

1. AN OVERVIEW

The impact of biotechnology on human life and economic progress of various nations world over has given a major impetus to accelerate research, development and application of this field in relevant socio-economic sectors. The cell fusion techniques, recombinant DNA technology, protein engineering and structural biology have made phenomenal progress as priority research areas. The country today has excellent expertise in more than 25 institutions, including the universities. In addition to basic research, the scientists are actively engaged in fermentation based activities, production of valuable biologicals, plant or animal cell culture, marker assisted selection and breeding, value addition, prospecting of biological resources, molecular taxonomy and micropropagation methods for producing high quality, genetically superior planting materials.

The period under reporting has been a very exciting one, in terms of transfer of important technologies to industry as also in generating some significant R&D leads. The department interacted with a large number of scientists, technologists and engineers. Special focus has been to improve the crop architecture, soil fertility; reducing pollution load; generating protocols for many economically important trees; development of vaccines and diagnostics; and new drugs, specially from plant resources such as immunomodulators. The department has consolidated a number of programmes including demonstration, popularisation and extension activities as also creation of awareness amongst the general public. An important initiative is to become partner in the international rice genome effort and work on chromosome 11. The details are being finalised. A bilingual BIOTECH NEWSLETTER has been published on 14th September to mark the 50th Anniversary of Hindi as Raj Bhasha. This has been widely appreciated by the scientists, industry and others interested in biotechnology.

1.1. ADVISORY STRUCTURES

The department has a Scientific Advisory Committee (SAC) and Standing Advisory Committee (Overseas) (SAC-O), to advice on policy matters, prioritisation and monitoring of special projects from time to time.

Scientific Advisory Committee (SAC-DBT)

Scientific Advisory Committee (SAC-DBT) met on March 12, 1999. The members appreciated the efforts of the department in the areas of genome research, molecular taxonomy, new vaccines and diagnostics and expansion of bioinformatic centres. The first meeting of the reconstituted Scientific Advisory Committee (SAC-DBT) was held on 25th November 1999. The issues discussed included : policy relating to genetically modified food items, restructuring of post-doctoral research cum training programs, transparency in dealing with biosafety guidelines and institutionalisation of handling human cell lines. It suggested that there is need to prepare a policy paper on GM food safety. The members appreciated the success of post-doctoral programmes in the past in terms of capacity building for younger generation. It was mentioned that due to the efforts of the department, biologists in India feel that quality of science in biology has

improved as also awareness for commercialisation of research leads through technology transfer and patenting.

Standing Advisory Committee (Overseas)

The tenth meeting of the Standing Advisory Committee (Overseas) (SAC-O) was held on December 12-14, 1999. Specific recommendations were made for continued support to basic and applied research. Some areas for biotechnology research in the 21st century were identified such as: plant biotechnology, human health and environment, industry and scientist interaction, commercialisation of diagnostic kits and research on DNA vaccines and edible vaccines, through a brainstorming discussion.

1.2. RESEARCH AND DEVELOPMENT

The Biotechnology Research and Promotion Committee (BRPC) and Task Forces through a number of meetings examined 270 projects and recommended 156 in carefully identified areas. Conscious efforts were to support large multicentric, network projects, and product and application oriented activities in addition to fundamental research.

1.2.1. Basic Research in Modern Biology

Studies were carried out to elucidate the factors involved in the sex specific heterochromatinization of paternal genome- a phenomenon related to genomic imprinting in mealy bugs. Two middle repetitive sequences that are differentially organised between the two sexes and also within the same diploid nucleus were identified at IISc, Bangalore. Hydrogel polymers and their nanoparticles, which completely evade Reticuloendothelial system (RES) and remain in blood for a long time without having coating of PEG on the particle surface, have been successfully prepared and water-soluble drugs have been encapsulated at University of Delhi. It was observed that high increase of hexokinase and succinic dehydrogenase activities are associated with initiation of basidiospore formation in gill tissue of fruit-body and an ordered cloned DNA map of chromosome of the hypertoxigenic strain 569B of *Vibrio cholerae* has been constructed at IICB, Calcutta. Localisation of the transcriptional activator protein Pdc2p, and the protein Pdc1p encoding the enzyme structure was demonstrated. (TIFR, Mumbai). Three-dimensional structure has been solved by molecular replacement methods by the programme XPLOR using papain as the phasing model by the Bose Institute, Calcutta.

1.2.2. Agricultural Biotechnology

The main emphasis has been to improve the crops with molecular biology and bioengineering for sustainable agriculture. Transgenic cabbage plants were shown to carry Cry 1A(b) gene as evidenced by southern hybridisation of genomic DNA. Insect feeding bioassay with Diamond Black Moth larvae confirmed that transgenic plants were tolerant to insect pests. Under *Brassica juncea* hybrid seed programme, six constructs were successfully used to generate male sterile lines. At NBRI, Lucknow, various ripening – related genes from banana have been cloned. Also, tobacco transformation using coat protein gene of TLCV-pBI 121 construct was done through *Agrobacterium* and transgenic plants were generated. Transgenic lines of chickpea and pigeonpea

expressing Bt – endotoxin gene have been generated. Interesting leads have been obtained on transformation of two indica rice cultivars (IR-50 and ADT 36) with p5cs (for salinity tolerance). Transgenic tobacco was produced by employing binary vectors containing GUS gene under the control of deletion constructs of leaf – specific gene promoter. Initial studies show that these promoters may provide tissue specific and light regulated expression. In the multicentric project on characterisation of quality traits in wheat, success has been achieved in identifying STMS and STS markers linked with the grain protein content and with pre-harvest sprouting tolerance. A multi-institutional project on development of transgenics in cotton, rice, mungbean and tomato envisages collaboration between different laboratories to develop transgenics resistant to various biotic stresses.

1.2.3 Biological control of plant pests, diseases and weeds through biotechnology

Under a time bound goal oriented programme for the large scale adaptation of the biopesticide technology under IPM and their adaptation by the farmers, substantial area of land was covered in various agroclimatic zones of the country for managing pests and diseases of important regional crops. The cost of crop protection was optimised and income/profit was maximised. An IPM module with various strategies has been developed for green (organic) cotton. Under irrigated condition, the mean net profit in IPM field was Rs.8010/ha. The pesticide residue analysis of cotton kapas showed that none of the linked samples collected from the 22 farmers' holdings had the residue above the prescribed tolerance limit. Successful demonstration trials in this programme have culminated as a recommendation by the State Dept. of Agriculture in various states. An Indian Patent application entitled “A novel composition of a Fermentation Medium useful for Economic Mass Production”, involving inexpensive industrial bio-products for the mass production of spores of *Trichoderma viride* has been filed. Patents for mass production technologies of *Myrothecium verrucaria*, *Trichogramma*, *Beaveria bassiana* and *Verticillium lecanii* have been taken at different centres. The biocontrol products developed at various centres were distributed among the farmers free of cost and were used in cotton, rice, groundnut, sunflower, pulses, sugarcane, tobacco, Chilli, and vegetables. RRL, Jammu has transferred the technology as an integrated package for biofertilizers and biopesticides to two industries viz., M/s Pratishta Industries Ltd., Secundrabad, A.P. and M/s Javeri Agro-industries & Investment Co. Ltd., Javeri Nursery Premises, Amrawati, M.S. In addition, 5 new potential biopesticide technologies viz. *Aspergillus niger* (fungal antagonist), *Debaromyces hansenii* (yeast antagonist), *Steinernema carpocapsae* (nematode), internode borers lure (Sex pheromones); and *H. purea* NPV (Baculovirus) against teak defoliators are being revalidated.

A major R&D programme on the role of biological resources for Integrated Nutrient and Pest Management (INPM) for increasing agricultural productivity in existing cropping system by way of managing their pest profile / incidence made a steady progress.

1.2.4. Biofertilizers

A number of projects were supported on crop specific biofertilizers in order to understand the basic mechanism of nitrogen fixation which will help better technology

development in integrated nutrient management. Efficient nitrogen fixing strains of *Rhizobium*, *Acetobacter*, *Azotobacter*, *Azospirillum* and blue green algae suitable for different agroclimatic regions have been isolated and demonstrated in field condition. In addition, mycorrhizal strains suitable for almost all crops have been isolated and mass production technology transferred for commercial production to small entrepreneurs as well as to corporate bodies. A network programme on integrated use of biofertilizers in nutrient management for region specific cropping systems has been started. Various cropping systems have been selected based on socio- and agroclimatic conditions with special reference to change in soil microbial population and the effect of nutrient residue on subsequent crop and ultimately the soil health.

1.2.5. Plant Tissue Culture/Micropropagation

The hardening facility at Jodhpur has perfected protocols for a number of Arid Zone tree species and nearly 20,000 plants were transferred to the field at different locations in collaboration with the State Forest departments and other agencies. A Regional Hardening Unit has been set up at Jammu for large-scale production of Medicinal and Aromatic Plants and Horticulture Crops. Double grafted plants of Citrus have been transferred to the greenhouse and some of them have begun fruiting. Six hundred tissue culture raised plants of Rangpur Lime and Rough Lemon have been field planted. The Bunchy Top Virus in Banana is being characterised and the host response studied. A number of successful intravarietal and interspecific and intergeneric crosses of orchids involving sympodial and monopodial varieties have been made. A Network multi-institutional programme on Coffee improvement using biotechnology tools as Jai Vigyan S&T Mission has been launched. It aims at developing improved coffee varieties with low caffeine and resistant to diseases. About 2000 plants of coffee have been hardened and field planted. Field evaluation of tissue culture raised tea plants of 3 UPASI clones – UPASI – 3, 26 & 27 is being conducted under different agro-climatic conditions at multi-locations. A complete protocol for regeneration of Black Pepper has been standardised. Saffron regeneration technology is being refined for scale-up. Detailed studies have been conducted on the use of molecular markers for the study of genetic variation of tissue culture raised plants.

1.2.6. Biodiversity Conservation and Environment

To facilitate absorption and utilisation of technology, major emphasis has been given on involvement of user industry and demonstration of technologies developed at the site of the industry. In over a dozen projects, a number of industries are involved in process development, process optimisation and validation. A number of technology packages such as ecorestoration of mine spoil dumps, microbial remediation of petroleum sludge and oil spill, phytoremediation of dye industry effluent treatment and palm oil mill effluent treatment have been standardised and are being negotiated for technology transfer.

1.2.7. Bioprospecting

Under the multi-institutional collaborative programme on “Bioprospecting of Biological Wealth using Biotechnological Tools”, there are 15 institutes involved in the

study in the two hot-spot regions – North-Eastern Himalayas and South-Western Ghats and also the Western Himalayas.

For the North-Eastern region maps have been prepared at a scale of 1: 2,50,000. Deptt. Of Space has been able to map *Taxus* and its associated species in the Tale Valley of Arunachal Pradesh. It is significant as this species occurs gregariously and are well protected. A Biomonitoring system has been evolved involving 13 colleges in 5 States. Monitoring has been done in 15 organismic groups and the number of study sites from where information on these organismic groups have been recorded. Complete documentation and genetic characterisation is being done for 10 identified priority species, which are endangered, and of medicinal and economic importance. Studies on the microbial diversity along the coastal agri-ecosystem and forest system in the Western Ghats are being conducted. 15 plant species from coastal systems have been collected and screened for potential anti-microbial and anti-pesticidal properties against 10 microbes. Isolation, characterisation and cloning of potential genes for stress tolerance are being carried out. A salt tolerant gene has been identified and successfully expressed. The complete c-DNA library from mangrove species has been constructed and this has been screened for stress related genes. A gene resistant to cold temperature has been isolated, identified and characterised.

Closely linked to the Bioprospecting, a major Programme is under implementation on Molecular Taxonomy with the main objective of inventorization and documentation and molecular characterisation of identified economically important and/or endangered species from different regions of India for their sustainable utilisation.

1.2.8. Medicinal and Aromatic Plants

The Network of the three gene banks set up by the DBT is fully equipped with state-of-the-art facilities for conservation of seeds, live plants and *In vitro* material of rare, threatened and economically important species. A fourth gene bank has been established at RRL, Jammu to cover Western Himalayan Region. Under an integrated programme on taxol, about 1500 rooted stem cuttings of *Taxus* were planted in their natural habitats in Himachal Pradesh. The genetic diversity among *Taxus wallichiana* growing in the North Himalayan region has been estimated by RAPD analysis. This will help tagging high-yielding genotypes using DNA markers for micropropagation and mass multiplication. Various callus lines of *Taxus baccata* were screened by TLC/HPLC for taxol/10-DAB (a taxol precursor) production. Three promising cell lines were identified. The work carried out at NII; New Delhi has led to the identification and isolation of an isoquinoline alkaloid, berberine, an immunomodulatory agent from *Berberis aristata*. An MOU has been signed between NII and an industry for production of a herbal product using this agent for treatment of burn cases. Permission from Drug Regulatory Authority is being sought for carrying out clinical trials in collaboration with the industry. A programme on “Biotechnological approaches for herbal product development” has been launched under the National Jai Vigyan Science & Technology Mission. It aims at developing improved ergot production technology, agrotechnologies for high yielding variety of *Artemisia annua* and developing herbal therapeutic products for curing hyperlipidemia and arthritis alongwith other immunomodulators.

1.2.9. SERI-BIOTECHNOLOGY

Under Silkworm Genome Programme, the primers for the flanking sequences of some of the longer microsatellite motifs were designed and PCR amplification conditions were standardised. The amplification of diverse silkworm genome DNA yielded well defined PCR products. The analysis of allelic status of microsatellite loci in two parental strains and their F-1 offspring has been done. Mapping of the microsatellite loci in the F-2 population is in progress. A new and novel type of double stranded segmented RNA cytoplasmic polyhedrosis virus infecting *Antheraea mylitta* (Am CPV) has been identified. The expression of ORF-3 of Hepatitis E viral antigen using *Bombyx mori* nuclear polyhedrosis virus (BmNPV) system in silkworm (*Bombyx mori*) has been demonstrated.

Triploids in mulberry have been developed and are being field evaluated. The transient expression of marker gene in various explants from different commercially important genotypes of mulberry (*Morus* sp.) has been achieved to develop gene delivery methods in mulberry. Out of 64 castor genotypes evaluated, the genotype RG-323 and RG-902 fed to eri silkworm (*Philosamia ricini*) recorded significantly higher larval growth and other desired economic traits of eri silkworm.

1.2.10. Medical Biotechnology

The recombinant *V. cholerae* VAI.3 strain has undergone toxicology studies and animal efficacy. The DCGI has permitted to carry phase-I volunteer clinical trials. After due clearance from GEAC, the phase-I trials conducted at two centres have been completed successfully with no side-effects. There have been no side effects. The phase II/III clinical trials have been planned under Jai Vigyan Mission Programme. The DNA vaccine for rabies has also shown a high degree of efficacy in animals. The pre-clinical toxicological studies and efficacy trails in a phased manner will now be taken up. The Japanese Encephalitis Virus has been adapted successfully in Vero cell utilising micro-carrier technology, the required number of virion to produce tissue-cultured vaccines has been achieved. Immunogenicity studies are being carried out. Primer combinations targeting 16S rRNA/23S rRNA of pathogenic mycobacteria have been designed which are able to identify *M. tuberculosis*. This can be used as a rapid and specific diagnostic tool for tuberculosis. Another set of primers targeting spacer region has potential for molecular epidemiology of tuberculosis. Unique mutations have been identified in genes encoding for *M. tuberculosis* resistance to INH, streptomycin, rifampicin. Primers have been perfected to identify multi-drug resistant mtb. The system is now being evaluated in clinical samples i.e. sputum, CSF etc. For the first time, primers have been designed targeting kinesin gene, which can differentiate *L. donovani* strain obtained from cases of visceral leishmaniasis from post kala-azar dermal leishmanoid. Plant-derived flavonoid has high degree of anti-leishmanial activity both *in vitro* & *in vivo*. One of the compounds, Luteolin is ready for human clinical trials. Complete genomic mapping of chromosome 5&10 of *L. donovani* is being attempted to identify new target for drugs. The studies have revealed that HIV-I subtype C with quasi species C3 is the predominant HIV-I strain in circulation in India. Genomic analysis has revealed these strains to be closer to strains from sub-Saharan African Continent. No significant cross clade immune

response has been observed. Such observation has direct relevance on designing candidate vaccine for the country. HIV-viral bank is operational and has about 60 strains of HIV- I and 5 strains of HIV-2.

The NE part of India had unique Rota viral strain which produces diarrhoea in adults. The nucleotide sequence indicated that these strains to be closer to Chinese strains and unrelated to the suggested rotavirus strain in circulation in other parts of the country. This has necessitated development of rotavirus candidate vaccine for specific regions.

About fourteen diagnostic technologies for communicable and non-communicable diseases, which have been validated, are ready for further refinement and upscaling. Negotiations have been held with industries which are interested to take up the prototype technologies for commercialisation.

On the First National Technology Day, May 11, 1999, Leprovac an immunomodulator for leprosy and two HIV diagnostic test systems were launched.

1.2.11. Human Genetics and Genome Analysis

Fourteen genetic diagnosis cum counselling units are providing diagnosis and counselling for the common genetic disorders prevalent in the country to the affected families. About 11,000 affected families have benefited from these genetic units for prenatal diagnosis and counselling for major genetic disorders and 1,700 tribal population was also screened for these disorders. Three major projects in the areas of Functional Genomics, Bone Marrow Transplantation and Schizophrenia and Biopolar diseases in addition to one project in the area of gene therapy and Human Genome Diversity, which were implemented during 1998-99 are providing patient services in addition to research activities to identify novel mutation and also establishing linkages with other collaborating institutions to work in the areas of β -thalassemia, neuro-degenerative disorders, schizophrenia, spinocerebellar ataxia and others. Under diversity projects, standardisation of protocols for genotyping about 20 DNA marker loci has been completed.

1.2.12. Vaccine Research and Development

A National Jai Vigyan Mission on the development of new generation vaccines has been launched. The programme has targeted peptide/recombinant/genetically-modified organisms as candidate vaccines for cholera Rabies, Japanese encephalitis, Tuberculosis, Malaria and HIV/ AIDS.

1.2.13. Animal Biotechnology

Several lines of transgenic mice have been developed at National Institute of Immunology using interleukin-2 gene, hepatitis-B virus X gene, hepatitis-B virus X gene with c-myc gene, neomycin resistant gene, fragile x syndrome e gene and 5 HTIA receptor genes. Two ET born camel calves have been produced. Efforts are on to validate Vero cell cultured rabies vaccine for animals before commercialisation. Recombinant zona pellucida glycoproteins have been produced and are being tested in

stray dog population for fertility control. Significant progress has been made towards the development of diagnostics for blue tongue virus and PPR. A programme on indigenous cattle and buffalo breeds characterisation and their preservation in the form of embryos has been launched through National Dairy Development Board. Procedure for the isolation of two hydrolases viz. Pig liver esterase and Pig pancreatic lipase has been developed from the blood collected from slaughterhouse. A serum based protein binder has been developed which may serve as a binder in the finishing operation of leather processing to improve aesthetic value.

1.2.14. Aquaculture and Marine Biotechnology

Development of genetic markers for fish strain identification, disease resistant transgenic fish, establishment of cell and tissue culture system in aquatic species and development of freshwater prawn hatchery have progressed well. Mission mode projects have been successfully implemented at several sites for grow-out operations, hatchery and feed mill development and for the establishment of prawn complex. This has benefited the farmers and the entrepreneurs in adoption of various culture technologies through extension and training.

1.3. BIOTECHNOLOGY PRODUCT AND PROCESS DEVELOPMENT AND TECHNOLOGY TRANSFER.

1.3.1. Microbial and Industrial Biotechnology

Using *Nocardia spp.* several tetranortriterpenes were converted biologically into useful metabolites. Microbial strains for the conversion of cephalosporin C into 7- amino cephalosporanic acid have been identified and enzymatic conversion methods developed. To meet the increased oxygen demand, efforts are under way to clone and express bacterial haemoglobin protein gene in *Streptomyces* species. Cloning and characterisation of plasmids in *Amycolaposis spp* for efficient production of rifamycins were investigated. Microbial leaching of ores using mesophilic and thermophilic organisms revealed a better extraction efficiency by the latter. Several microbial strains have been isolated. The reduction in the Chemical Oxygen Demand load especially chromium was achieved while investigating several tolerant alkalophilic *Actinomyces spp.* A microbial polysaccharide, gellan was produced in high concentration using *Sphingomonas spp.* Production of cyclodextrins was standardised utilising microbial strains of *Bacillus firmus* and *Klebsiella pneumoniae*. Efficient microbial conversion of acrylonitrile into acrylamide was achieved. Several efficient cultures of Actinomycetes and fungi were isolated which produce high yields of alkaline protease. Fungal strains of lipases were isolated and production processes standardised. Techniques for production of xylanase were standardised. Microbial biodiversity programme has been initiated at fourteen centres, covering various ecological aspects and geographical locations of the country.

1.3.2. Food Biotechnology

Efforts are underway for commissioning of pilot plants for large-scale production of low cost nutrient food supplements developed through biotechnological processes. Several leads were obtained for rapid diagnosis of various food-borne pathogens like

Salmonella sp., *Bacillus cereus*, *Shigella sp.* and *Rotavirus*. A lead has been obtained for prevention of Rotavirus diarrhoea in children below two years of age, by use of Rota colostrum as a baby food supplement. Technologies for debittering of citrus juices are being perfected. Various tribal mushroom species have been screened for their edibility; protocols are being developed for their large-scale production. A rapid immunological diagnostic test is being developed for detection of argimone contamination in edible mustard oil.

1.3.3. Bioproducts

Two inter-departmental projects in association with the Department of Electronics made good progress, one of which is on the development of novel electroporation equipment and the other is for a system for sterilising hospital wastes using microwave technology. In an industry - institute collaborating project, a naked eye visible agglutination assay for ascertaining the HIV infective status of human was developed, and the technology is under transfer to the industry. Plastic wares suitable for biotech research were developed in different forms like vials, tubes and micropipette tips. Wettable polystyrene plates suitable for cell culture and ELISA plates to substitute the imported ones have been developed.

1.3.4. Micropropagation Technology Park:

The Two Micropropagation Technology Parks at NCL, Pune and TERI, New Delhi provided an effective platform for interaction between the academics and industry. A concerted effort has been made towards commercialisation of the Plant Tissue Culture Technology. The two MTP's produced 20 lakhs plants during the year, which were field planted at multi locations over nearly 3000 ha. Five technologies were transferred to the industry. A National workshop on Commercialisation of Micropropagation technology was organised and the priorities for R&D, large-scale production, regulatory procedures, and training identified.

1.3.5. Large Cardamom Product plan

Performance of elite *in vitro* cardamom plants in farmers' field over an area of 70 ha in Sikkim and Darjeeling district of West Bengal is being evaluated; 28 ha were field planted in addition to the 12.25 ha in 1998 season. The remaining target would be accomplished during the next season. Comparative study of growth performance revealed that plants propagated through tissue culture performed better than those through open pollinated seedlings.

1.3.6. Vanilla Product plan

Evaluation of tissue cultured plants of vanilla in planter's field in the states of Kerala, Karnataka and Tamil Nadu of an area of 15.25 ha during the 1999 was done. So far an area of 105 ha has been covered. Fourteen training programmes were conducted on cultural practices to be followed for vanilla cultivation in which 375 farmers participated.

1.3.7. Biosafety issues

Biosafety protocols and guidelines have been fully incorporated in contained field experiments using genetically modified plants of cotton, Indian mustard and other crops. The agronomic benefits accruing from their use have been discussed. Substantial information has been generated on two transgenic crops based on experiments conducted in Indian environment. Specialists, agricultural scientists and eminent biotechnologists visited the transgenic experimental plots. Several recombinant DNA drugs intended for commercial use were also reviewed. Efforts through workshops, lectures, publications etc. have helped in creating awareness in public and clearing their doubts on many issues of biotechnology research.

1.3.8. IPR and Patenting

The department had provided inputs to the Ministry of Industry on the applicability and scope of patenting biotech inventions within the framework of WTO and provided to the Ministry of Agriculture on the protection of plant varieties. In continuation of earlier efforts to expose the bench scale scientists about various aspects of intellectual property protection in the field of biotechnology, four roving seminars were conducted at Jaipur, Lucknow, Trivandrum and Guwahati. These were attended by more than 600 participants.

A patent facilitating cell and an Expert Advisory Committee are helping the scientists in writing patents from different spheres of activities. Two publications entitled “Biotechnology Patent Facilitating Cell” and “Patenting in Biotechnology - Patent information on Internet”, have been brought out to create awareness about patenting in Biotechnology.

1.4. BIOTECHNOLOGY BASED PROGRAMMES FOR SOCIETY

1.4.1. Biotechnology based Programme for SC/ST Population

The programme is meant specifically for the welfare of SC/ST population through proven technologies. It facilitates SC/ST population to upgrade their skills and create additional job avenues or help in improving their health status. The main activities are cultivation and distillation of medicinal and aromatic plants, vermicomposting, spirulina production, fish and poultry farming, production and application of various biofertilizers for better soil health, biological control agents for plant pests and survey of genetic disorders and counselling. Forty-three projects have been pursued in 19 states and union territories, which benefited about 15,000 families.

1.4.2. Biotechnology based programme for Women and Rural Development

DBT has started a new scheme, since past two years, for the empowerment and skill development of women and rural poor for their economic upliftment. Food technology, sericulture, floriculture, organic farming, waste management, medicinal plants, biodiversity conservation, aquaculture, environment protection and awareness building are the areas supported. This programme has benefited more than 6000 women including rural poor. Conscious efforts have been made to improve the community health and sanitation and also better use of local and herbal medicine. One of the major objectives of this scheme is to inform the grass root level population about their own natural resources and their judicious use for sustained income generation. A novel

approach is establishment of Biotechnology Park at Chennai, which is becoming operational. The entrepreneurs have selected their technologies for setting up industrial modules. Training programmes have been held.

Recognising the serious consequences of the earthquake in Himalayan region, a number of programmes have been started to rehabilitate the target population in that region utilising their plant resources and biotechnological tools. Some products are being made by local rural population for which training is also being imparted. The entire work is being co-ordinated by a local NGO known as Himalayan Environmental Studies and Conservation Organisation (HESCO), Dehradun. Many processed products like ginger pickle, squash, etc are already in production and the beneficiaries have started getting some income from these.

It has been decided to give awards to three women bioscientists every year on International Women's Day for their overall contributions in this field.

1.5. Human Resource Development

Impact of this programme is clearly visible in multifarious activities in the country. A number of teaching, training and popularisation programmes have been implemented. Financial assistance was continued to 37 post-graduate, post-doctoral, post MD/MS Certificate courses and one year post-graduate diploma courses. During the year, two M.Sc. biotechnology courses at Allahabad University, Allahabad and Himachal Pradesh Krishi Vishwa Vidhyalaya, Palampur have been approved. Around 30 scientists are being selected for the award of National and Overseas Associateships for research and training in leading research laboratories in the country and abroad. Eleven short-term Training Courses were conducted to train mid-career scientists in advanced research.

More than 100 national/international seminars/symposia/conferences, popular lectures by experts, participation in exhibitions in national/international exhibitions and activities of the National Science Day celebrations were supported. 15 students in Biology at CBSE 10+2 level examination have been selected for DBT scholarships in biology to be awarded on the National Science Day. Three popular monographs under the Foundation of Biotechnology series and Hindi version on two popular books under the Vistas of Biotechnology series have been brought out with the help of NISCOM, CSIR.

The National Bioscience Awards for Career Development have been announced to five young scientists. Establishment of a Biotechnology Chair in honour of Prof. G.N. Ramachandran at IISc, Bangalore has been approved. It has been noted that scientists trained under DBT programmes are receiving awards/distinctions/ honours by various agencies proving the excellence of these.

1.6. BIOTECH R&D FACILITIES, REPOSITORIES AND SERVICES

These facilities are used by the scientists, industries and students all over the country.

Centres of Excellence, Facilities, Repositories and Services

Programme support at IISc, Bangalore and Rajiv Gandhi Centre for Biotechnology, Trivandrum has resulted in excellent basic research. Drug design for mycobacterial infections, expression of MADS domain genes, estimation of relatedness in ants using DNA and genetic variations in Indian population of Asian elephant are some of the highlights at IISc, Bangalore. Seven repositories and four biotech facilities are being used by the scientists from all over the country, for advance research. A repository on *Drosophila* has been strengthened to develop educational kits for demonstrating genetic experiments in schools and colleges. Molecular experiments on obese-rat at animal facility at National Institute of Nutrition, Hyderabad revealed that the rat is distinctly different from similar obese-rat models elsewhere in the west. The work at repository on filaria, MGIMS, Wardha has resulted in patenting of a unique filarial antigen. The genetic engineering and strain manipulation at MKU, Madurai has demonstrated over production of daunorubicin, an anti-cancer antibiotic at pilot scale. A national containment facility for transgenic planting material has been set-up recently at NBPGR, New Delhi. This will facilitate the processing of the transgenic planting material from quarantine aspects and also develop DNA probes and markers required for evaluation of transgenic planting material.

1.7. BIOINFORMATICS

Major research institutions and universities have been linked through the Biotechnology Information system Network (BTISnet). The network at present comprises fifty-three Bioinformatics Centres. The program offers access to scientific information including DNA and Protein sequence data. Four major databases have been established at IISc, Bangalore, University of Pune, Pune, JNU, New Delhi and IMTECH, Chandigarh under National Jai Vigyan Science and Technology Mission, in the form of mirror sites of internationally recognised databases such as GDB, PDB, Plant Genomic Database as well as several resources hosted at EBI. These mirror sites will act as knowledge pathways for discoveries in modern biology and biotechnology. Six Interactive Graphics Facilities, which were established as part of the network, are supporting the promotion of developmental studies in Biotechnology. Two post diploma courses have been initiated at JNU, New Delhi and University of Calcutta, Calcutta to cover Eastern and Northern parts of the country. Various R&D activities in Bioinformatics have been started for the development of multimedia databases, and software. A Gene Scan software package developed by JNU was released by the Minister (S&T) during, November 1999. More than 20 training activities were organised to train the researchers and information handling personnel on the latest developments in Bioinformatics and Biocomputing.

1.8. INTERNATIONAL COLLABORATION

Many bilateral and multilateral collaborations in the field of biotechnology are benefiting the scientists to a great extent in expanding the knowledge base, training, joint projects and creation of advanced facilities. Under Indo-Russian collaboration, a joint centre for biotechnology is being considered. The Indo-Swiss collaboration has been extended into the second phase. Projects have been approved under ASEAN arrangements. A specific institutional framework for collaboration in biotechnology amongst the SAARC countries is being developed.

Under Indo- US Vaccine Action Programme two potential candidate vaccine strains (116E & I321) for Rotavirus Diarrhoea were developed. The phase-I clinical trial of both the strains has been completed in USA and these strains have been found to be safer. The phase-I clinical trial in India will be taken only after taking clearance from DCGI. A two-day workshop on Group-A Streptococcus was organised in April 1999 in New Delhi for development and use of vaccine in primary prevention of rheumatic fever/rheumatic heart disease in India. Thirteenth meeting of Joint Working Group (JWG) of VAP was organised in October 1999 in New Delhi. The meeting discussed initiating phase-I clinical trials in India for the rotaviral diarrhoea candidate vaccine strains, establishment of joint ventures etc. A two-day joint workshop on “Novel Vaccines Technologies” was organised alongwith JWG meeting. Recent developments in vaccinology such as DNA based recombinant DNA vaccine, edible vaccine and regulatory aspects were discussed.

Also the Indo-US collaboration in Contraceptive and Reproductive Health Research considered 36 projects; 10 were recommended for further processing; 5 projects are already funded. Four projects with CONRAD have progressed well in the areas of reproductive health.

1.8.1. G-15 ACTIVITIES

The proceedings of the G-15 symposium on “State-of-the-art strategies and technologies for conservation of medicinal and aromatic plants” held at Kuala Lumpur during September, 1998 has been published by the FRIM, Kuala Lumpur, Malaysia. An inventory of important medicinal and aromatic plants of the Asian region has also been published.

1.8.2. Jute Biotechnology

The Phase-1 of the UNDP-GOI supported project is implemented at 3 centres – IIT Kharagpur, M.S. University Baroda and Calcutta University. A laboratory scale protocol for enzyme retting for jute fibre was developed. The process involves retting of the fibre using an enzyme obtained from different microorganisms. A field demonstration was conducted to test the efficacy of the protocol. A second demonstration has also been conducted in 1999, alongwith National Centre for Jute Diversification, Calcutta. The results of this demonstration indicate that the enzyme could now be produced on a large scale at the farmers’ field.

1.9. AUTONOMOUS INSTITUTIONS

1.9.1. National Institute of Immunology (NII), New Delhi.

The National Institute of Immunology (NII) has excelled in the pursuit of rigorous fundamental research as is evident from the exponentially increasing number of publications in the top ranking journals covering the research interests of the Institute. Impact of the work carried out at NII is also reflected in the high number of citations for the work from this Institute. Most recently, a major fundamental discovery concerning

pathogenesis, which concerns survival of bacteria in phagocytes, has been reported in the Journal of Cell Biology, a highly acclaimed journal among the scientific community. It has been shown that Salmonellae specifically recruits early fusion factors and promotes fusion with early endosomes. This is the first demonstration about the molecular mechanism of how Salmonellae survive in phagocytes. The complete genome of an Indian isolate of JEV (GP78) has been sequenced revealing its evolutionary closeness to the Chinese SA14 isolate. A novel immunomodulatory use of an Indian medicinal plant product (NII-60) to prevent septic shock received a US patent and was transferred to an Indian Pharmaceutical industry for commercialisation. A transgenic mice expressing the hepatitis B virus X gene has been generated. In a novel strategy, genes for different stages of *Plasmodium falciparum* have been stitched and expressed in baculovirus system. The resultant proteins elicit good immune response in experimental animals.

1.9.2. National Centre for Cell Science (NCCS), Pune

Studies conducted at NCCS, Pune indicated that the bone marrow derived factor induces cellular migration adenocarcinoma cells *in vitro*. An active component, a 55 kDa Protein, has been identified. CDNA library of possible oncogene generated from clone M3: Mouse melanoma cells was able to induce large tumours in nude mice and displayed propensity to metastasise. These properties of transformation and metastases are significant since most of the known oncogenes require co-operation from two or more oncogenes from supporting transformation. A haemolytic bacterium, *Aeromonas jandei* was obtained from mosquito mid-gut for the first time.

1.9.3. National Brain Research Centre (NBRC)

The National Brain Research Centre has initiated its networking activities, organised an “International Colloquium on Brain Research” in which about 250 neuroscientists from India and abroad participated; and some training programmes. Two bilateral agreements have been signed between National Institute of Mental Health (NIMH), USA and RIKEN Brain Science Institute, Japan.

1.9.4. National Centre for Plant Genome Research (NCPGR), New Delhi

The Centre has initiated the work for analysing chickpea genome, identifying genes, develop suitable regeneration protocols for improving the nutritional quality and resistance against various diseases and abiotic stresses. More than 100 ESTs have been sequenced from chickpea. The foundation stone for the new building of the Centre was laid by the Hon’able Minister for S&T on 30th November. There was a scientific interactive meeting preceding this function.

1.9.5. Centre for DNA Fingerprinting and Diagnostics (CDFD), Hyderabad

The Centre received 155 cases comprising of paternity disputes, identification, rape, murder and other crimes. Memorandum of understanding (s) has been entered with two State Forensic Laboratories. For DNA diagnosis of various genetic disorders, the Centre received 409 cases and for chromosomal diagnosis, 129 cases. The bioinformatics facility is fully functional with several databases. Fundamental research has also been initiated to sequence the genome of silk worm and for molecular analysis of

Mycobacterium tuberculosis. An advanced training course on DNA Fingerprinting was held during the year.

1.9.6 Bharat Immunologicals & Biologicals Corpn. Ltd. (BIBCOL), Bulandshahr

The company is formulating Oral Polio Vaccine (OPV) from imported bulk since January 1996. The company has supplied 200 million doses of vaccine to National Immunisation Programme; part of it was also supplied to UNICEF. The company has received WHO-GMP certificate. Efforts have been made to supply OPV to SAARC countries.

1.9.7. Indian Vaccines Corpn. Ltd. (IVCOL), Gurgaon

Structural reorganisation has been undertaken for optimum utilisation of the facilities already created. This includes establishment of National Brain Research Centre and Biotechnology Research Complex with Indian industrial partners.

2. International Centre for Genetic Engineering and Biotechnology (ICGEB), New Delhi

Significant progress has been made in research activities both in the areas of mammalian biology and plant biology. Molecular interaction studies that mediate invasion of erythrocytes and hepatocytes have provided insights towards development of novel drugs and vaccines against malaria. In hepatitis, mouse model of HBV-related liver cancers has been developed. HEV gene has been engineered into plants for development of an edible vaccine. Recombinant human interferon gamma cleared toxicity and safety studies for treatment of drug resistant tuberculosis. Hepatitis B vaccine entered into phase II clinical trials. In plant biology, new strategies have been adopted for the introduction and expression of heterologous genes in nucleus and chloroplast. Methods have been developed to combat emergence of resistance in insects towards insecticides of *Bacillus thuringiensis*. Biotypes of gall midge found in India have been fingerprinted and PCR-based markers developed. Two kits for hepatitis C and hepatitis B have been transferred to the industry.

3. ADMINISTRATION AND FINANCE

Vigorous efforts were made to implement the Official Language Act and Rules for progressive use of Hindi. The Hindi Fortnight was celebrated from 1-14 September, 1999 with competitions in Hindi essay writing, typing and debate; cash awards and certificates were given to the winners. The officers and staff of the department were also encouraged to do more work in Hindi. The use of computers is helping to speed-up the work output and enhance the efficiency. All matters relating to the Parliament were attended on time.

To Conclude

Implementation of time targeted mission projects, multi-centric programmes with the involvement of the scientific community, expanding the human resource development activities, science popularisation and technology demonstration and transfer have been the salient features, during the year. The university research in major way on various

aspects of modern biology has been supported. A conscious effort has been made to benefit the weaker sections, rural areas and women through biotechnology. The State Governments are now taking keen interest in generating biotechnology-based activities. The impact of the excitement and relevance of this field has been widely recognised and felt all over the country. The peer reviewing and monitoring systems have been further strengthened and streamlined. Major emphasis has been given to computerised administration and finance and use of the bioinformatics network in important activities. The new initiatives during the year are expected to fructify by the end of the 9th Plan period, thereby strengthening the expertise and base of biotechnology research. Biotechnology entrepreneurship with industries and scientists teaming up for technology packaging and commercialisation is rapidly progressing. This approach would yield rich dividends in the years to come. The goal is to generate the basic knowledge on all fundamental aspects of modern biology, nurture excellence, enthuse young scientists for a career in biology and use all these to develop products, processes and technologies, which are economically and environmentally sustainable and would benefit the people.