems in the vacuum system of the Transmission Electron Microscope have, during the year, impaired services from the instrument. The local agents who have a service contract on the instrument have not been able to render the required assistance and the manufacturer has been contacted. The problems are expected to be overcome soon.

RESUME OF ACTIVITIES
(From April '88 to March '89)

	Outside user (No. of samples)	*Bose Institute user* (No. of samples)
Mass Spectrometer	31	88
N.M.R.	28	35
X-Ray Diffractometer	6	One
UV-VIS Spectrophotometer	108	714
Liquid Scintillation	1188	619
E.P.R.	131	86
A.AB. Spectrophotometer	215	74
	Time of use (in hrs.)	*Time of use (in hrs.)*
Fluorimeter	106	19
Gas Chromatograph	68	3
S.E.M.	259	133
Prep. Ultracentrifuge	7	438
T.E.M.	90	12

J. C. BOSE UNIT AND MUSEUM

The main task of this Unit is to maintain the original instruments of Acharya J. C. Bose and to make replica of the same. Highlighting the "Life and Works of of Acharya Bose" is also a major assignment of this Unit. As regards work under process, satisfactory progress has been made for the instruments, viz., Compound Lever Crescograph, Microwave Apparatus ane some accessories.

As requested by Birla Industrial & Technological Museum for their new gallery on "Vibration" at Purulia Centre for the supply of a replica of Oscillating Plate Phytograph (invented by Acharya J. C. Bose) the work has been taken up.

One construction diagram of the Compound Lever Crescograph with its technical report and the history of the instrument has been donated to Natherlands on request.

Development of J. C. Bose Museum at Bose Institute is also a major work of the Unit. Exchange programme wiih Visva-Bharati in this regard is in the final stage. The work of highlighting of the major achievements of Acharya J. C. Bose and subsequent achievements of Bose Institute has been undertaken and negotiation with B.I.T.M. for the display of the material is in process.

This Unit actively helped in preparing two films, one for the ELECTRO-TECHNIQUE GALLARY of the National Council of Science Museums on the instruments of Acharya J. C. Bose and the other on "History of Science and Technology on the Indian Subcontinent" (entitled 'Bharat Ki Chhap') by Nehru Centre, Bombay, under the D.S.T. Comet Project and Doordarshan has started telecast of this serial in their National Network Programme.

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)	Anniversary Day	....	30th November, 1988
(2)	Science Day	....	28th February, 1989

Birla Industrial & Technological Museum, Calcutta, is organising an exhibition on "300 Years of Development of Science, Technology and Industry of Calcutta" in connection with the celebration of Tri-Centenary of the City of Calcutta and this Unit is involved in this Programme regarding the Bose Institute and the works of Acharya J. C. Bose.

On invitation the J. C. Bose Unit & Museum demonstrated Acharya Bose's instruments and manuscripts in the exhibition organised by Y. S. Palpara Mahavidya laya, Midnapore, during April 21—22, 1988.

Besides. the J. C. Bose Unit & Museum furnished information, xerox copies of papers and photographs of Acharya J. C. Bose and the Bose Institute to various organisations/eminent persons on request.

REPORT ON COURSE WORK

First cycle of course work completed successfully by February 1989. Most of the scholars completed both core and advanced part of the course work. Based on their evaluation and suggestions from faculty members and the Director, we have made several changes in the second cycle of course work due to start on 11th September, 1989.

The changes include :

(i) Expanding the Methods and Techniques Course.

(ii) Introducing a Computer Course with hands on Training.

(iii) Reducing time devoted to other Core Courses.

(iv) Restructuring the advanced Courses to include Courses on Cell Biology, Biotechnology and Advanced Experimental Techniques.

DIC

1. During the period January 1989 to March 1989, one Junior Information Scientist-I, two Junior Information Scientists-II and one Junior Technical Assistant have joined their posts. Various biosoftwares and related data bases were installed during the period. The thrust area is Genetic Engineering.

2. The Department of Bio-chemistry, Bose Institute, organised a workshop on 'Cloning sequencing and chromosomal localization of Animal Genes' (sponsored by Department of Biotechnology) and, as a part of the Workshop, DIC organised a lecture (delivered by Dr. P. Parrack of DIC) on the current status of the available bioinformation, with particular emphasis on the programmes available in DIC, Bose Institute. This lecture was accompanied by a live demonstration of the software available.

3. As a part of their course work, the M.Sc. students of the Dept. of Microbiology of Calcutta University utilized computer facilities of DIC, Bose Institute. Students of the same Department are utilizing the computer facilities of DIC as part of their project work.

4. Many people are already using the DIC frcilities in a regular way. A partial list is given :

1. (a) **List of Major In-House Users :**
   1. Dept. of Biochemistry
   2. Dept. of Biophysics
   3. RSIC
   4. Dept. of Microbiology
   5. Dept. of Physics.

1. (b) **List of the other Major Users :**
   1. Prof. J. Das (and his group) (Indian Institute of Chemical Biology)
   2. Dr. (Mrs) I. Ghosh (—do—)
   3. Dr. C. Roychoudhury (—do—)
   4. Dr. D. Das Gupta (SINP, Crystallography and Molecular Biophysics Division)

5. Dr. A. Thakur (Calcutta University) Microbiology Dept.
6. Dr. P. Roychoudhury (—do—)
7. Dr. Tapati Banerjee (—do—)
8. Dr. T. Krishnan (Cholera Research Institute), Calcutta

5. (a) V. S. Sundarajan attended a Course on 'C' language at CMC. He also attended National Workshops on Bioinformations in Poona and Shantiniketan.

5. (b) Dr. P. Parrack visited DIC's at Bangalore, New Delhi on two separate occations to have discussions on common problems.

6. The Centre has obtained a number of books for the DIC library, one Scientific Subroutine Library has been made operational on MV-II.

7. A FAX machine has been perchased which whould be made operational shortly.

8. Dr. P. Parrack obtained his Ph.D. degree from Indian Institute of Science, Bangalore.

9. In all the working days of the Institute, the MV-II system has been used by the users in Bioinformation during the prime shift (12.00 hrs). The remaining times allotted to other related users.

APPENDIX—A

Acharya Jagadish Chandra Bose Memorial Lecture

The 50th Acharya Jagadish Chandra Bose Memorial Lecture was delivered by Dr. A. P. Mitra, F.R.S., Director-General, C. S. I. R. and Secretary, Dept. of Science & Industrial Research, on ' Frontiers of Atmospheric Science".

Lectures

1. Prof. Shunichiro Nakamura of Tokyo University of Agriculture delivered a lecture on "Some Aspects of Seed Biology".
2. Dr. Delphi Chatterjee of Colorado State University, USA, delivered a talk on "Structure and Function of surface Antigens of Mycobacteria'.
3. Prof. Ajoy K. Bose, Stevens Institute of Technology, New Jersey, USA delivered a lecture on "Newer Instrumentation Techniques".
4. Prof. Jim Willand, Dept. of Biochemistry, Cleveland State University delivered a lecture on "Instant of catalysis by metallo-enzymes".
5. Dr. Subrata Majumder, Dept. of Pediatrics, University of Pennsylvania, Philadelphia, USA delivered a talk on "Translocation of Protein Kinase C in Human Neutrophil".
6. Dr. Paul Wheeler, Department of Biochemistry, Hull University, England delivered two lectures : (i) Studying metabalism in leprosy bacilli : problems and prospects, (ii) Ribid metabolism in Mycobacterium leprae and other pathogenic bacteria".
7. Dr. B. Pramanik, Schering Corporation, USA, delivered a lecture on "FAB MASS spectroscopy : Application in Protein Chemistry".
8. Dr. F. Scott Mcdermott, Visiting Scientist, Plasma Physics Section, Saha Institute of Nuclear Physics, delivered a talk on "Tokamak as a Tool in Plasma Physics".
9. Dr. S. N. Seal, Institute for Cancer Research, Philadelphia, USA delivered a talk on "Initiation of Protein Synthesis in Wheat-germ".
10. Dr. A. K. Bhattacharjee, Institute of Tapology and Dynamics of System, CNRS, University of Paris, delivered a lecture on "Computer Assisted Molecular Design".

11. Prof. Polly Roy of University of Alabama, School of Public Health, Birmingham, Alabama, USA delivered a lecture on "Molecular Biology and self assembly processes of blue tongue virus expression vectors".

12. Dr. Rahul Ray of Boston University School of Medicine, USA delivered a lecture on "Binding site-probing of vitamin D binding protein and vitamin D receptor by photoaffinity labelling".

13. Dr. M. R. Srinibashan, Indian Institute of Science, Bangalore, delivered a talk on "Ferroelectric Phase Transitions : Dielectric and Spectroscopic Studies".

14. Dr. P. Roychowdhury, Asst. Director (Retd.), Physical Chemistry Division, National Chemical Laboratory, Poona, delivered Acharya J. C. Bose Endowment Lecture on "Ultrasonics and its application to polymer solutions".

15. Dr. Ravi V. Gomatam, Bhaktivedanta Institute, Bombay delivered a talk on "Chance, Causality and Consciousness in modern Science".

16. Dr. Barbara Hohn of Friedrich Miescher Institute, Basel, Switzerland delivered two lectures (i) Agrobacterium mediated gene transfer to dicots and monocots, (ii) Agrobacterium and virus mediated gene transfer in plants.

Obituary

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

1. Sri Aurobinda Bose—Ex. Employee, 8.4.88
2. Sri Chinmoy Nandi—Research Scholar, 16.4.88
3. Sri Ashutosh Guha Thakurata—Ex. Employee, 6.1.89
4. Dr. B. C. Kundu—Ex. Dy. Director, 22.1.89

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. S. K. Mukherjee
2. Prof. A. K. Sharma
3. Prof. S. Bose
4. Prof. Sivatosh Mukherjee
5. Dr. K. N. Mitra
6. Sri Sanjoy Sen

} Nominees of the Governing Body

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

1. Prof. Sivatosh Mukherjee
2. Prof. Arun Kumar Sharma
3. Prof. Sushil Kumar Mukherjee
4. Dr. K. N. Mitra
5. Shri Sanjoy Sen
6. Prof. Sunando Bose
7. Shri Debabrata Bose
8. Prof. B. K. Bachhawat
9. 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

Director : Professor B. B. Biswas, M.Sc., Ph.D., F.N.A., F.A.Sc.

Dy. Director : Professor A. K. Mishra, M.Sc., Ph.D.

Members of Research Staff and Scholar

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.

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

Department of Physics (Contd.)

Research Scholars : Smt. Lipika Santra, M.Sc.
Smt. Tuktuk Sur, M.Sc.
Smt. Kumkum Bhattacharya, M.Sc.
Shri Krishnendu Chakrabarty, M.Sc.
Mrs. Aparna Das (Sen), M.Sc.
Smt. Santa Bandyopadhyay, M.Sc.
Smt. Samita Seal, M.Sc.
Shri 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 Amit Chakrakbarty
Shri Gautam K. Biswas
Shri Sanat K. Saha
Shri Aloke Hazra
Smt. Eli Mukherjee

Research Scholar (Junior) : Shri Subhansu Roy

Department of Botany

Chairman : Prof. A. K. Roychoudhury, M.Sc., Ph.D.

Professor : Prof. Sunirmal Chanda, M.Sc., Dr. rer. nat (Gottingen)

Department of Botany (Contd.)

Readers	:	Dr. A. Das, M.Sc., Ph.D. (upto 31.12.88) Dr. B. Majumder, M.Sc., Ph.D. Dr. S. Gupta, M.Sc., Ph.D. Dr. S. N. Ganguly, Ph.D., D.Sc. Dr. (Mrs) B. Ghosh, M.Sc., Ph.D. Dr. B. B. Mukherjee, M Sc., Ph.D
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 Assistant	:	Dr. (Mrs) S. Bhattacharya, M.Sc., Ph.D.
Research Scholars	:	Sm. Gitali Das, M.Sc. Sm. Malabika Pandit, M.Sc. Sm. Sujata Saha, M.Sc. Sm. Amita Bhattacharya, M.Sc. Sm. Malabika Roy, M.Sc. Sm. Aditi Chattopadhyay, M.Sc. Shri Biswajit Bera, M.Sc. Shri Soumen Chattopadhyay, M.Sc. Sm. Swapna Banik, M.Sc.

Department of Microbiology

Chairman	:	Prof. A. C. Ghose, M.Sc., Ph.D.
Professors	:	Dr. S. L. Chakrabarty, M.Sc., Ph.D.
Readers	:	Dr. (Mrs.) A. L. Chandra, M.Sc., Ph.D. Dr. (Mrs.) A. Das, M.Sc., Ph.D. Dr. Timir Baran Samanta, M.Sc., Ph.D. Dr. (Mrs.) Geeta Nanda, M.Sc., Ph.D. Dr. Pran K. Chakrabarty, M.Sc., Ph.D.

Department of Microbiology (Contd.)

Lecturers	:	Dr. (Mrs.) Kalyani Sen, M.Sc., Ph.D. Dr. (Mrs). Roma Chakrabarty, M.A., Ph.D. Dr. Pradosh Roy. M.Sc., Ph.D. (from 2.12.88)
Research Scholars	:	Shri Susanta K. Dey, M.Sc. (upto 6.4.88) Sm. Banhisikha Chattopadhyay, M.Sc., (upto 18.1.89) Shri Subhas Chandra Jana, M.Sc. Sm. Anuradha Ghosh, M.Sc. Shri Ramprosad Mukherjee, M.Sc. Shri Swadesh Ranjan Biswas, M.Sc. Shri Bijoy Kumar Mohanty, M.Sc. Shri Anup Kumar Halder, M.Sc. Sm. Sumana Das, M.Sc. Sm. Jharna Dutta, M.Sc. Shri Alok Dhar, M.Sc. Sm. Ruby Das, M.Sc. Shri Ramkrishna Sadhukhan, M.Sc. Sm. Nilanjana Bose, M.Sc. (upto 19.6.88) Shri Tapas Sen Gupta, M.Sc. (upto 1.1.89) Shri Amitabha Chaudhuri, M.Sc. Shri Amares Sinha, M.Sc. (from 22.6.88)

Department of Biochemistry

Chairman	:	Prof. R. K. Mandal, M.Sc., Ph.D.
Professors	:	Dr. S. Ghosh, M.Sc., Ph.D. Dr. N. C. Mandal, M.Sc., Ph.D.
Readers	:	Dr. (Mrs.) S. Biswas, M.Sc., Ph.D. Dr. B. Bhattacharyya, M.Sc., Ph.D.
Lecturers	:	Dr. I. B. Maity, M.Sc., Ph.D. (Upto 10.11.1988) Dr. (Mrs.) P. Sinha, M.Sc., Ph.D. Dr. P. Gupta, M.Sc., Ph.D.

Department of Biochemistry (Contd.)

Research Scholars	:	Shri Utpal Dutta (Upto 30.9.1988) Sm. Mita Pal (Upto 30.9.1988) Shri Sibaprasad Bhattacharyya Shri Niranjan Das Sm. Rina Saha Sm. Sarbani Maity Shri Asim Kumar Mandal (Upto 1.2.1989) Shri Asish Roychaudhury Shri Debaprasad Saha Md. Golam Farook Shri Utpal Ghosh Shri Sudip Chatterjee (From 6.9.1988) Shri Santanu Dasgupta (From 6.1.1989) Md. Nizam Haider (From 1.1.1989) Sm. Karabi Chatterjee (From 3.3.1989) Sm. Mau Mukhopadhyay (From 3.3.89)

Department of Biophysics

Reader-in-Charge	:	Dr. Asoke Banerjee, M.Sc., Ph.D., M.Ny.A.Sc. (USA)
Lecturer	:	Dr. Siddhartha Roy, M.Sc., Ph.D.
Research Scholars	:	Shri Goutam Biswas Shri Subhasis Chakravarty Shri Utpal Banik Smt. Anusree Bhattacharya Smt. Tista Bhattacharya Shri Bankim Chandra Das
Pool Officer	:	Dr. Manick Das

Animal Physiology Section

Professor-in-Charge	:	Dr. A. K. Medda, M.Sc., D.Phil., F.N.A.Sc.
Reader	:	Dr. A. K Ray, M.Sc., Ph.D.

Animal Physiology (Contd.)

Lecturer	:	Dr. Rama Ghosh, M.Sc., Ph.D.
Research Scholars	:	Sm. Sarbani De Sm. Debjani Ghosh Shri Santanu Das (From 22.6.88) Shri S. Lahiri (Upto 30.9.88) Shri Madhumita Ghosh (Upto 30.7.88) Shri Shyam Sundar De (Upto 26.7.88)

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. Ms. 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)
Assistant Registrar	:	Shri P. K. Sinha, B.A., L.L.B.
Audit & Finance Officer	:	Shri M. L. Datta, B.Com., B.A., L.L.B.

Department of Biochemistry (Contd.)

Research Scholars	:	Shri Utpal Dutta (Upto 30.9.1988) Sm. Mita Pal (Upto 30.9.1988) Shri Sibaprasad Bhattacharyya Shri Niranjan Das Sm. Rina Saha Sm. Sarbani Maity Shri Asim Kumar Mandal (Upto 1.2.1989) Shri Asish Roychaudhury Shri Debaprasad Saha Md. Golam Farook Shri Utpal Ghosh Shri Sudip Chatterjee (From 6.9.1988) Shri Santanu Dasgupta (From 6.1.1989) Md. Nizam Haider (From 1.1.1989) Sm. Karabi Chatterjee (From 3.3.1989) Sm. Mau Mukhopadhyay (From 3.3.89)

Department of Biophysics

Reader-in-Charge	:	Dr. Asoke Banerjee, M.Sc., Ph.D., M.Ny.A.Sc. (USA)
Lecturer	:	Dr. Siddhartha Roy, M.Sc., Ph.D.
Research Scholars	:	Shri Goutam Biswas Shri Subhasis Chakravarty Shri Utpal Banik Smt. Anusree Bhattacharya Smt. Tista Bhattacharya Shri Bankim Chandra Das
Pool Officer	:	Dr. Manick Das

Animal Physiology Section

Professor-in-Charge	:	Dr. A. K. Medda, M.Sc., D.Phil., F.N.A.Sc.
Reader	:	Dr. A. K Ray, M.Sc., Ph.D.

Animal Physiology (Contd.)

Lecturer	:	Dr. Rama Ghosh, M.Sc., Ph.D.
Research Scholars	:	Sm. Sarbani De Sm. Debjani Ghosh Shri Santanu Das (From 22.6.88) Shri S. Lahiri (Upto 30.9.88) Shri Madhumita Ghosh (Upto 30.7.88) Shri Shyam Sundar De (Upto 26.7.88)

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. Ms. 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)
Assistant Registrar	:	Shri P. K. Sinha, B.A., L.L.B.
Audit & Finance Officer	:	Shri M. L. Datta, B.Com., B.A., L.L.B.

Administration (Contd.)

Workshop Superintendent : Shri Alok Mukherjee, B.E. (Mech.)

Librarian : Mrs. Ila Biswas, M.Lib (Sc.)

Medical Officer (Part-time) : Dr. S. R. Ghosal, M.B.B.S., D.C.H. (Cal.)

GRANT-IN-AID-SCHEME

Department of Science and Technology

Scheme No. 1. Genetic Engineering Unit.

Programme Coordinator : Prof. B. B. Biswas

Investigators : Prof. S. Ghosh
Prof. R. K. Mandal
Prof. N. C. Mandal
Dr. (Mrs.) S. Biswas
Dr. B. Bhattacharyya

Research Associate : Dr. Anuradha Lohia
(Upto 30.6.1988)

Research Fellows : Shri Jaydip Dasgupta
(Upto 31.12.1988)
Md. Nizam Haider (Upto 31.12.1988)

Scheme No. 2. "Polyamine in controlling plants under stress condition"

Investigator-in-Charge : Dr. Bharati Ghosh

Junior Research Fellows : Sm. Rina Basu
Shri Arup Chakraborty

Indian Council of Medical Research

Scheme No. 1. "Phynylhydrazine hydrochloride-thyroid hormone-cyanocobalamin interactions in animals".

Investigator-in-Charge : Prof. A. K. Medda

Junior Research Fellow : Smt. Mitali Pramanik

Scheme No. 2. "Pharmacological, biochemical and immunological studies on the venom of scorpion occuring in West Bengal."

Investigator-in-charge : Dr. S. Ghosh

Research Scholars : Shri Asitava Bose
Shri Sudip Chatterjee
(Upto 31.8.1988)

Scheme No. 3. "Studies on L-asparaginase producing bacteria with regard to antineoplastic activity".

Investigator-in-Charge : Prof. S. L. Chakrabarty

Junior Research Fellow : Shri Subha Manna
(from 10.5.1988)

Scheme No. 4. "Microbial synthesis of L-DOPA by mutagenesis".

Investigator-in-Charge : Dr. Arati Das

Research Associate : Dr. Sharmila Chattopadhyay

Scheme No. 5. "Evaluation of fish oil diet as a curative or protective measure against occlusive heart diseases".

Investigator-in-Charge : Prof. Jyotirmoy Dutta

Senior Research Fellow : Smt. Ishani Banerjee
Shri Sagarmoy Saha

Scheme No. 6. "Studies on the Biology of reproduction and fertility and fertility regulation".

(I) Inhibin of mammalian origin and raising anti-serum against inhibin in rabbit : Use of inhibin and antinhibin in fertility and sterility of males, etc.

(II) Aetiology of dysfunctional uterine bleeding in IUD and non-IUD fitted women.

Investigator-in-Charge : Prof. Parul Chakrabarti

Research Associate : Dr. Parikshit Bera
(upto January, 1989)

Junior Research Fellow : Shri Subhansu Roy
(upto April, 1989)

Council of Scientific & Industrial Research

Scheme No. 1. "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 : Shri Tapan K. Chaudhury

Scheme No. 2. "Progression of cellular senescence in embryos of deteriorating wheat and rice seeds".

Investigator-in-Charge : Dr. Swati Sen-Mandi

Senior Research Fellow : Smt. Smritimala Ganguly
Smt. Kalpana Saha (upto 28.2.89)

Scheme No. 3. "Biological control of the propagation of Parthenium hysterophorous (family Asteraceae) in West Bengal".

Investigator-in-Charge : Prof. Sunirmal Chanda

Senior Research Fellow : Dr. Swati Gupta

Scheme No. 4. "A synthetic taxonomical approach using pollen morphology in some members of Asteraceae".

Investigator-in-Charge : Prof. Sunirmal Chanda

Senior Research Fellow : Dr. Aparna Pal

Scheme No. 5. "Studies on phase boundaries connecting DNA structure".

Investigator-in-Charge : Dr. Asok Banerjee

Research Fellow : Shri Bankim Chandra Das

Scheme No. 6. "Chemical mapping of active sites of Amino acyl tRNA synthesis".

Investigator-in-Charge : Dr. Siddhartha Roy

Research Fellow : Smt. Anusree Bhattacharya

Scheme No. 7. "Thyroid hormone regulation of brain function".

Investigator-in-Charge : Dr. A. K. Roy

Junior Research Fellow : Shri Pradip Kumar Sarkar

Scheme No. 8. "Production and purification of L-asparaginase from *Vibrio cholerae* for the study of antineoplastic activities".

Investigator-in-Charge : Prof. S. L. Chakrabarty

Senior Research Fellow : Shri Susanta Kumar Dey
(from 7.4.88)

Scheme No. 9. "Structure Function and Sequence Homology of Cytochrome P_{450} in Fungi".

Investigator-in-Charge : Dr. Timir B. Samanta

Senior Research Fellow : Debjani Dutta (upto 31.1.89)

Scheme No. 10. "Immobilization of steroid transferming microorganisms".

Investigator-in-Charge : Dr. Timir B. Samanta

Junior Research Fellow : Tapan K. Dutta

Scheme No. 11. "Biochemical studies on the movements of higher plants".

Investigator-in-Charge : Dr. (Mrs.) S. Biswas

Research Fellows : Sm. Ambalika Roy
Shri Mahadev Pal (upto 28.2.89)

Scheme No. 12. "Tubulin substructure and identification of its functional domains".

Investigator-in-Charge : Dr. B. Bhattacharyya

Research Fellows : Shri Krishnendu Mukhopadhyay
Sm. Manjari Majumdar

Scheme No. 13. "DNA replication in the Yeast *Saccharomyces cerevisiae* : A Genetic approach".

Investigator-in-Charge : Dr. Pratima Sinha

U.N.D.P.

Scheme No. 1. "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 & Cellular Genetics).

Research Scholar : Shri Jaydip Dasgupta (From 1.1.89)

Scheme No. 2. "Irradication of Leprosy in India".

Investigators : Prof. Parul Chakrabarti
Prof. N. C. Mandal
Dr. Asok Banerjee

Scheme No. 3. "Plant Improvement using modern biotechnology".

Research Associate : Dr. S. Das

Research Fellow : Mr. N. S. Banerjee

Scheme No. 4. "Approaches to treatment and prevention of Leprosy".

Investigator-in-Charge : Prof. Parul Chakrabarti

INDO-US Collaborative Project

Scheme No. 1. "Bio-active Substances from the Indian Ocean"

Principal Investigator-in-Charge : Prof. A. K. Barua

Jt. Principal Investigator-in-Charge : Prof. Parul Chakrabarti

Participants : Dr. S. N. Ganguly
Dr. B. B. Mukherjee

Research Associates : Dr. Sarmila Roy
Dr. Manikuntala Kundu (Upto May, 1988)

Senior Research Fellows : Shri Anup K. Roy
Shri Tapas Das (Upto January 1989)
Shri Debasis Ghoshal

INDO-US Project (NIH)

Scheme No. 1. Liposomes in the delivery of partially thiolated polynucleotides as potential antitumour agents".

Investigator-in-Charge : Prof. Parul Chakrabarti

Senior Research Fellow : Dr. Joyoti Bast (Upto May, 1988)

Junior Research Fellow : Shri Anirban Siddhanta (Upto September, 1988)

Scheme No. 2. "The interaction of drugs with adenosine triphosphatase and lipids in model membranes—Part II"

Investigator-in-Charge : Dr. P. C. Sen

Junior Research Fellow : Shri Goutam Adhikary

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".

Investigator-in-Charge	:	Dr. Kalyani Sen
Co-Investigator	:	Dr. Roma Chakravorty Prof. Arun K. Roy Chowdhury (Department of Botany)
Senior Research Fellow	:	Shri Tilak Banerjee

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	:	Shri Dipak K. Bhattacharyya

Indian Council of Agricultural Research

Schome No. 1. "Metabolism of myoinositol phosphates in plants".

Investigator-in-Charge	:	Dr. (Mrs.) S. Biswas
Research Fellows	:	Shri Ratan Kumar Maitra (Upto 30.7.1988) Sm. Mau Mukhopadhyay (Upto 2.3.1989) Sm. Karabi Chatterjee (Upto 2.3.1989) Sm. Mita Pal (From 29.12.1988)

Scheme No. 2. "Studies on somatic hybridisation in Corchorus sp.".

Investigator-In-Charge	:	Prof. S. K. Sen
Research Associates	:	Mr. S. R. Sikdar Mrs. G. Chatterjee
S.R.F.	:	T. Saha C. Ganguly

DST/SERC

Scheme No. 1. "Study on hairy root causing plasmids of Agrobacterium rhizomes", a possible genetic engineer for crop plants.

Investigator-in-Charge	:	Prof. S. K. Sen
Research Officer	:	Dr. Sampa Das
Research Fellows	:	Ms. Runa Roy Mr. N. S. Banerjee

DST/GR

Scheme No. 1. "Micropropagation of Tea."

Investigator-in-Charge	:	Prof. S. K. Sen
Co-Investigator	:	Dr. T. Jha

USDA/FERRO

Scheme No. 1. "Use of plasmids of Agrobacterium sp. to genetically transform monocot plant cells and transfer of useful genes to crop plants".

Investigator-in-Charge	:	Prof. S. K. Sen
Technical Officers	:	Shri S. R. Sikdar Shri D. Basu

Burn Standard Co. Ltd.

Scheme No. 1. "Magnesite Microbial Beneficiation".

Investigator-in-Charge	:	Prof. A. K. Mishra
Research Fellow	:	Suparna Ghosh

Indian School of Mines

Scheme No. 1. "Removal of H_2S from oil and/or gas and recovery of sulfur from H_2S (ISM No. 5)"—An ONGC project in collaboration with Prof. D. Chandra, Indian School of Mines, Dhanbad.

Investigator-in-Charge	:	Prof. A. K. Mishra
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 (ISM No. 6)"—An ONGC project in collaboration with Prof. D. Chandra, Indian School of Mines, Dhanbad.

Investigator-in-Charge : Prof. A. K. Mishra

Research Fellows : Smt. Indrani Roy
: Smt. Chirajoyoti Deb

University Grants Commission

Scheme No. 1. "Applied palynostratigraphy of the Late Cretaceous-Early Tertiary Sediments of India".

Investigator-in-Charge : Prof. Sunirmal Chanda

Research Associate : Dr. (Mrs) Urmila Deb.

Hindusthan Liver Research Foundation

Scheme No. 1. "Effect of Polyamines on nodule senescence in leguminous plants".

Investigator-in-Charge : Dr. Bharati Ghosh

Senior Research Fellow : Smt. Sakuntala Chattopadhyay

Junior Research Fellow : Smt. Kajari Lahiri

C. S. I. R. Ad-hoc Fellows

1. Sm. Dipta Bhattacharyya
2. Sm. Alo Pal
3. Shri Amit Maity
4. Shri Bidyut Ghosh
5. Shri Asim Kumar Mandal (From 2.2.1989)
6. Shri Dulal Panda
7. Shri Mahadev Pal (From 1.3.89)
8. Shri Utpal Dutta (From 1.10.1988)
9. Shri Santanu Roychaudhury (From 1.11.1988)
10. Shri Narayan Mandal, M.Sc. (upto 27.2.89)

11. Shri Tapas Sen Gupta, M.Sc. (from 2.1.89)
12. Sm. Neena Ghosh Dastidar (from 21.2.89)
13. Dr. Prankrishna Datta, S.R.F.
14. Shri Sagarsona Jash, S.R.F.
15. Miss Suchata Chandra, J.R.F.
16. Ms. P. Nayak
17. Mrs. S. Leelavathi
18. Shri V. S. Reddy
19. Shri T. Saha

C. S. I. R. Ad-hoc Research Associate

1. Dr. Manikuntala Kundu
2. Dr. Joyoti Basu
3. Dr. (Mrs.) S. Banerjee
4. Dr. S. R. Sikdar

U. G. C. Ad-hoc Fellow

1. Shri T. Anoop Kumar, J. R. F.

DBT National Associate

1. Dr. G. Sarkar

APPENDIX—B

Participation in Academic Activities, Conferences/Symposia/Traning Programmes

Department of Physics

1. Department of Physics organised a two and half-a-day Symposium entitled "Regional meeting on Radiation Physics" sponsored by the Department of Science and Technology, Council of Scientific and Industrial Research, Government of India ; S. N. Bose National Centre for Basic Sciences, Calcutta ; Department of Atomic Energy, Government of India and International Radiation Physics Society during November 30—December 2, 1988.

2. Prof. M. H. Engineer organised the National Workshop (sponsored by the Department of Science and Technology, Government of India) on 'CHAOS' which was held at S. N. Bose National Centre for Basic Sciences, Calcutta, from February 7-18, 1989.

3. Prof. S. C. Roy attended and chaired one session on Radiation Sources and Detectors, at the 4th International Symposium on Radiation Physics held at Sao Paulo, Brazil, during October 3-7, 1988.

4. Prof. S. C. Roy attended Seminar-cum-Workshop on Physical Techniques in Medical Sciences organised by Indian Physical Society, held in Calcutta during December 12-15, 1988.

5. Prof. S. C. Roy, Dr. A. K. Chatterjee, Dr. S. N. Changdar, Dr. D. Bhaumik, Dr. B. Roy and Dr. I. Bose attended the International Symposium on Raman Spectroscopy held at the Indian Association for the Cultivation of Science, Calcutta, during November 2-7, 1988.

6. Prof. S. C. Roy attended the International Conference on Nuclear Reaction Mechanism held in Calcutta during January 3-9, 1989.

7. Dr. A. K. Chatterjee participated in International Symposium on Nuclear Reaction Mechanisms organised by SINP and VECC, Calcutta, during January 3-9, 1989.

8. Dr. S. N. Changdar attended International Conference on Cryogenics in December 1987.

9. Prof. M. H. Engineer participated in a two-day International Meeting on 'Path Integrals' held at BARC in January 1989.

10. Dr. I. Bose delivered an Invited Talk at Winter Workshop on Strongly Correlated Systems organised by IIP, Bhubaheswar, and held at Puri (January 2-16, 1989).

11. Dr. B. Roy and Dr. I. Bose participated in the Low Temperature Physics Workshop held at IACS, Calcutta, during August 30 September 2, 1988.

12. Dr. D. Home participated and delivered talks at :

    (a) Workshop on Foundations of Quantum Mechanics, University of Bari, Italy, June 15-25, 1988.

    (b) International Meeting on Philosophy of Arts and Sciences, Rimini, Itaty, August 20-27, 1988.

    (c) Second Chittagong International Conference on Mathematical Physics, Chittagong, Bangladesh, December 17-19, 1988.

    (d) National Seminar on 60 years of Dirac Equation, Shantiniketan, Visva-Bharati, January 28-30, 1989.

    (e) National Workshop on Quantum Optics, Goa, March 17-22, 1989.

    (f) 54th Annual Meeting of the Indian Academy of Sciences, Calcutta, October 31-November 1, 1988.

    (g) He also participated in the DST Seminar on Review and Updating of National Thrust Areas in Physical Sciences, Shantiniketan, February 23-25, 1989.

13. Prof. M. H. Engineer was invited to PRL, Ahmedabad, for two weeks during the visit there of Prof. M. V. Berry, FRS, the Vikram Sarabhai Professor of Physics for 1988-89.

14. Dr. Arun Kumar Chatterjee participated as a visiting scientist in an experiment

on ^{3}He induced reaction on ^{13}C at Van de Graaf Laboratory, BARC, Trombay, Bombay, during the period 22nd June to 26th July, 1988.

15. Dr. I. Bose delivered invited talks at :

(a) The Physics Department, Indian Institute of Science, Bangalore, in the Theoretical Physics Colloquium Program in December, 1988.

(b) The Physics Department, Indian Institute of Technology, Kanpur, in April 1988, as a Theoretical Physics Seminar Circuit (TPSC) Speaker.

(c) The Institute of Physics, Bhubaneswar in April, 1988, as a TPSC Speaker.

16. Dr. D. Home visited the following places during his official visit abroad :

(a) Institute Henri Pioncare, Paris, June 27-July 15, 1988.

(b) Ludwin Maximilians University of Munich, West Germany, July 16-23, 1988.

(c) Queen's University of Belfast, Northern Ireland, July 24-August 1, 1988.

(d) Mathematical Institute, University of Oxford, U. K., August 2-12, 1988.

(e) Nuclear Physics Division, Bhabha Atomic Research Centre, Bombay, March 24-29, 1989.

17. Prof. M. H. Engineer delivered a series of Invited Talks on "Berrys Phase" at SINP.

18. Prof. M. H. Engineer, Dr. A. K. Chatterjee, Dr. S. N. Changdar and Dr. D. Bhaumik participated in the Teaching Program of Bose Institute.

19. Prof. M. H. Engineer was invited to teach a M.Sc. course on Statistics at the Department of Microbiology, CalcuttaUniversity.

20. Prof. M. H. Engineer took over as Officer-in-Charge, Distributed Information Centre from May 2, 1988. He is responsible for work of this Department of Biotechnology-sponsored Centre for Bio-Informatics, located at Centenary Campus, Bose Institute.

21. Prof. S. C. Roy has been named as Indian Coordinator of a Joint Indo-US

Project, sponsored by U. S. Govt. The project whose U.S. Coordinator is Prof. R. H. Pratt is titled :

'Investigations as the Primary interaction of gamma rays with matter'.

Department of Chemistry

Prof. N. K. Sinha delivered an invited talk on "Physical Chemical studies on eggwhite proteins of reptiles" at Purdue University, West Lafayette, Indiana, U.S.A. on September 14, 1988.

Prof. J. Dutta was elected as the "Scientist-in-Charge" of the Biochemistry Section of the Annual Convention of Chemist (Silver Jubilee Session) 1988, organised by the Indian Chemical Society, held at Calcutta between 23rd and 27th December, 1988. He organised the Biochemistry Session, including a symposium on "Nitrogen Fixation".

Prof. Dutta delivered the following invited lectures :

(i) "Potentiality of yeast as source of edible oil" in a seminar organised by the "Science Club" Calcutta, Bose Institute on 4th February 1989.

(ii) "Can fish oil prevent heart diseases" in a seminar at the Acharya Brojendra Nath Seal College, Coochbehar, on 6th March, 1989 at the College, held on the occasion of the Centenary Celebration of the College.

(iii) "Science teaching" in a seminar organised by 'Paschimbanga Vigyan Mancha" on 14th March, 1988, held at the Information Centre, Calcutta.

Prof. J. Dutta took part in the organisation of the 2nd People's Science Congress, held at Jubabharati Stadium, Calcutta from 16th to 18th March under the joint sponserships of the "National Net Work of People Science Movement" Govt. of India and Govt. of West Bengal. He took part in the deliberations in the sessions on "Environment and Science" and "Self reliance and Science".

Prof. Dutta has taken part in the course work of our Institute and the teaching programme at M. Tech. classes of Calcutta University.

Prof. Dutta has been elected as a member of the State Council of the newly formed Department of Science and Technology of the Govt. of West Bengal.

Prof. P. Chakrabarti was invited to present a paper entitled "Lectin from *Mycobacterium smegmatis* in the International lectin conference, Interlec 10, held at Prague, Czechoslavakia. Prof. Chakrabarti also presented a paper in the 14th IUB Congress held at Prague, Czechoslavakia.

Prof. Chakrabarti was invited to deliver a talk entitled "Altered membrane properties of a nystatin-resistant *Aspergillus niger*" in the 2nd National Symposium and Workshop on Liposome research in Delhi.

Prof. Chakrabarti was invited to present a paper entitled "Diphenylhexatriene : a probe in membrane studies", in the National Symposium on Light and Life in Calcutta in 1984.

Prof. Chakrabarti chaired a session in the International conference on "Bioactive substances from the marine organisms" held at Goa in 1989.

Dr. P. C. Sen participated in the following symposia/meetings.

(i) International conference on Biomembranes in health and disease at Industrial Toxicology Research Centre, Lucknow.

(ii) Delivered a lecture in 25th Annual Convention of Chemists held at Calcutta.

(iii) Delivered lecture at Indian Institute of Chemical Biology under the auspices of Society of Biological Chemists' of India, Calcutta chapter.

(iv) Delivered lecture to M.Sc. students in the Department of Physics, Jadavpur University on a topic entitled "Methods of Investigation for the study of Membrane properties".

(v) Delivered a lecture at Indian Association for the Cultivation of Science, under the auspices of Royal Society of Chemistry, Eastern India Section.

Dr. M. Chakrabarty (i) participated as a member of Local Committee, in the 25th Annual Convention of Chemists' held jointly at Bose Institute and University of Calcutta during December 23-27, 1988 and presented a paper entitled "Chemical investigation of *Polyalthia longifolia*."

(ii) Participated and presented a paper entitled "Unusual one-pot formation of

a phenyl ketene Trimer" in the 76th session of the Indian Science Congress held at Madurai Kamraj University, Madurai, during January 7-12, 1989.

(iii) Participated in the 12th National Symposium on Organic Chemistry held in the Dept. of Chemistry, University of Calcutta, Calcutta during February 15-16, 1989.

(iv) Participated in the 5th National Symposium on Recent Advances in Organic Chemistry held in the Dept. of Chemistry, University of Kalyani, during March 28-29, 1989.

Dr. Manikuntala Kundu was awarded IUB Travel fellowship to attend 14th IUB Congress held in Prague in July 1988 and presented a paper entitled "Phospholipid transfer protein from goat liver".

Dr. Kundu was awarded CSIR Travel fellowship to attend 4th International Congress on Cell Biology, held in Montreal, Canada, in August, 1988 and presented a paper entitled "Altered lipid composition and amino acid transport in a nystatin resistant mutant of "*Aspergillus niger*".

Dr. Joyoti Basu was awarded IUB Travel fellowship to attend 14th International Union of Biochemistry held in Prague in July, 1988 and presented a paper entitled "Amino acid transport in *Aspergillus niger*". Dr. Basu was awarded a travel fellowship by the organiser to attend 4th International Congress on Cell Biology held in Montreal, Canada, in August, 1988 and presented a paper entitled "Abnormal erythrocyte membrane cytoskeleton structure in chronic myelogenous leukemia".

Sri Debasis Ghosal acted as the course Director in the Workshop "Maternal-Child nutrition and Technicalities of Immunization" held at Bose Institute in March 28-29, 1989. Sri Ghosal also delivered a lecture on "Nutrition and Immunity" in the Workshop.

Sri Anoopkumar presented a paper on lipid and prostanoates from marine squid *Loligo duvacelli* in the Indo-US Symposium on marine bioactive substances held at Goa in February 1989.

Professor D. P. Chakraborty received Sir J. C. Ghosh Memorial Award 1986 of the Indian Chemical Society and delivered the Sir J. C. Ghosh Memorial Lecture 1986.

Professor D. P. Chakraborty was elected Treasurer of the Indian Science Congress Association for the year 1989 to 1991.

Professor D. P. Chakraborty as the Convener of the Silver Jubilee Session of the Annual Convention of Chemists held at Calcutta organised the meetings of the Convention which included various symposia under different Scientists-in-Charge of six sections.

Professor D. P. Chakraborty elected Scientist-in-Charge of Organic Chemistry Section of Annual Convention of Chemists of Indian Chemical Society for the years 1988-1990.

During the Silver jubilee session he organised a national symposium on "Synthetic Organic Chemistry including Photochemistry" which was addressed by 10 eminent organic chemists including D. Nasipuri, A. V. Ramarao.

Professor D. P. Chakraborty delivered an invited talk at the National Symposium on Plant Taxonomy held at Kalyani University, Kalyani, 1989.

Professor D. P. Chakraborty represented Indian Chemical Society as a member of the Organising Committee at the National Symposium on Organic Chemistry held at Kalyani.

Sri Amit Chakraborty presented a paper at the Annual Convention of Chemists held at Calcutta, 1988.

Dr. Joyoti Basu was awarded the INSA Young Scientists Medal for 1989.

Department of Botany

Prof. A. K. Roychoudhury was invited to deliver a popular talk 'Genetic relationships of human populations' at the Birla Industrial & Technological Museum, Calcutta on July 15, 1988. He also delivered another popular lecture on 'White Tiger; its origin and propagation in India' at Federation Hall on April 1, 1989.

Dr. B. Majumder attended sixth Bangladesh Botanical Conference held at Chittagong University during 18-19 January, 1989 and presented a paper entitled "Problems and prospects of saline soil of Sunderban."

Dr. Bharati Ghosh presented a paper entitled "The novel plant growth regulators" on fourth S. M. Sircar Memorial Conference at Arambag College, Hooghly. She was invited to deliver a lecture entitled "The big role of tiny molecules-Polyamines" in Silver Jubilee Session of Annual Convention of Chemists at Calcutta. She was

invited to attend the "Group Monitoring Workshop" at National Institute of Oceanography, Panaji, Goa and submitted a paper on "Polyamines in controlling plants under stress condition." She was also invited to attend the Plant Growth Regulator Symposium in the Department of Botany, University of Jodhpur.

Dr. K. K. Mukherjee presented a paper in the National Symposium on Modern Trends in Plant Taxonomy, Kalyani University, 26-27 March, 1989.

Prof. Sunirmal Chanda participated in the following Seminars/Symposia/Conferences :

1. Delivered an inaugural key-note address on "Role of culture and identification of indigenous plants in Ayurvedic research" under the auspices of West Bengal Ayurvedic Medical Association and Indo-German Association's National Seminar on "Role of Ayurveda in family planning", held in Max Muellar Bhaban, Calcutta on 9.4.88.

2. Attended 7th International Palynological Congress at Brisbane, Australia held on 28th August to 3rd September 1988 where chaired the scientific session on Tropical Aerobiology and delivered two key-note addresses, (1) Role of tropical pollen grains and spores in respiratory allergy and plant pathology and (2) Quantitative and qualitative analyses of modern pollen rain in tropical forests.

3. Attended Sixth Biennial National Botanical Conference, held on 18th and 19th January, 1989 at the University of Chittagong. Chittagong, Bangladesh, where chaired a scientific session on "Forest and Environment", and delivered a key-note address on "Role of forest management in environmental protection".

4. Delivered an invited seminar lecture at the Botany Department, Dhaka University, Dhaka, Bangladesh, on 22.1.89 on "Application of Palynology and Aerobiology in Life, Earth and Medical Sciences.

5. Attended "National Seminar on 19th Century in major Indian languages, literature, history and culture" at Visva-Bharati, Santiniketan from 17th to 19th March 1989. Delivered a key-note address on History of Sciences in India in the nineteenth Century" and also chaired an academic session.

6. Attended "National Symposium on Modern Trends in Plant Taxonomy" at Dept of Botany, Kalyani University on 27-28 March, 1989. Delivered an invited lecture on "Aspects of pollen morphology and plant taxonomy" on 27.3.89.

Prof. Chanda has been nominated as Guest Professor at the Botany Department, Visva-Bharati, Santiniketan. He visited the Birbal Sahni Institute of Palaeobotany, Lucknow as a member of the Research Advisory Council of the BSIP.

Dr. N. C. Barui, Dr. Swati Gupta, Smt. Sikha Manna and Smt. Swapna Banik participated in the Sixth Biennial National Botanical Conference, held on January 18-19, 1989 at the University of Chittagong, Chittagong, Bangladesh and presented papers.

Department of Microbiology

Prof. A.C. Ghose delivered one Planery Lecture on 'Immunology and Eye' at the Annual Convention of Opthalmological Society of West Bengal on September 29, 1988 held at S. S. K. M. Hospital, Calcutta. He acted as Chairman in one of the sessions of the 25th Annual Convention of Chemists (Biochemistry Section) held at Calcutta on 23-27 December, 1988. He also attended Indo-UK Workshop on Diarrhoeal diseases held at N. I. C. E. D., Calcutta during 9-13 January, 1989 and presented an invited paper. Prof. Ghose was also associated with teaching (Hony) of M.Sc. students of the Departments of Biochemistry ; Biophysics, Molecular Biology and Genetics of the University of Calcutta.

Prof. S. L. Chakraborty acted as a member of scientific panel of Indian Council of Agricultural Research and participated at the 36th meeting of the scientific panel for Fisheries held on November 24, 1988 at Krishi Bhavan, New Delhi.

Dr. Arati Das attended the 32nd Annual General meeting of the Indian Mycological Society held in the Department of Botany, Calcutta University on October 8, 1988.

Dr. T. B. Samanta delivered an invited talk at the Society of Biological Chemists, Calcutta Chapter, held on May 20, 1988 at the Department of Biochemistry, Calcutta University. He also delivered a course of lectures on Microbiology and Immunology to B. Tech. students, Department of Chemical Technology, University College of Science, Calcutta during September-December, 1988. Dr. Samanta chaired the session in Biochemistry section at the Annual Convention of Chemists held at Bose Institute, Calcutta on December 1988.

Dr. P. K. Chakrabarty participated in the National Symposium on Modern Trends in Plant Taxonomy held at the Department of Botany, Kalyani University, West Bengal during March 27-28, 1989 and presented a paper entitled, "Relatedness and taxonomy of root nodule bacteria".

Dr. Roma Chakravorty participated in the 22nd Annual Convention of the Indian College of allergy and applied immunology at Delhi during November 1-3, 1988 and presented the paper entitled, "The air-spora of the Metro Railway Complex, Calcutta".

Shri Anup Kumar Halder, Shri Ramkrishna Sadhukhan and Shri Bijoy Kumar Mohanti attended the 76th Session of the Indian Science Congress held at Madurai in January 7-12, 1989 and presented respectively the following papers : Properties of nitrate reductase in *Rhizobium meliloti* ; Amylase from *Myceliophthora thermophila* D-14, a thermophilic fungus' ; and 'Effect of pretreatments on the release of silica from Magnesite ore by the species of Bacillus'.

During 1988-89, Departmental Seminars were organised by Dr. Geeta Nanda and Anup Kumar Halder till December 1988 and then from January 1989 by Dr. Arati Das and Narayan Mandal.

Department of Biochemistry

Prof. B. B. Biswas participated in the following symposia/meetings.

1. Participated and Chaired a session in Genetic Engineering Research in India held in Bangalore in July, 1988.
2. Delivered the plenary lecture in the first International conference of Association of Plant Physiologist of SAARC countries on the Role of Plant Physiology and Biotechnology on crop productivity at Tribhuvan University, Kathmandu, Nepal.
3. Participated and chaired a session on Gene Expression and Development held at National Institute of Immunology, New Delhi in December, 1988.
4. Delivered inaugural address and Chaired a session in the Chemical convention of Chemistry held in Calcutta in December, 1988.
5. Delivered inaugural address and participated in the Indo-USSR workshop on Genetic Engineering held at I.I.C.B. in Calcutta in March. 1989.
6. Participated and Chaired a session in the Silver Jubilee Celebration of Indian Photobiology Society held in Calcutta.

7. Participated as a member/Chairman of several Committees of ICAR, ICMR and DBT and attended Research Advisory Committee meeting of National Institute of Cholera and Enteric diseases in Calcutta.

8. Participated as a member of the Council of Indian Statistical Institute, Calcutta.

9. Participated in the teaching of M.Sc. course in Molecular Biology and Biophysics at Calcutta University.

10. Participated in the meetings of Senate, Calcutta University.

11. Participated as a member of the meetings of Faculty of Interdisciplinary and Applied Sciences, University of Delhi (South Campus).

12. Participated in the editorial board meetings of Indian J. Biochem. Biophys. at Delhi.

13. Participated in the annual meeting of Indian Academy of Science held in Calcutta and also Raman Centenary meeting.

14. Participated as a member of the Presidency College (Calcutta) Governing Body meetings.

Prof. S. Ghosh participated in the following Symposia/meetings.

1. Gave Basic Biochemistry course of lectures to 1st year M.Sc. class students of the Department of Biophysics & Molecular Biology, Calcutta University, Calcutta.

2. Organized M. Tech. practical classes on Recombinant DNA Technology of Jadavpur University students in laboratory.

3. Gave Recombinant DNA Technology course lectures to Bose Institute Research Scholars.

4. Delivered lectures on "Plant-microbe interaction that enhances plant productivity : Recent Studies with *Azospirillum brasilense*".

   (a) Institute of Microbial Technology, Chandigarh.

   (b) School of Biological Sciences, University of Nebraska, Nebraska, USA.

   (c) Boston Biomedical Research Institute, Department of Molecular Biology, Harvard Medical School, Boston, USA.

   (d) Indian Chemical Society Annual Convention at Bose Institute, Calcutta.

5. Under the Study Tour Programme of the UNDP-FAO Project Plant improvement using modern biotechnology" following laboratories were visited.

   (a) Department of Biochemistry & Biophysics, Davis, USA ; Division of Molecular Plant Biology, University of California, Berkeley, USA ; School of Biological Sciences. Nebraska University, Nebraska ; Laboratory of Plant Biology, Rockefeller University, New York ; Department of Molecular Biology, Harvard Medical School, Boston ; Department of Cellular & Developmental Biology, Harvard University, Boston ; Max-Planck Institute, fur Zuchungsforchung, Koln ; Rajksuniversiteit, Gent, Belgium and AFRC Institute of Plant Biology, Cambridge, U.K.

Prof. R. K. Mandal participated in the following Symposia/meetings and delivered lectures ;

1. Entitled "Organization, cloning and divergence of ribsomal RNA genes in fish" at the Indo-soviet Symposium on Genetic engineering held in IICB, Calcutta.

2. Entitled "Organization and developmental regulation of rRNA genes in catfish *Heteropneustes fossilis*" in Symposium on Genetic Engeneering Research in India held at IISc, Bangalore.

3. Gave invited plenary lecture at the National Seminar on Cell Biology held at the University of Mysore, Mysore.

4. Chaired a sesson in the 25th Annual Convention of Chemists, Calcutta.

5. Took part in the deliberation in the DST seminar on Review and update of thrust areas in Life Science, held in Sanjoy Gandhi Institute of Medical Sciences, Lucknow.

6. Delivered lecture entitled "Organization, cloning and evolution of a highly repetitive DNA in fish" in the SBC, Mysore Chapter.

7. Delivered a talk on "Light and Life" in the Birla Industrial and Technological Museum, Calcutta.

8. Delivered a talk on "Molecular Biology : Biochemical aspects" in the Symposium at Indo-German Association, Calcutta.

9. Delivered a talk in Bengali on "Science in everyday life" over AIR, Calcutta.

10. Participated in the Indo-French collaborative marine life project on board 'Calypso' of Cousteau Society around Andaman Islands.

11. Participated as members of several Research/Programme Advisory Committees of DST, DOD, Bidhan Chandra Krishi Viswavidyalaya, and Science and Technology Department, Govt. of West Bengal, Calcutta.

12. Participated in Teaching in M.Sc./M.Tech. courses of Calcutta, Kalyani and Jadavpur Universities.

Dr. P. Gupta participated in the following seminars/meetings :

1. Participated in the FEBS Laboratory course on Microinjection held at Freie University, Berlin.

2. Visited the Department of Genetics and Molecular Biology, University of Edinburgh, Scotland.

3. Conducted a DBT sponsored Laboratory Course on "Cloning, Sequencing and Chromosomal Localization of Animal genes in the Department of Biochemistry, Bose Institute, Calcutta.

4. Acted as Project Supervisor for M.Sc. final year student of the Department of Biophysies, Molecular Biology and Genetics, University of Calcutta, Calcutta.

5. Acted as Examiner for M.Sc. examination of Calcutta University, Calcutta.

6. Taught in our Institute's Advanced Course on Genetic Engineering.

Dr. P. Gupta and Prof. R. K. Mandal organized as Course Directors the DBT sponsored workshop on "Cloning, sequencing and chromosomal localization of animal genes".

Shri Joydip Dasgupta participated in the Symposium on Genetic Engineering research in India held in Bangalore.

Shri Utpal Datta participated in the DBT workshop on Chromosome manipulation in fish, held in Madurai Kamaraj University, Madurai.

Shri Ashim Banerjee participated in the laboratory course on Radiation Safety organized by BARC, Bombay.

Department of Biophysics

Dr. Asok Banerjee delivered an invited talk on "antiviral nucleosides,/their structure & function" at National Seminar on crystallography at Benaras Hindu University.

Dr. Banerjee delivered an invited talk on "Mathematical Molecular Modelling of Bio-macromolecules" at Mathematical Modelling Workshop, Indian Inst. of Chemical Biology, Jadavpur" sponsored by CSIR.

Dr. Siddhartha Roy attended XIIIth. International Conference on Magnetic Resonanse in Biological System and stayed to Brandeis University for an collaborative research on Stable isotope labeled nucleic acid during November, 1988.

Animal Physiology Section

Prof. A. K. Medda delivered an invited lecture in the National Symposium on Cryobiological Research in Animal Production and acted as Co-Chairman of the Session *V* on General Physiology at the 4th Annual Conference of Society of Animal Physiologists of India, held in September, 1988, at Makhdoom, Farah, Mathura. He also attended the 76th Session of the Indian Science Congress Association, held at Madurai in January, 1989. Prof. Medda also participated in National Symposium on Modern Trends in Environmental Biology and Seminar on Environment and Animal Life, and also acted as Chairman/Co-Chairman of a session of the symposium held at Rahara, West Bengal, in February, 1989.

Dr. A. K. Ray, Dr. A. K. Dasmahapatra, Sm. Mitali Pramanik, Shri Abhijit Panigrahi and Sm. Uma Bhattacharyya presented papers at the National Symposium on Modern Trends in Environmental Biology and Seminar on Environment and Animal Life, held at Rahara, West Bengal, in February, 1989. Dr. A. K. Dasmahapatra also presented paper at 76th Session of Indian Science Congress Association at Madurai in January, 1988.

Ph. D. Degrees Awarded

Name of the Candidate	Title of the Thesis	Name of the Research Guide
Department of Physics		
1. Aruna Bose	Use of Surface of Revolution Geometry in the Measurement of Incoherent Scatteting Cross Section of Gamma Rays.	Dr. Arun Kumar Chatterjee
Department of Chemistry		
1. Syamal Chakrabarti	Investigation of eggwhite proteins of reptiles.	Prof. N. K. Sinha
2. Chitra Mazumder	Effect of polyene antibiotics on some biochemical of *Aspergillus niger*.	Prof. P. Chakrabarti
3. Asis Kumar Datta	Studies on the floral and faunal lipids of Sundarban mangrove ecosystem.	Dr. A. Ghosh
4. Sumita Ray	Studies on lipids	Dr. A. Ghosh
Department of Botany		
5. Aparna Pal	On the pollen morphology of some members of Indian Asteraceae with reference to taxonomy and affinity.	Prof. S. Chanda
6. Swati Gupta	Morphology, aerobiology physiology and chemistry of the pollen grains of some subtropical Eastern Himalayan plants.	Prof. S. Chanda

7. Sakuntala Chatterjee	Studies on polyamines and ammonia assimilatory enzymes during germination and root nodule development of *P. mungo* L.	Dr. Bharati Ghosh
8. Smritimala Ganguli	Viability and vigour of wheat seeds.	Dr. Swati Sen-Mandi
Department of Microbiology		
9. Debjani Dutta	Studies on Aryl hydrocarbon Hydroxylase produced by *Aspergillus ochraceus* TS	Dr. T. B. Samanta
10. Syamal Kanti Chakrabarti	Relatedness among members of slow-and fast-growing rhizobia.	Dr. Pran K. Chakrabarty
11. Swapan Kumar Ray	Studies on extracellular methionine productton by *Bacillus megaterium* isolated from soil.	Dr. Geeta Nanda
Department of Biochemistry		
12. Sujay Dasgupta	Molecular cloning of the ribosomal RNA genes of catfish *Heteropneustes fossilis*.	Prof. R. K. Mandal
13. Manidipa Mukhopadhyay	Studies on A mutant of bacteriophage lambda which shows Host killing in absence of *N* gene function.	Prof. N. C. Mandal
14. Pushpita Maulik	Studies on the role of glutamate dehydrogenase and glutamine synthesize in N-assimilation by *Azospirillum brasilense*.	Prof. S. Ghosh

Animal Physiology Section

15.	Anathbandhu Chaudhury	Physiological studies on the thyroid hormone actions in silkworms (*Bombyx mori* L.).	Prof. A. K. Medda

PMCG Section

16.	Amit Bandopadhyaya	Characterisation of chromatin proteins in mirotic prophase.	Prof. S. K. Sen
17.	Sadhu Leelavathi	Androgenic plant production in Brassica spp. to evolve genetic reconbinants.	Prof. S. K. Sen
18.	Vanga Siva Reddy	Use of androgenic plant production techniques in evolving novel genetic variants in rice.	Prof. S. K. Sen
19.	Samir R. Sikdar	Genetic Manipulation studies in oil-yeilding Brassica sps.	Prof. S. K. Sen

APPENDIX—C

(List of publications)

Department of Physics

1. Order and Einstein's Concept of God : S. N. Changdar ; World Seminar on the Synthesis of Science and Religion (Bombay, India—in 1986). Published in 1988, page 265.
2. Spin-wave spectra in an order-parameter-preserving antiferromagnet : Indrani Bose, *J. Phys. C : Solid State Phys.*, **21** L841 1988.
3. Effect of loops on spiral lattice animal statistics : Indrani Bose, Purusattam Ray and Subhashish Mukhopadhyay ; *J. Phys. A : Math. Gen.* **21** L979, 1988.
4. Interpretation of Quantum Measurement without the Collapse Postulate ; D. Home and M. A. B. Whitaker, *Physics Letters A*, **128**, 1, 1988.
5. Is Quantum Mechanics with CP Nonconservation Incompatible with Einstein's Locality Condition at the Statistical Level ? : D. Home, A. Datta and A. Raychaudhuri, *Physics Letters A*, **130**, 187, 1988.
6. New Facets of the Einstein-Podolsky-Rosen Paradox from Elementary Particle Physics : D. Home, *Current Science*, **57**, 455, 1988.
7. Wave Function Collapse in the Ensemble Interpretation : D. Home and P. T. Landsberg, in the Book Microphysical Reality and Quantum Formalism (Kluwer, Dordrecht, 1988).
8. Einstein-Podolsky-Rosen Paradox for the K^0-K^{-0}, B^0-B^{-0} Systems : D. Home, in the Book Quantum Mechanics versus Local Realism (Plenum, New York, 1988).
9. EPR Paradox-Present Status and Future Outlook : D. Home, in the Book Schrodinger Birth Centenary Refresher Course in Theoretical Physics (World Scientific, Singapore, 1988).

Department of Chemistry

10. Structure and Stereochemistry of Mollugogenol G—A triterpenoid sapogenin from *Mollugo hirta* : A. K. Barua, S. Ghosh, K. Basu and A. Patra ; *J. Ind. Chem. Soc.* **66**, 64, 1989.

11. Spleen and thymus organogenesis under vitamin B—complex and ascorbic acid deficiency in weaning mice : A possible relationship with brain development : D. Ghosal, A. K. Barua and S. Basu ; *Trans. Bose Res. Inst.* **50(4)**, 1987.

12. Physical and chemical characterization of macroglobulin from marine turtle eggwhite : Dipak K. Mandal, A. K. Ray and N. K. Sinha ; *Int. J. Biol. Macromol.* **11**, 100-104, 1989.

13. Purification and characterization of proteinase inhibitor from *Artocarpus integrifolia* seeds : G. C. Kundu and N. K. Sinha ; *Phytochemistry*, **28**, 725-728, 1989.

14. Abnormal erythrocyte membrane cytoskeleton structure in chronic myelogenous leukemia : Joyoti Basu. Manikuntala Kundu, Madan Mohan Rakshit and Parul Chakrabarti ; *Biochem-Biophys. Acta*, **945**, 121-126, 1988.

15. Abnormalities in erythrocyte membrane in acute lymphoid leukemia : Mnaikuntala Kundu, Joyoti Basu, Madan Mohan Rakshit and Parul Chakrabarti ; *Biochem. J.*, **258**, 903-906, 1989.

16. Yeast lectin, in Lectins-Biology, Biochemistry : Joyoti Basu, Manikuntala Kundu and Parul Chakrabarti ; *Clinical Biochemistry* (eds. Bog-Hansen, T. C. and Freed, D. L. J.), **6**, 401-404, 1988.

17. Studies on a lectin from *Saccharomyces cerevisiae* : Manikuntala Kundu, Joyoti Basu and Parul Chakrabarti ; *Ind. J. Biochem. Biophys.* **25**, 204-208, 1988.

18. Lipids and fatty acids of the bivalve *Andara granosa* from lower long sand of gangetic delta regions of W. Bengal : S. Chattopadhyay, P. K. Pal, A. Ghosh, S. Misra, T. K. Dam and A. Chowdhury ; *J. Mar. Biol. Assoc.* India, **29**, 383-387, 1988.

19. Sterols and terpenoids of the seagrass *Porterisia coarctata* grown in two different mangrove habitats of Sunderban : S. Misra, A. Chowdhury, S. Chattopadhyay and A. Ghosh ; *J. Mar. Biol. Assoc.* India, **29**, 365-366, 1988.

20. Mesuarin : a new 4-phenyl coumarin from *Mesua ferrea* L : P. Bhattacharyya, P. K. Chakrabartty and B. K. Chowdhury ; *Chemistry and Industry*, 239, 1988.

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Department of Botany

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Plant Molecular & Cellular Genetics Section

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Statement of Accounts for the year 1988-89

Bose

93/1, Acharya Prafulla Ch. 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	4,68,24,585.87
Sir J. C. Bose Cent. Building Fund	III	91,19,509.69
Acharya J. C. Bose Cent. Lab. Fund	IV	15,99,768.49
Salt Lake Land Procurement Fund	V	14,46,213.80
Special Fund	VI	9,42,013.68
House Building Advance Fund	VII	14,03,560.00
Bose Institute Council Payable Account	VIII	1,46,276.38
Excess of Recipts over expenditure in respect of Miscellaneous Grant-in-Aid Schemes (Net)	IX	23,55,764.19
Deposits and other liabilities	X	32,32,912.07
		6,88,96,387.19

Sd/-
M. L. DUTTA
Audit & Finance Officer
Bose Institute

Sd/-
A. J. DUTTA
Registrar
Bose Institute

Sd/-
B. B. BISWAS
Director
Bose Institute

Institute

Calcutta-700 009

31st March, 1989

PROPERTIES & ASSETS	SCHEDULE NO.	Amount Rs. P.
Investment and other properties	XI	23,25,783.11
Fixed Assets from Non-Recurring Grant	XII	4,65,74,955.60
Sir J. C. Bose Cent. Building	XIII	91,19,509.69
Acharya J. C. Bose Cent. Laboratory	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	10,02,060.00
Workshop Stores	XVIII	62,037.65
Security Doposit	XIX	41,254.00
Receivable Account	XX	6,98,581.42
Excess of expenditure over income as per Annexed Accounts		6,49,590.75
Cash & Bank Balance	XXI	45,18,410.35
Notes on Accounts		
		6,88,96,387.19

This is the Balance Sheet referred to in our separate report of even date.

Sd/-
RAY & RAY
Chartered Accountants

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			
A. Salaries, Scholarships & Allowances			
Director & Administration	4,45,775.00	7,62,579.35	12,08,354.35
Research (including Experimental Farms)	29,73,759.73	45,01,451.31	74,75,211.04
Workshop	5,19,291.05	6,08,351.30	11,27,642.35
Library	1,10,777.15	1,69,594.85	2,80,372.00
Lower Sub-Ordinate	1,78,300.98	2,48,396.18	4,16,697.06
Dearness Pay	16,511.00	23,100.00	39,611.00
Addl. Dearness Allowances	9,46,911.54	10,82,937.77	19,79,849.31
House Rent Allowances	7,78,633.80	11,55,617.60	19,34,251.40
City Compensatory Allowances	1,34,233.96	1,44,164.62	2,78,398.58
Medical Benefits	7,49,733.77	1,50,291.73	9,00,025.50
Tiffin Allowances	360.00	—	360.00
Pension	5,91,934.49	—	5,91,934.49
Gratuity	3,08,628.00	—	3,08,628.00
Leave Salary	1,36,540.50	—	1,36,540.50
Provident Fund Contribution	21,530.00	—	21,530.00
Exgratia	—	8,500.00	8,500.00
Interim Relief	7,400.00	9,600.00	17,000.00
Overtime & Honorarium	13,848.15	—	13,848.15
Add-hoc Bonus	1,00,236.00	1,69,372.00	2,69,608.00
Hill Allowance	480.00	—	480.00
Arrear dues (Academic staff for 1987-88)	7,12,832.43	1,15,743.42	8,28,075.85
Leave Travel Concession	9,462.00	—	9,462.00
	87,51,679.50	90,94,700.08	1,78,46,379.58

Carried Over

Institute

Calcutta-700 009

COUNCIL

at 31st March, 1989

INCOME	Non-plan Rs. P.	Plan Rs. P.	Total Rs. P.
By			
,, Grant from Govt. of India	1,20,00,000 00	93,00,000.00	2,13,00,000.00
,, Interest from Bank	—	1,76,954.25	1,76,954.25
,, Interest from C. E. S. C.	—	2,150.50	2,150 50
,, Service Charge	20,054.60	30,000.00	50,054.60
,, Miscellaneous Receipts	29,449.93	20,000.00	49,449.93
,, Excess of Income over expenditure transfer from Governing Body Account	1,37,239.37	—	1,37,239.37
,, Overhead Charges	—	8,500 00	8,500.00
	1,21,86,743.90	95,37,604.75	2,17,24,348.65

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.
B/F	87,51,679.50	90 94,700.08	1.71,46,379.56
B. Laboratory Expenses :			
Physics	1,19,568.14	18,023.94	1,37,592.08
Chemistry	1,67,330.80	29,862.08	1,97,192.88
Botany	1,56,525.29	30,349.26	1,86,874.55
Microbiology	2,23,903.89	37,707.97	2,61,611.86
Biochemistry	1,97,666.80	8,164.40	2,05,831.20
Biophysics	—	98,851.84	98,851.34
Animal Physiology	69,796.20	19,962.99	89,759.19
Library	19,783.78	6,626.26	26,359.99
Plant Molecu. & Cellu. Genetics	65,102.79	20,654.56	85,757.35
Workshop	1,15,593.46	17,444.06	1,33,037.52
Experimental Farms	36,230.15	9,903.00	46,133.15
	99,23,180.75	93,92,249.94	1,93,15,380.69

Carried Over

Institute

Calcutta-700 009

COUNCIL

at 31st March, 1989

INCOME	Non-plan Rs. P.	Plan Rs. P.	Total Rs. P.
B/F.	1,21,86,743.90	95,37,604.75	2,17,24,348.65
	1,21,86,743.90	95,37,604.75	2,17,24,348.65

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	99,23,130.75	98,92,249.94	1,98,15,380.69
C. Maintenance and Other Contingencies			
General (including Bank Charges, Reg. of House Building Mortgage cost, Legal expenses)	2,59,929.61	12,485.50	2,72,415.11
Building repair and maintenance	60,129.25	11,800.60	71,929.85
Car repair and maintenance	1,32,720.32	15,805.02	1,48,525.34
Telephone and Telex	50,301.01	27,480.99	77,782.00
Security Guard	98,639.20	9,089.05	1,07,728.25
Electric and Gas bill	11,07,001.29	1,08,265.29	12,15,266.58
Travelling (including abroad)	42,570.39	11,155.61	53,726.00
Rent and Taxes	2,275.44	—	2,275.44
Publication	50,721.79	7,633.71	58,355.50
Stationary and Printing	6,209.25	6,433.10	12,642.35
Postage Expenses	36,269.00	9,899.35	46,168.35
Audit Fees (1987-88)	6,600.00	—	6,600.00
Garden Maintenance	40,600.00	13,400.00	54,000.00
Scholar's Hostel	54,026.60	—	54,026.60
Advertisement	6,201.00	6,920.00	13,121.00
Fire Insurance	9,419.00	3,307.00	12,726.00
House Building Loan Fund (By transfer)	3,00,000.00	—	3,00,000.00
U.N.D.P. (By transfer)		3,00,000.00	3,00,000.00
Grand Total :	1,21,86,743.90	99,35,925.16	2,21,22,669.06
To Excess of Expenditure over Income for this year brought down	—	3,98,320.41	3,98,320.41
To Excess of Expenditure over Income from last year's Account brought forward	—	2,51,270.34	2,51,270.34
		6,49,590.75	6,49,590.75

Sd/-
M. L. DUTTA
Audit & Finance Officer
Bose Institute

Sd/-
A. J. DUTTA
Registrar
Bose Institute

Sd/-
B. B. BISWAS
Director
Bose Institute

Institute

Calcutta-700 009

COUNCIL

at 31st March, 1989

INCOME	Non-Plan Rs. P.	Plan Rs. P.	Total Rs. P.
By Brought Forward	1,21,86,743.90	95,37,604.75	2,17,24,348.65
	1,21,86,743.90	95,37,604.75	2,17,24,348.65
By Excess of Expenditure over Income for this year carried down	—	3,98,320.41	3,98,320.41
	1,21,86,743.90	99,35,925.16	2,21,22,669.06
By Balance transferred for Balance Sheet	—	6,49,590.75	6,49,590.75
	—	6,49,590.75	6,49,590.75

Sd/-
RAY & RAY
Chartered Accountants

Bose

93/1, Acharya Prafulla Ch. Road,

Income & Expenditure Account of the Governing

EXPENDITURE	Rs.	P.
To		
Administrative Expenses	14,400.00	
Donation	24,500.00	
Printing & Stationary	15.00	
Rent & Taxes	1,737.60	
Travelling Expenses	5,545.00	
Excess of Income over Expenditure	1,37,289.57	
	1,83,486.97	

Sd/-
A. J. DUTTA
Asst. Secretary
Bose Institute
Governing Body

Sd/-
B. B. BISWAS
Secretary
Bose Institute
Governing Body

Institute

Calcutta-700 009

Body for the year ended at 31st March, 1989

INCOME	Rs.	P.
By		
Interest General	1,59,209.39	
Birla Jute Scholarship Fund	2,684.00	
J. C. Bose Scholarship Fund	5,500.00	
Urmila Devi Benevolent Fund	977.78	
Richard Marry Keating Fund	9,832.25	
Membership Subscription	60.00	
Refund of Income Tax	3,630.00	
Transferred from Suspense	1,542.55	
	1,83,436.97	

Sd/-
RAY & RAY
Chartered Accountants

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.89

	Bose Institute Rs. P.	Governing Body Rs. P.	Total Rs. P.
SCHEDULE NO. I			
Capital Account ;			
As per last Account		23,19,073.20	
Add : This year's transfer from interest A/c.		6,709.91	23,25,783.11
SCHEDULE NO. II			
Grants for Capital Expenditure :			
From Govt. of India			
As per last account		3,85,56,621.55	
Add : Received this year		32,00,000.00	
		4,17,56,621.55	
Refund of CIT Instalment		36,866.41	
		4,17,93,487.96	
Less : Transfer to Plan (R)		5,00,000.00	
		4,12,93,487.96	
Transfer to Cent. Bldg. 3rd Floor Account		21,13,850.15	
		3,91,79,637.81	

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.89

	Bose Institute Rs. P.	Governing Body Rs. P.	Total Rs. P.
SCHEDULE NO. II (Contd.)			
Add : Grant from Govt. of W.B.			
As per last A/c.		40,000.00	
Sir J. C. Bose's Contribution through Trust Fund No. 1			
As per last A/c.		1,23,402.49	
Transfer from Council Revenue Account			
As per last A/c.		9,092.82	
Transfer from Grant-in-Aid Scheme			
As per last Account	68,80,099.85		
Add : This year	2,88,319.90		
	71,68,419.75		
Less : Adjustment with Biochemistry N/R	1,95,967.00	69,72,452.75	4,63,24,585.87
SCHEDULE NO. III			
Sir J. C. Bose Cent. Building Fund			
Ground & 1st floor			
As per last account		47,44,000.00	
2nd Floor			
As per last A/c.		15,00,000.00	
3rd Floor			
This year's transfer from N/R grant		21,13,850.15	
,, from W/Stores		11,659.54	
Annexe			
As per last Account		7,50,000.00	91,19,509.69

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.89

	Bose Institute Rs.	P.	Governing Body Rs.	P.	Total Rs.	P.
SCHEDULE NO. IV						
Acharya J. C. Bose Cent. Lab. Fund						
As per last A/c.						
Grant from Govt. of India			1,54,500.00			
Grant from Govt. of W. Bengal			2,00,000.00			
Sir J. C. Bose's Contribution through Trust Fund No. 1 created by him			2,00,000.00			
Transfer from N/R Grant for CIT land instalments						
As per last Account	10,82,134.81					
Less : Refund of CIT Instalment	36,866.41		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 W.B.		12,00,000.00				
Transfer from N/R grant		2,46,213.80			14,46,213.80	

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.89

	Bose Institute Rs.	P.	Governing Body Rs.	P.	Total Rs.	P.
SCHEDULE NO. VI						
Special Funds :						
J. C. Bose Scholarship Fund						
As per last A/c.			50,000.00		50,000.00	
Sir J. C. Bose Medal Fund						
As per last account			1,02,615.71			
Add : Income, this year			9,007.50		1,11,623.21	
Sir J. C. Bose Endowment Fund						
As per last account			4,92,724.77			
Add : Income, this year			49,000.00			
			5,41,724.77			
Less : Expenditure during this year			800.00		5,40,924.77	
Richard Merry Keating Fund						
As per last account			1,04,541.67		1,04,541.67	
Birla Scholarship Fund						
As per last account			20,000.00		20,000.00	
Urmila Devi Benevolent Fund						
As per last account			8,800.00		8,800.00	
Sir Nilratan Sarkar Prize Fund						
As per last account			19,453.33			
Add : Income, this year			3,080.00		22,533.33	
Samir Sinha Memorial Fund						
As per last account			10,000.00			
Add : Income, this year			500.00		10,500.00	
Sir J. C. Bose's Contribution through Trust Fund No. 1, created by him						
As per last account			35,994.54			
Add : Income, this year			1,800.00		37,794.54	

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.89

	Bose Institute Rs. P.	Governing Body Rs. P.	Total Rs. P.
SCHEDULE NO. VI (Contd.)			
Prof. S. M. Sircar Memorial Lecture Fund			
As per last account	4,138.20		4,138.20
Director's Discretionary Fund			
As per last account	20,966.61		
Less : Advance, during this year	7,000.00		
	13,966.61		
Add : Realisation during this year	3,750.00		17,716.61
C. D. S. Fund (Employees)			
As per last account	6,529.76		6,529.76
Apparatus & Book Purchase Fund			
As per last account	6,911.59		6,911.59
			9,42,013.68
SCHEDULE NO. VII			
House Building Advance Fund			
As per last account	11,00,000.00		
Add : Transfer from Non-plan Recurring grant this year	3,00,000.00		
	14,00,000.00		
Add : Interest received on loan	3,560.00		14,03,560.00

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.89

	Bose Institute Rs. P.	Governing Body Rs. P.	Total Rs. P.
SCHEDULE NO. VIII			
		9,037.01	
Bose Institute, Council			
Add : Excess of Income & Expd. A/c.		1,37,239.37	1,46,276.38
SCHEDULE NO. IX			
Excess of Receipts over expenditure in respect of Miscellaneous grant-in-Aid Schemes (Net)	23,55,764.19		23,55,764.19
SCHEDULE NO. X			
Deposit & Other Liability			
For Goods and expenses		27,73,390.09	
,, Earnest Money/s Deposit		1,68,787.86	
,, Party Income Tax		0.02	
,, Fire Damage Compensation		10,520.00	
,, Cumulative Time Deposit		46.50	
,, Postal Recurring Deposit		572.80	
,, Insurance Premium		2,235.86	
,, Professional Tax		7,938.82	
,, Provident Fund Suspense		1,188.35	
,, Co-operative Credit Society		10,749.23	
,, P. M. Drought Relief Fund		113.00	
,, P. F. Payable		57,136.00	
,, Suspense		783.54	
,, Short Tern Technician Course		1,99,500.00	32,32,912.07
			6,88,96,387.19

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.89

	Bose Institute Rs. P.	Governing Body Rs. P.	Total Rs. P.
SCHEDULE NO. XI			
Investment and Properties			
Fixed Deposit with State Bank of India			
As per last Account		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 Account			
Land at Calcutta		1,26,613.00	
,, at Darjeeling		16,000.00	
,, at Falta (On leasehold land)		56,832.16	1,99,445.16
Building at Calcutta		2,89,620.25	
,, at Darjeeling		27,566.00	
,, at Falta (On leasehold land)		49,992.00	3,67,178.25
Furniture & Fittings			
As per last Account		20,771.48	
Add : This year's transfer from Interest Account		6,709.91	27,481.39
Apparatus			
As per last Account		78,816.94	78,816.94
Books & Journal			
As per last Account		28,667.62	28,667.62
			23,25,783.11

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.89

	Bose Institute Rs. P.	Governing Body Rs. P.	Total Rs. P.
SCHEDULE NO. XII			
Fixed Assets from N/R Grant			
As per last Account			
Building at Calcutta		8,74,350.09	
,, at Shyamnagar		92,647.99	
,, at Madhyamgram			
As per last Account Rs. 5,57,634.98			
Add : This year Rs. 32,132.29		5,89,767.27	15,56,765.35
Apparatus and Equipment			
As per last Account Rs. 1,44,02,323.51			
Add : During this year 17,80,504.36		1,61,82,827.87	
Transfer from terminated Schemes			
As per last Account Rs. 68,10,099.85			
Add : During this year 2,88,319.90			
		70,98,419.75	
Less :			
Adjustment with			
Biochemistry N/R Rs. 1,95,967.00		69,02,452.75	2,30,85,280.62
Workshop Apparatus			
As per last Account		6,05,889.09	
Add : This year		1,830.00	6,07,719.09
Air-conditioning (Centenary Building)			
As per last Account		1,79,225.56	
Furniture & Fittings			
As per last Account		14,55,578.38	14,55,578.38
Laboratory Remodeling (Build Dark and Cold Room)			
As per lase Account		11,68,735.36	11,68,735.36

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.89

	Bose Institute Rs. P.	Governing Body Rs. P.	Total Rs. P.
SCHEDULE XII (Contd.)			
Books Journals			
As per last Account	98,16,860.86		
Add : This year	18,12,869.62		1,16,28,730.48
Electrical Installation at Centenary Building (including Security Deposit Rs. 39000/- with C.E.S.C.)			
As per last Account	10,44,829.88		10,44,829.88
Renovation works at Main Campus			
As per last Account	17,75,847.72		
Add : This year	8,626.00		17,84,473.72
Tube well			
As per last Account	2,43,170.01		2,43,170.01
Fire Damage Lab. Equipment			
As per last Account	65,000.00		65,000.00
Motor Car (including a Car received from DST valued at Rs. 70,000/-)			
As per last Account	2,89,785.17		2,89,785.17
Gas Plant			
As per last Account	46,256.00		46,256.00
Glass House			
As per last Account	14,432.46		14,432.46
Boundary Wall, at Madhamgram			
As per last Account	2,85,737.27		2,85,737.27
Hostel Building (under progress)			
As per last Account	31,03,270.00		
Add : This year	16,000.00		31,19,270.00
Internal Telephone			
As per last Account	466.75		466.75
			4,65,74,955.60

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.89

	Bose Institute Rs. P.	Governing Body Rs. P.	Total Rs. P.
SCHEDULE NO. XIII			
Sir J. C. Bose Centenary Building			
As per last Account			
Ground & 1st floor	46,80,736.51		
2nd floor	13,84,459.23		
3rd floor (under progress)			
As per last Account Rs. 1,11,350.00			
Add : This year Rs. 21,44,099.40		22,55,449.40	
Annexe			
As per last Account	8,48,864.55		91,19,509.69
SCHEDULE NO. XIV			
Acharya J. C. Bose Cent. Laboratory Madhyamgram Expt. Farm			
As per last Account		3,09,461.50	
O.I.T. land on lease of which Rs. 10,82,134.81— Rs. 36,866.41 (Adjusted)—Rs. 10,45,268.40 paid by Transfer from Non-Recurring Grant		11,88,994.21	
Lease Deed Registration cost			
As per last Account		23,735.50	
Boundary wall, plan cost, etc.			
As per last Account		74,493.98	15,96,685.19

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.89

	Bose Institute Rs. P.	Governing Body Rs. P.	Total Rs. P.
SCHEDULE NO. XV			
Land at Salt Lake			
As per last Account	14,46,213.80		14,46,213.80
SCHEDULE NO. XVI			
Special Fund Investment			
Sir J. C. Bose Scholarship Fund			
Fixed Deposit with State Bank of India			
As per last Account		50,000.00	50,000.00
Sir J. C. Bose Medal Fund			
Fixed Deposit with SBI			
As per last Account		65,750.00	
Add : During this year		41,000.00	1,06,750.00
Sir J. C. Bose Endowment Fund			
Fixed Deposit with State Bank of India			
As per last Account		4,00,000.00	
Add : During this year		1,00,000.00	5,00,000.00
Richard Merry Keating Fund			
As per last Account			
Fixed Deposit with State Bank of India		82,500.00	
£ 500 Pref. Shares (CESC)		6,041.67	
		88,541.67	
Add : During this year		16,000.00	1,04,541.67

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.89

	Bose Institute Rs. P.	Governing Body Rs. P.	Total Rs. P.
SCHEDULE NO. XVI (Contd.)			
Birla Scholarship Fund			
As per last Account			
200 Nos. 15% Non-convertible			
Debenture of Birla Jute & Industries Ltd.		20,000.00	20,000.00
Urmila Devi Benevolent Fund			
As per last Account			
3% Conversion loan lodged with Govt. W. Bengal		8,800.00	8,800.00
Sir Nilratan Sarkar Prize Fund			
Fixed Deposit with State Bank of India			
As per last Acconnt		15,000.00	15,000.00
Sir J. C. Bose's contribution through			
Trust Fund No. 1			
Fixed Deposit with State Bank of India		36,000.00	36,000.00
Samir Sinha Memorial Prize Fund			
Fixed Deposit with State Bank of India		10,000.00	10,000.00
Prof. S. M. Sarkar Memorial Lecture Fund			
Fixed Deposit with United Bank of India		4,000.00	4,000.00
C.D.S. Fund with P. F. Commissioner			
As per last Account		6,213.96	6,213.96
			8,61,305.63
SCHEDULE NO. XVII			
House Building Advance			
As per last Account	8,61,600.00		
Add : Loan sanction during this year	2,11,000.00		
	10,72,600.00		
Less : Recovery during this year	70,540.00		10,02,060.00

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.89

	Bose Institute Rs. P.	Governing Body Rs. P.	Total Rs. P.
SCHEDULE NO. XVIII			
Workshop Stores			
As per last Accaont	1,21,220.28		
Less : Adjustment during this year	59,182.63		62,037.65
SCHEDULE NO. XIX			
Security Deposit :			
Electric & Telephone	18,169.00	75.00	
Others	250.00		
Gas Cylinder	4,600.00		
Petrol	5,000.00		
Telex	10,000.00		
Electric (W.B.S.E.B.)	2,160.00		
Regional Computer Centre	1,000.00		41,254.00
SCHEDULE NO. XX			
Receivable Account			
Special Advance	1,650.00		
Advance	1,33,495.00		
Income Tax Staff	115.02		
Festival Advance	1,15,847.03		
D.M. Bose Birth Centenary Celebration	6,558.53		
Symposium on Radiation Physics	41,150.23		
R.S.I.C.	2,53,489.23		
Governing Body	1,46,276.38		6,98,581.42

Bose Institute

CALCUTTA-700 009

Schedule for Consolidated Balance Sheet as at 31.3.89

	Bose Institute Rs. P.	Govering Body Rs. P.	Total Rs. P.
SCHEDULE NO. XXI			
Cash & Bank Balance :			
In Hand	4,499.71	160.20	
With United Bank of India	17,58,862.04		
,, Union Bank of India (On Saving Account)	1,00,154.28		
On Guarantee Margin Account	52,959.00		
With Grindlays Bank Plc.	28,97,024.88		
,, State Bank of India		2,04,750.24	45,18,410.85
			6,82,46,796.44

Sd/-
M. L. DUTTA
Audit & Finance Officer
Bose Institute

Sd/-
A. J. DUTTA
Registrar
Bose Institute

Sd/-
B. B. BISWAS
Director
Bose Institute

Bose Institute

CALCUTTA-700 009

Summary of the Grants-in-aid Scheme Accounts for the year 1988-89

Balance Receivable	Amount Rs.	P.	Amount Rs.	P.
A. Projects :				
C. S. I. R. Schemes :				
Dr. Parimal Ch. Sen	1,051.13			
Dr. Asoke Ch. Ghosh	124.20			
Dr. Siddhartha Roy	43,771.14			
Dr. B. Bhattacharya	14,627.14			
Dr. Dolly Ghosh	8,570.77		68,144.38	
D. S. T. Projects :				
Dr. B. B. Biswas	13,633.08			
Dr. S. K. Sen	2,11,899.93			
Dr. Bharati Ghosh	19,321.44			
Dr. D. P. Chakrabarty	14,299.51			
Dr. Bimalendu Mitra	85,897.69		3,45,051.65	
D. N. E. S. project :				
Dr. Parul Chakraborty			16,956.91	
Government of West Bengal Project :				
Dr. B. B. Mukherjee			20,141.93	
Hindusthan Lever Project :				
Dr. S. K. Sen			1,373.37	
I. C. A. R. Projects :				
Dr. Susweta Biswas	1,73,202.64			
Dr. Swati Sen Mandi	49,124.26			
Dr. S. K. Sen (3)	3,28,753.36			
Dr. S. K. Sen (2)	38,197 64			
Dr. S. K. Sen (1)	24,745.58			
Dr. S. Ghosh	96,548.71			
Dr. Bharati Ghosh	15,232.99			
Dr. D. P. Chakraborty	64,267.20		7,90,072.98	

(Contd.)

Bose Institute

CALCUTTA-700 009

Summary of the Grants-in-aid Scheme Accounts for the year 1988-89

Balance Receivable	Amount Rs.	P.	Amount Rs.	P.
I. C. M. R. Scheme :				
Prof. J. Dutta (O)			13,228.60	
I. S. M. Project :				
Dr. A. K. Mishra (6)			22,264.69	
N. I. K. Project :				
Dr. Parul Chakraborty			14,677.39	
U. S. D. A. (FERRO) Project :				
Dr. S. K. Sen			85,360.97	
		(A)	13,77,272.27	
B. Pool/Associateships/Fellowships, etc.				
Dr. Anuradha Lohia			49.66	
C. S. I. R. Associateship :				
Dr. Manikuntala Kundu			5,285.47	
C. S. I. R. Fellowships :				
Sm. Sucheta Chanda	2,208.02			
Shri Amit Kr. Maity	1,592.82			
Shri V. S. Reddy	563.95		4,364.79	
I. C. M. R. Fellowship :				
Sm. Mitali Pramanik			1,678.30	
U. G. C. Associateship :				
Dr. Amitava Chattopadhyay			9,404.62	
		(B)	20,782.84	
		TOTAL A+B	13,98,055.11	
		Balance Payable	23,55,764.19	
			37,53,819.30	

Bose Institute

CALCUTTA-700 009

Summary of the Grants-in-aid Scheme Accounts for the year 1988-89

Balance Payable	Amount Rs. P.	Amount Rs. P.
A. Projects -		
Bioactive Substance Project		
Prof. A. K. Barua		4,08,877.05
Burn Standard Project		
Prof. A. K. Mishra		1,02,646.88
C. S. I. R. Schemes :		
Dr. Bharati Ghosh		18,750.00
Dr. Swati Sen Mandi		4,817.50
Dr. Asoke Banerjee		12,485.92
Dr. Susweta Biswas		17,968.28
Dr. Amita Pal		4,499.72
Dr. N. K. Sinha		5,140.75
Dr. Manisha Bose		18,128.69
Dr. T. B. Samanta		2,46,251.21
Dr. Bharati Ghosh (O)		21,644.51
D. S. T. Project :		
Dr. T. B. Jha		42,683.68
D. A. E. Project :		
Dr. Parimal Sen		54,099.00
Department of Environment :		
Dr. Kalyani Sen		50,564.91
D. I. C. Project :		
Dr. M. H. Engineer		7,64,929.45
D. B. T. Workshop :		
Dr. Prabhakar Gupta		15,040.99
Govt. of West Bengal :		
Dr. S. K. Sen		88,235.78

(Contd.)

Bose Institute

CALCUTTA-700 009

Summary of the Grants-in-aid Scheme Accounts for the year 1988-89

Balance Payable	Amount Rs. P.	Amount Rs. P.
Hindusthan Lever Project :		
Dr. Bharati Ghosh		12,676.29
I.C.M.R. Projects :		
Dr. Parul Chakraborty	43,028.29	
Dr. S. Ghosh	31,170.01	
Prof. J. Dutta (5)	49,187.51	1,23,385.81
I.S.M. Projects :		
Dr. A. K. Mishra (5)	2,333.90	
Dr. A. K. Mishra (3)	19,954.02	22,287.92
U.N.D.P. Projects :		
Prof. B. B. Biswas, Prof. S. Ghosh		
Prof. S. K. Sen and Prof. R. K. Mondal	3,63,614.87	
Prof. P. Chakraborty, Prof. N. C. Mondal		
and Dr. Asoke Banerjee	2,88,440.06	6,52,054 93
A.E.R.B. Project :		
Prof. S. C. Roy		16,569.13
Indo-US Collaborative Project :		
Prof. S. C. Roy		8,88,300.00
		(A) 35,41,438.30

(Contd.)

Bose Institute

CALCUTTA-700 009

Summary of the Grants-in-aid Scheme Accounts for the year 1988-89

Balance Payable	Amount Rs. P.	Amount Rs. P.
B. Associateships/Fellowships/Pool, etc.		
C.S.I.R. Pool		
Dr. Manick Ch. Das		5,355.06
C.S.I.R. Associate ship :		
Dr. Suchitra Banerjee	1,119.63	
Dr. Jayati Basu	489.26	1,608.89
C S.I.R. Fellowships :		
Sm. Samita Seal	1,449.85	
Sri Santanu Roy Chowdhury	2,900.00	
Sri Utpal Dutta	24,527.06	
Sm. Pritilata Nayak	9,762.27	
Sm. Debjani Dutta	236.35	
Sri Prankrishna Dutta	2,543.43	
Sm. Swati Gupta	4,010.60	
Sm. Alo Pal	1,884.88	
Sri Narayan Ch. Mondal	1,798.21	
Sm Dipta Bhattacherjee	4,277.63	
Sri Bidyut Ghosh	1,741.41	
Sm. Sadhu Leelavati	17,554.07	
Sri Chinmoy Nandi	129.30	
Sm. Aparna Pal	25,368.33	
Sri Susanta Kr. Dey	430.68	
Sri Sagar Sona Jash	1,954.04	
Sri Pradip Sarkar	215.84	
Sri Tapan Kr. Sengupta	215.61	
Sri Asim Kr. Mondal	725.00	
Sri Dulal Panda	1,444.15	
Sri Thakurdas Saha	3,625.00	
Sm. Chaitali Bhaumik	18,876.30	
Sri Subir Kr. Nag Das	643.45	
Sri Subrata Mazumder	19,073.10	1,45,386.56

(Contd.)

Bose Institute

CALCUTTA-700 009

Summary of the Grants-in-aid Scheme Accounts for the year 1988-89

Balance Payable	Amount Rs. P.	Amount Rs. P.
Department of Biotechnology :		
Dr. Gurupada Sarkar		21,312.23
D.A.E. Associateship :		
Sri A. S. Rishi		8,916.35
I.C.M.R. Fellowships :		
Sri Subha Manna	2,394.75	
Sm. Sarmila Chattopadhyay	2,594.45	
Sri Subhra Lahiri	774.56	
Sm. Debjani Dutta	2,514.90	8,278.66
U.G.C. Associateships :		
Sri T. Anoop Kumar	20,280.20	
Dr. Urmila Deb	1,243.05	21,523.25
		(B) 2,12,381.00
		TOTAL A+B : 37,58,819.30

Sd/-
M. L. DUTTA
Audit & Finance Officer
Bose Institute

Sd/-
A. J. DUATTA
Registrar
Bose Institue

Sd/-
B. B. BISWAS
Director
Bose Institute

Bose

93/1, Acharya Prafulla Ch. Road,

GENERAL PROVIDENT

Balance Sheet

FUND AND LIABILITIES	Rs. P.	Rs. P.	Rs. p.
P. F. Accumulation Account			
Employees Subscription			
As per last account		35,58,970.92	
Add : Subscription during the year			
Council :	10,80,829.00		
R.S.I.C.	83,661.00	11,64,490.00	
		47,23,460.92	
Less : Withdrawals during the year	1,32,065.08		
Less : Transfer to P. F. Accumulation Interest account	500.00	1,32,565.08	45,90,895.84
Office Contribution			
As per last account		41,25,920.62	
Add : Contribution during the year			
Council :	21,530.00		
R.S.I.C.	4,312.00		
Add : Transfer from P. F. Accumulation Voluntary account	1,000.00	26,842.00	
		41,52,762.62	
Less : Withdrawals during the year		3,626.00	41,49,136.62
Voluntary Contribution			
As per last account		4,72,820.42	
Add : Contribution during the year			
Council :	Nil		
R.S.I.C.	Nil	4,72,820.42	
Less : Withdrawals during the year	1,02,957.34		
Less : Transfer to P. F. Accumulation Office Contribution account	1,000.00	1,03,957.34	3,68,863.08

Contd.

Institute

Calcutta-700 009

FUND ACCOUNT

as at 31st March, 1989

PROPERTY AND ASSETS	Rs. P.	Rs. P.
Investments		
Fixed Deposit with State Bank of India		
As per last account	98,69,961.81	
Less : Matured during the year	17,93,691.97	
	80,76,269.84	
Add : Addition during the year	30,93,691.97	1,11,69,961.81
Income Tax Recoverable		
As per last account		3,460.00
Loan to Members		10,34,862.00
Amount Receivable		
Council :	57,136.00	
R.S.I.C.	2,430.00	59,566.00
Interest Accrued including not due—		12,92,445.82
Bank Balance with State Bank of India		
On Savings Bank Account		
As per Reconciliation Statement		3,05,495.17
		1,38,65,790.80

Contd.

Bose

93/1, Acharya Prafulla Ch. Road,

GENERAL PROVIDENT

Balance Sheet

FUND AND LIABILITIES			Rs.	P.
B/F.			1,38,65,790.80	
Interest paid to Employees				
As per last account		33,90,685.00		
Add : Credited during the year @ 12% p.a. for GPF and 11.50% p.a. for CPF	12,89,536.00			
Add : Transfer from P. F. Accumulation Employees Subscription account	500.00	12,90,036.00		
		46,80,721.00		
Less : Withdrawals during the year		71,566.00	46,09,155.00	
			1,37,18,050.54	
Undistributed Income				
As per Separate Account Annexed			1,45,392.16	*
Suspense Account				
As per Schedule			2,348.10	
			1,38,65,790.80	

Sd/-
M. L. DUTTA
Audit & Finance Officer
Bose Institute

Sd/-
A. J. DUTTA
Registrar
Bose Institute

Institute

Calcutta-700 009

FUND ACCOUNT

as at 31st March, 1989

PROPERTY AND ASSETS	Rs.	P.
B/F.	1,38,65,790.80	
	1,38,65,790.80	

Sd/-
B. B. BISWAS
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.
To Interest paid to members @ 12% p. a. in G. P. Fund and 11.50% in C.P.F.	12,89,536.00	
	12,89,536.00	
To Balance brought down	1,75,727.42	
To Balance carried over to Balance Sheet	1,45,392.16	
	3,21,119.58	

Sd/-
M. L. DUTTA
Audit & Finance Officer
Bose Institute

Sd/-
A. J. DUTTA
Registrar
Bose Institute

Sd/-
B. B. BISWAS
Director
Bose Institute

Institute

Calcutta-700 009

FUND ACCOUNT

at 31st March, 1989

INCOME	Rs.	P.	Rs.	P.
By Interest on :				
Fixed Deposit	10,97,109.64			
Savings Bank account	16,698.94		11,13,808.58	
Balance Carried down			1,75,727.42	
			12,89,536.00	
By Balance brought forward from last year's account			3,21,119.58	
			3,21,119.58	

Sd/-
RAY & RAY
Chartered Accountants

REGIONAL SOPHISTICATED

Managed by

Balance Sheet as at

FUNDS & LIABILITIES	1988-89 Rs. P.	1988-89 Rs. P.	1987-88 Rs. P.
Grant-in-Aid Account :			
As per last account	2,28,72,909.18		2,24,55,466.03
Add : Non-Recurring Grant, received from D.S.T.	4,11,374.00		3,50,000.00
Add : Interest on Saving Bank account	44,104.60	2,33,28,387.78	67,463.15
Sundry Creditors :			
For Goods	3,29,207.36		4,48,063.93
For Professional Tax	—		7.00
For PF Contribution	1,300.00	3,30,507.36	
Advance From Customer :			
For Sample Testing		9,082.25	14,178.25
Co-operative Account :			
For loan realisation		375.22	375.22
Bose Institute Account :			
For Salary M. T. and etc.		2,53,775.42	—
		2,39,22,128.03	2,33,35,533.58

NOTE : Bank Guarantee Rs. 81,968.00

Sd/-
M. L. DUTTA
Audit & Finance Officer
Bose Institute

Sd/-
A. J. DUTTA
Registrar
Bose Institute

Sd/-
B. B. BISWAS
Director
Bose Institute

INSTRUMENTATION CENTRE

Bose Institute

31st March, 1989

ASSETS & PROPERTIES	1988-89 Rs. P.	1988-89 Rs. P.	1987-88 Rs. P.
Fixed Assets :			
Equipment :			
As per last acconnt	1,90,90,169.24		1,85,60,248.31
Add : Addition during the year	20,075.34	1,91,10,244.58	5,29,920.93
Spares 'Plan' :			
As per last account	19,82,158.43		18,30,973.03
Add : Addition during the year	7,80,361.70	27,62,520.13	1,51,185.40
Furniture & Air-Conditioner :			
As per last account	3,13,773.20		3,09,701.60
Add: Addition during the year	NIL	3,13,773.20	4,071.60
Current Assets, Loans & Advances :			
Cash & Bank Balances in hand	11,674.76		11,399.07
With Scheduled Bank			
On Savings Bank account	6,26,920.38		14,06,516.83
On Guarantee account	16,400.00	6,54,995.14	16,400.00
Advances recoverable in cash or in kind or for value to be received :			
Festival Advance	9,480.00		10,560.00
Bose Institute		9,480.00	17,973.00
Suspense for F.T.N.M.R. :			
As per last account		1,26,353.00	1,26,353.00
Non-Plan Deficit account :			
As per separate account		14,761.98	3,60,230.81
Accrued Grant account Receivable from DST		9,30,000.00	—
		2,39,22,128.03	2,33,35,533.58

This is the Balance Sheet referred to in our report of even date.

Sd/-
RAY & RAY
Chartered Accountants

REGIONAL SOPHISTICATED

Managed by

Income & Expenditure Account (Non-Plan)

EXPENDITURE	1988-89 Rs. P.	1988-89 Rs. P.
To		
Employees' Remuneration and Benifts :		
Basic Pay (including arrear for Rs. 34,507.00)	6,41,873.00	
Dearness Pay	1,53,772.00	
Addl. Dearness Allowance	4,860.00	
Interim Relief	2,000.00	
House Rent Allowance	1,18,369.00	
Tiffin Allowance	—	
Medical Allowance/Assistance	52,413.55	
City Compensatory Allowance	22,360.00	
P. F. Contribution	4,312.00	
Ex-Gratia	—	
Overtime Allowance	834.10	
Bonus	15,720.00	10,16,533.65
Traveling Expenses :		1,730.00
Consumable/Laboratory Expenses :		
Contingency Expenses	37,836.65	
Laboratory Expenses	54,732.23	
F.T.N.M.R. Expenses	47,047.80	1,39,616.68
Other Expenses for Laboratory ;		
General Charges	1,558.00	
Labour Charges	1,366.00	
Books & Periodicals	908.85	
Advertisement	—	
Bank Charges	1,026.00	4,858.85
Brochure Expenses :	—	
Maintenance Expenses :	—	1,80,043.24
		13,42,782.42
Excess of Income over Expenditur during the year		3,45,468.83
		16,88,251.25
Excess of Expenditure over Income brought down from last year's account		3,60,230.81
		3,60,230.81

Sd/-
M. L. DUTTA
Audit and Finance Officer
Bose Institute

Sd/-
A. J. DUTTA
Registrar
Bose Institute

Sd/-
B. B. BISWAS
Director
Bose Institute

INSTRUMENTATION CENTRE

Bose Institute

for the year ended at 31st March, 1989

INCOME	1988-89 Rs. P.
By	
Source of Income :	
Grant (received from D.S.T. Govt. of India)	16,30,000.00
Consultancy Fees (Sample testing)	58,251.25
	16,88,251.25
By Excess of Income over expenditure for this year brought forward	3,45,468.83
By Balance transferred to Balance Sheet	14,761.98
	3,60,230.81

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, 1989 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 separately 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 filling of Returns were not complied with.

2. Sanction of the Central Government for appointment of Auditor is awaiting.

3. *Security Deposits Rs. 41,524.00*

   Confirmations of receipts of deposits were not available for verification.

4. *Amount Receivable Rs. 6,98,581.42*

   The above amount includes Rs. 1,33,495.00 being general advance in which there is a sum of Rs. 20,633.89 brought forward from last account which should be adjusted at an early date.

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 26 September, 1989

Bose Institute

CALCUTTA

SCHEDULE NO. XXII : NOTES FORMING PART OF ACCOUNTS FOR 1988-89

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 Possession on different dates. The balance land could not be handed over as it was disputed. The Governing body in its meeting held on 31.7.1989 has decided not to claim the balance land from the Government 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 14.2.196. Supplementary Lease Deed for 0.6996 Kottah is yet to be executed.

(c) *Manicktola* : 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 & condition of Lease and obtained a refund of Rs. 36,888.41 from C.I.T. and accounted for accordingly.

2. Fixed Assets :

(a) It appears that there is inadequate control in regard to maintenance of registers including identification and location, physical verification, ascertainment of damaged or unserviceable assets, etc. A Technical Committee was formed to assess condemned 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, those 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. In Festival Advance Account there is a difference of Rs. 72.97 between Ledgers and Schedule which should 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 10 years. This should be settled and dealt with accordingly.

9. Contracts remaining to be executed in Capital Accounts—Rs. 30.00 lakhs.

10. Contingent Liability—

(a) Letter of Credit Rs. 17,41,436.03

(b) Bank Guarantee Rs. 2,64, 713.00

Sd/-	Sd/-	Sd/-
M. L. Dutta	A. J. Dutta	B. B. Biswas
Audit & Finance Officer	*Registrar*	*Director*
Bose Institute	Bose Institute	Bose Institute

Dated : 26 September, 1989

Sd/-
RAY & RAY
Chartered Accountants

Bose Institute

CALCUTTA

GENERAL PROVIDENT FUND ACCOUNT

AUDITORS' REPORT

We have audited the attached Balance Sheet of the Contributory Provident Fund of the Bose Institute as at 31st March, 1989 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, subject to the following observations :

(a) An amount of Rs. 901.90 (Dr.), debited by Bank (S.B.I.) in C/A on 26.7.1983 could not be linked up with accounts and kept in the suspense.

(b) An amount of Rs. 1,350.00 (Cr.), credited by Bank on 18.10.85 but could not be traced and kept under suspense.

These should be located and accounted for accordingly.

The 26 September, 1989

RAY & RAY
Chartered Accountants

Regional Sophisticated Instrumentation Centre

AUDITOR'S REPORT

We have audited the attached Balance Sheet of Regional Sophisticated Instrumentation Centre as at 31st March, 1989 and the Income and 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, 1989 and Income and Expenditure Account gives a true and fair view of the deficit of Income and Expenditure for the year ended on that date subject to the following observations :

1. **Suspense F.T.N.M.R. Rs. 1,26,353** (Dr)

The Centre and purchases 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 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 off or mortgage any property acquired by it with such grants without prior approval of the Government.

4. An I.P.O. of Rs. 740.00 deposited in Union Bank for more than 7 years is not yet cleared and kept as unreconciled. This should be written off.

5. List of liabilities includes M/s. Allied Publishers Agency Rs. 8,439.36 and "Erection charges of Sophisticated Instrument"—Rs. 50,000.00 for which no bills were available for verification. As explained these are lying unpaid over five years.

6. An amount of Rs. 44,104.60 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 A/c.

7. Excess of Expenditure over Income for Rs. 3,60,230.81 brought forward from previous year is shown separately. Net operating result representing surplus for the year, being Rs. 3,45,468.83 (Cr) has been set off with the previous year excess of expenditure of Rs. 3,60,230.81 (Dr) leaving a debit balance of Rs. 14,761.98.

Sd/-
RAY & RAY
Chartered Accountants

The 26th September, 1989