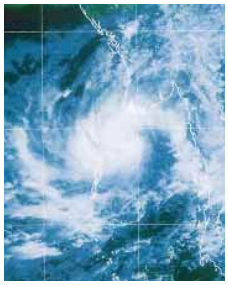


CHAPTER XXXII

DEPARTMENT OF BIOTECHNOLOGY

In 1982, following detailed deliberations with the scientific community, and based on the recommendations of the then Scientific Advisory Committee to the Cabinet, a National Biotechnology Board (NBB) was constituted by the Government to foster programmes and strengthening indigenous capabilities in this newly emerging discipline. Subsequently, a separate Department of Biotechnology (DBT) was set up in February, 1986. Since then a strong infrastructure for biotechnology research and services has been created in both national laboratories and academic institutions. An integrated programme for generating human resource and encouraging research and development was initiated. Support was provided for basic, applied and product-oriented research, with a view to attaining excellence and product development.

Biotechnology scenario in the world is changing rapidly. The announcement of working draft of Human Genome, International Rice Genome Initiative, development of Transgenic Rice with Pro-vitamin A and complete genome sequencing of a number of small organisms are some illustrative examples. These innovations have long term benefits for development of products and processes for health care, agriculture and allied areas for bioindustrial development.

During the last decade the DBT has adopted a holistic approach to the accelerated pace of progress of New Biology and Biotechnology based on the biological wealth of the country. The main thrust of the programmes was on research support on long-and short-term basis leading towards scientific excellence, development of new products or processes, large-scale demonstrations, validation of R&D leads, involvement of user agencies and industries, technology development and transfer, innovations for patenting purpose. Emphasis was also laid on establishing new centres of excellence, infrastructural facilities, programme support in priority areas, expansion of bioinformatics network and human resource development. The effort has been to ensure that biotechnology tools are utilized to harness the biological wealth for societal and economic benefit of the country on an environmentally sound basis.

The Department has initiated several important programmes relevant to national needs and priorities. The major initiatives have been taken to establish National Centre for Plant Genome Research (NCPGR), National Brain Research Centre (NBRC), National Bioresource Development Board (NBDB), Programmes on functional genomics, sequencing of silkworm genome and chromosome 11 in rice, and leishmania have been initiated. *Jai Vigyan* missions on vaccines, genomics, databases and herbal products are some other important projects. Revised guidelines for transgenic plants for research and development have been laid down. National Facility for Containment and Quarantine of Transgenic Plants, approval for large-scale field trials of insect

resistant cotton by private sector and several other transgenic research leads would contribute towards agriculture and plant science areas. The work of Patent Facilitation Cell, International Depository Authority for Microorganisms, National Facility for Diagnosis of Viral Disease of Tissue Culture Planting Material, programmes on bioprospecting for biological molecules, molecular taxonomy and Integrated Nutrient Management have progressed well. R&D leads have been pursued for technology transfers. Biotechnology programmes for societal benefit have been focussed for the service of target population in rural areas particularly women, SC/ST and weaker sections. A Women's Biotechnology Park and a Biovillage have been set up. Human resource development continues to be a priority.

An important effort has been the creation of awareness amongst industries, State Governments and financial institutions about the importance of biotechnology. Several states are setting up institutional framework, Departments of Biotechnology, Biotechnology Parks, Advisory structures, Centres of Excellence etc. Many small and large industrial houses have come forward to develop new partnerships. International collaboration is providing rich dividends.

Salient Achievements

Product and Process oriented biotechnological research and development for application in agriculture, health sector and industry for the benefit of society have been given a major thrust. R&D and demonstration programmes have been supported in different fields based on the advice of Expert Task Forces in different areas.

Basic Research and Emerging Areas: Basic research programmes in modern biotechnology have been supported to provide new vistas to the knowledge required for understanding the intricacies involved in any applied research. Support to basic research through R&D projects has been vital to develop expertise and investigating basic biological processes for future applications. Programmes on protein engineering, drug and molecular design, identification potential molecules for development of vaccines and diagnostics for infectious diseases have shown promising results. An Indian patent has been filed for a highly efficient and cost-effective process for the preparation of large quantity (300-400 mg) of pure (native-like) recombinant streptokinase. Patent applications have also been filed for rapid method for immobilization of biomolecules and Enzyme-Linked Immunosorbent Assay.

Plant Biotechnology : Concerted efforts have been made to promote and strengthen the area of agricultural biotechnology. The programmes are directed to major problems of identified priority crops, development of transgenics for both quality and quantity improvement and basic research in the area of plant molecular biology. An initiative has been taken by the Department to join the International Rice Genome Sequencing programme with a commitment to sequence 10 Mb of chromosome 11 in a period of five years. Development of markers for high quality protein content and cloning/modification of triticin gene with enhanced lysine content in wheat, development of molecular methods for hybrid seed mustard, production of transgenic plants of tobacco with viral resistance are some of the other important achievements. Transgenic pigeonpea, chickpea and tomato resistant to insects are ready for evaluation and transgenic mustard is to be field evaluated for male sterility restoration studies and herbicide resistance.

Biofertilizers: A number of projects have been implemented with an objective to develop integrated nutrient packages for different cropping systems in various agro-climatic zones of the country and development of transgenic efficient strains of inoculants and technology for mass production of biofertilizers. Under the network programme on integrated nutrient management, several packages have been developed and tested for field applications at 17 centres across the country.

The experiments will facilitate judicious application of chemical fertilizers and adoption of microbial inoculants for various cropping systems. Eleven thousand trials and demonstrations have been conducted, benefiting 19000 farmers. Technologies for large-scale production of mycorrhizal and rhizobial biofertilizers have been transferred to four industries.

Biological Pesticides: An R&D network programme has been supported for developing a package of practices which is cost effective, sustainable and eco-friendly in different crop eco-systems for control of pests, diseases and weeds of important crops across the country. Under the Integrated Pest Management, an area of 65,000 hectares has been covered in different agroclimatic zones, benefiting more than 30,000 farmers so far. Biopesticide formulation technologies have been transferred to the industry.

Animal Biotechnology: The Department has provided support for various programmes on animal health, diagnostics, animal byproducts, genetic characterization and transgenics, with the overall objective to enhance the productivity in animals through advanced techniques. Promising leads have been obtained on indigenous breed characterization and embryo preservation. Embryo transfer technology was perfected in cattle and 1000 genetically superior calves were born including 100 buffalo calves. Embryo transfer technique in camel was standardized and a new protocol for camel superovulation was developed for the first time. Transgenic mice carrying antibiotic markers, Hepatitis-B antigens, inter-leukin genes and other markers have been developed. A new rabies vaccine for animals has been produced and is being tested for technology transfer.

Aquaculture and Marine Biotechnology: A number of programmes have been supported for development of transgenic fish, bioactive components from marine sources and improved

Bunnies produced through nuclear transfer.

production of both fish and feed. Demonstration projects have been implemented for grow-out operations, hatchery and feed mill development for prawn. This has benefited a large number of farmers and entrepreneurs. A record production of over 10 tonnes/ha/yr in two crops of prawn has been achieved through semi-intensive aquaculture. Through intensive crop farming, production level of 18 tonnes/ha/yr has been achieved. An indigenous feed has been developed and tested for prawns. Genomic libraries of carps were constructed. A vibrio based vaccine against white spot disease in prawn is ready.

Plant Tissue Culture: The Department has been supporting programmes on plant tissue culture with the main objective of developing regeneration protocols of economically important forest trees,

Synchronous fruiting of banana plants raised through tissue culture.

Tissue culture raised sugarcane – hardened plants in polyhouse.

horticulture, and plantation crops. A total of 20 protocols for regeneration have been developed. Field performance was tested for the tissue culture raised plants in a number of plantation crops (tea, coffee and pepper). Molecular diagnostic kit has been developed for detection of Bunchy Top Virus in Banana.

Micropropagation Technology Parks: Micropropagation Technology Parks at NCL, Pune and TERI, New Delhi are serving as a platform for transfer of proven technologies and training in tissue culture. So far 6.5 million plants have been produced and planted in 7500 hectares in 17 states. Technologies for 10 species have been transferred to the industry. A satellite park has been set up in the north-eastern part of India for popularization of technology and production of planting material for the region. Regional hardening units have also been set up for different agro-climatic regions.

Bioprospecting and Molecular Taxonomy: A Network programme on Bioprospecting and Molecular Taxonomy has been implemented for characterization and cataloguing of the economically important plant species, using molecular markers, with focus on the two hot spot regions and prospecting of the genes and molecules of bioindustrial importance. The biome mapping of five North-Eastern states and three states of the Western Ghats has been successfully carried out by the Department of Space. A total of nine stress tolerant genes have been identified from plant species. A cold tolerant gene from plant species from Himachal Pradesh has been isolated. A salt tolerant gene has also been identified and cloned in a mangrove. Bioactive molecules having biocidal activities have been isolated and characterized from seven plant species.

Under the programme on molecular taxonomy, molecular characterization of millets, legumes and endemic species of Eastern Ghats is being carried out.

Seri-biotechnology: A number of projects on biotechnology for improving the productivity and quality of silk, along with the improvement of the host-plants in both mulberry and non-mulberry sericulture, are in progress. The silkworm genome initiative has provided some leads. Triploid mulberry plants have been field evaluated. Putative transgenic mulberry plants are being multiplied for further analysis.

Medicinal and Aromatic Plants : Biotechnological

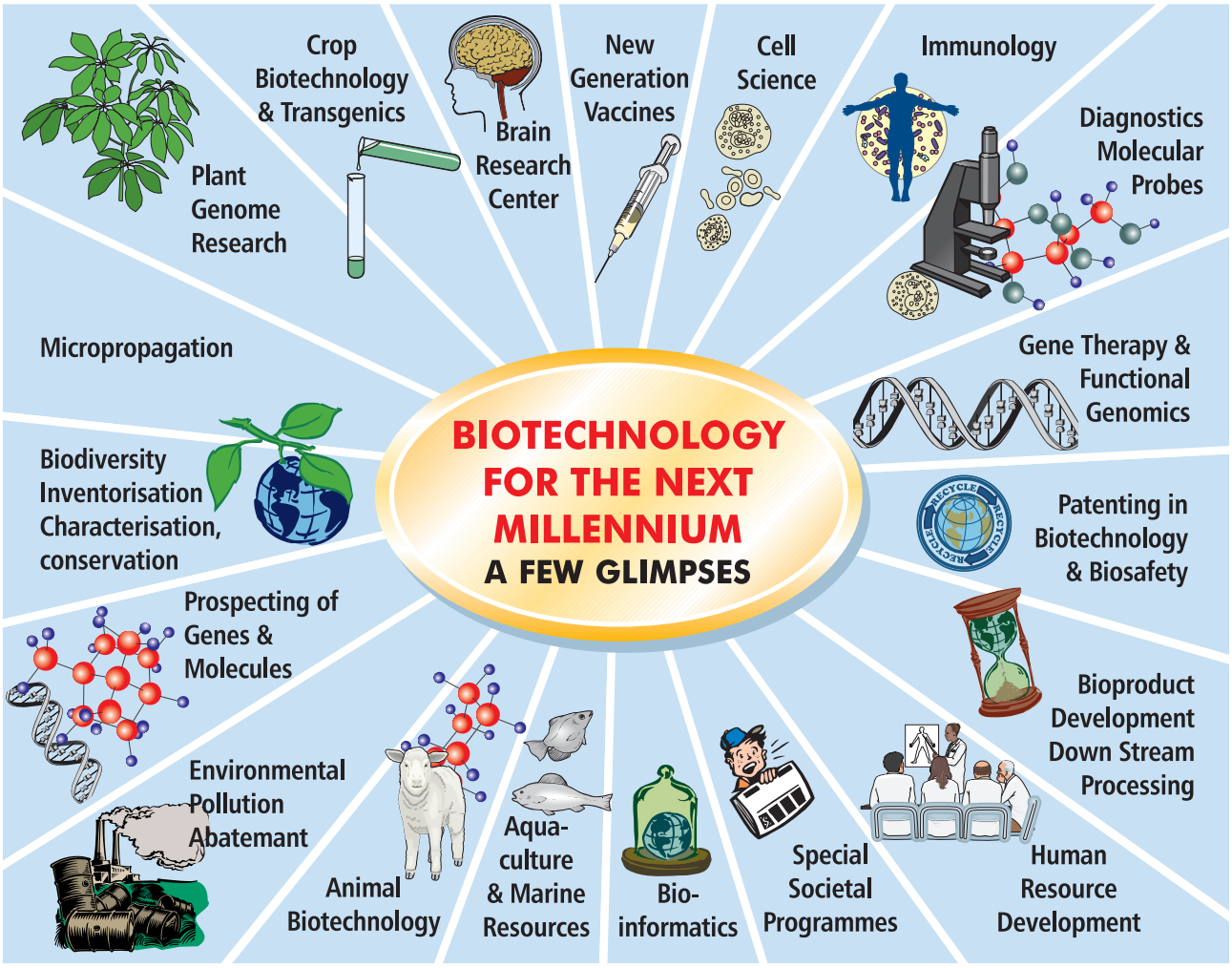
interventions for conservation, micropropagation, production of secondary metabolites, biotransformation of intermediates into pharmaceutically important products and genetic improvement have proved to be very useful. Immunomodulator compounds from *Piper longum* have been identified and a patent filed in India/ USA for the process and product. The technology has been transferred to industry. Four Gene Banks have been set up for conserving collected accessions of rare, threatened, endangered and economically important species of medicinal and aromatic plants.

Top: Cocoon rearing for sericulture by rural women. Bottom: Cultivation of medicinal plants in Himalayas.

Biodiversity Conservation and Environment: A number of programmes have been supported for developing environment friendly technologies through the application of biotechnological tools. Ecological restoration technology for revegetating limestone quarries has been successful in Mussoorie and Delhi region. The crude oil and oil sludge degrading bacterial consortia namely "OIL ZAPPER" has been successfully demonstrated. The technology packages have been transferred to the Industry for commercial exploitation.

Protocols for collection, evaluation, propagation and reintroduction of 15 mangrove species have been standardized. Over 5000 micropropagated plants were transplanted in semi-natural habitat after hardening. A collaborative proposal on "Conservation of Endangered Animals", has been supported to work on the Asiatic lion and tiger and establish a gene bank, and a semen bank.

Medical Biotechnology: The main objective of the programme is development of diagnostics, new generation vaccines for prophylactic and therapeutic use, drug delivery systems, production of important biological/ biomolecules, and close interactions with industries for transfer of technologies. Research projects were implemented in the areas of major infectious and non-infectious diseases viz. tuberculosis, HIV, malaria, leishmaniasis, cholera, *Helicobacter pylori*, dengue, typhoid, cancer, heart diseases and contraceptive vaccine. Projects on oral cancer and clinical applications of the stem cells have been initiated. Three diagnostic kits for detection of



HIV-I & II, a therapeutic vaccine for leprosy, the Leprovac, as an immunomodulator and a drug delivery system for systemic fungal infections have been developed and transferred to industry. Two hepatitis C diagnostic tests and a prototype vaccine for rotaviral diarrhoea have been developed and validated. Special projects for development of edible vaccines for rabies and cholera are in an advanced stage. Eight test systems for diagnosis of dengue, hepatitis and reproductive hormones have been transferred to the industries.

Human Genetics and Genome Analysis: The Human Genome Project has ushered in a new era of genomics. The technological developments that have taken place since the initiation of this international mega project have provided opportunities for a big leap in the area of human genetics and genome analysis. Several programmes were initiated in the area of Human Genetics & Genome Analysis during 1990-91, with the main aim of providing genetic diagnosis and counselling to families with genetic disorders, to develop new methods for diagnosis of such disorders; and to find out the functions of the genomic DNA sequences. For this purpose fourteen genetic clinics were established for providing molecular diagnosis and counselling for the common genetic disorders such as beta-thalassemia and other haemoglobinopathies and Duchenne Muscular Dystrophy (DMD) prevalent in the country. About 13,845 affected families have benefited from these units so far.

A number of programmes have been identified through expert level consultations for developing

projects related to the Post Genome Era. Action has been initiated to further strengthen the areas of functional genomics, proteomics, pharmacogenetics, custom made drug designing, development of molecular diagnostic methods for various infections, genetic disorders and targets for drug development.

In the programme on functional genomics started a few years ago, powerful computational capability for handling large-scale human genome sequence data, robotic methodologies for genotyping and PCR based diagnostics for common genetic disorders have been developed.

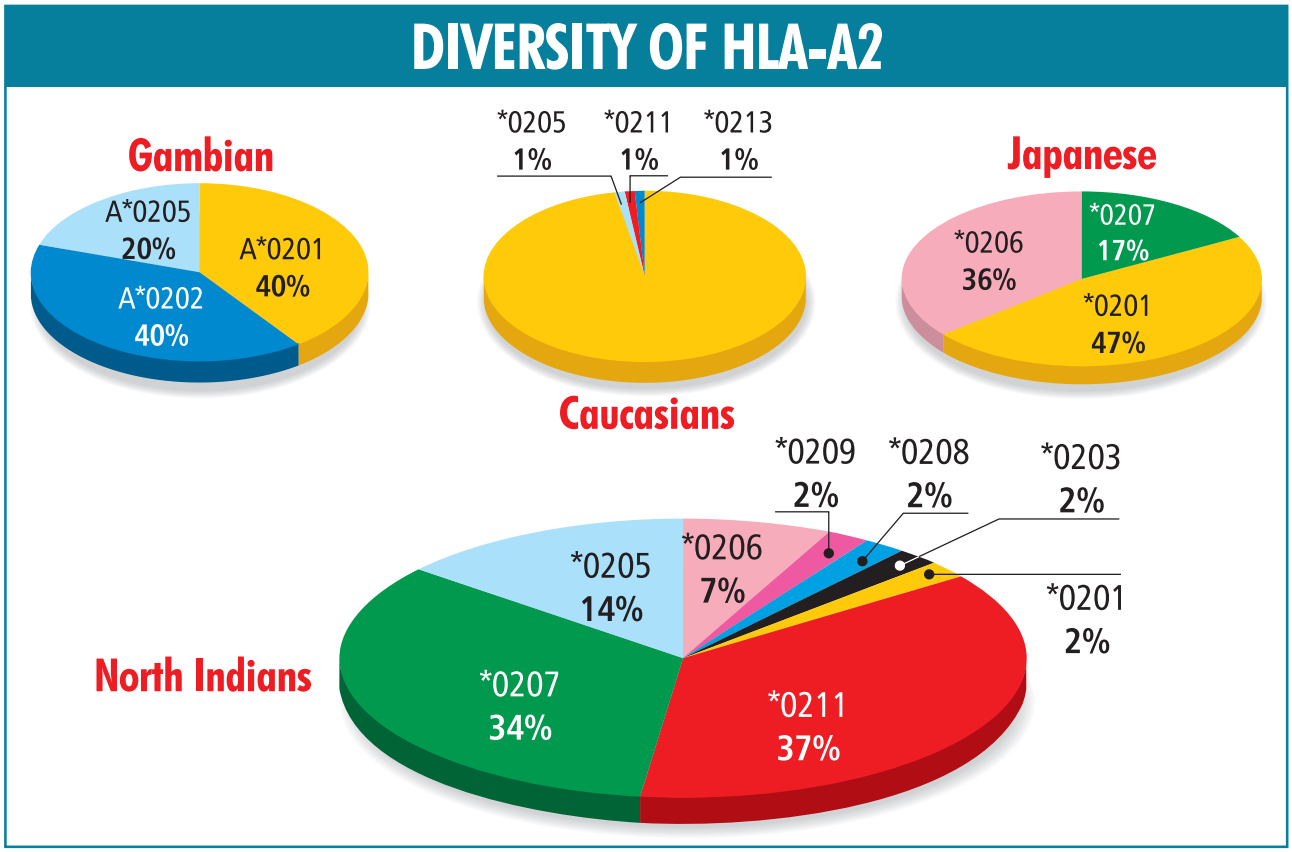
Bioethics: The Department has set up a National Bioethics Committee to consider the issues related to the universal declaration on human genome and human rights and to liaise with the International Bioethics Committee of UNESCO.

Food Biotechnology: In the area of Food biotechnology low cost nutritious food has been developed for providing high energy to children. The National Dairy Development Board, Anand undertook pilot plant process standardization for the production of 'Soft Chikki'. Eighty pilot product trials were carried out and various processing conditions were standardized. Other projects such as 'Dal analogue"' made out of edible grade defatted soyflour and wheat flour resembling the ordinary 'dal' with similar cooking properties and containing 35% more proteins has been developed.

Jai Vigyan National S&T Missions

The Department has launched four Jai Vigyan National S&T Missions in the area of development of new generation vaccines, biotechnology for herbal product development, coffee improvement and establishment of mirror sites for genomics. There have been several leads:

The main objectives of the New Generation Vaccines Development mission are to study the efficacy of DNA, recombinant/ peptides vaccines



for cholera, malaria, tuberculosis, Japanese encephalitis (JEV) and rabies (for animals); develop preventive/ therapeutic DNA candidate vaccines. A DNA based vaccine for JEV using NI1 and NS 3 enveloped proteins has been developed.

The Herbal Product Development Programme aims at (a) developing improved ergot production technology, (b) agro technologies for high yielding *Artemisia annua*, (c) therapeutic applications of a compound isolated from *Tinospora cordifolia,* (d) developing herbal product for hyperlipidemia, and (e) developing immuno modulatory and anti-arthritic agents of herbal origin. Field experiments are underway on *Jeevan Raksha* variety of *Artemisia annua* indigenously developed to yield 20 to 80 kg of artemisinin/ha with a view to further improving the yield.

A network programme on Coffee Improvement through Biotechnological approaches has been supported with two major objectives: germplasm characterization, mapping and cataloging and genetic transformation for improved varieties resistance to disease and pests and also with low caffeine content. A complete regeneration system has been developed for arabica and robusta coffee through various explants. Protocols have also been standardized for embryo rescue from distant crosses. A simple working protocol has been developed to extract high molecular weight genomic DNA from leaf samples of coffee.

Several internationally recognized databases have been established in India under the National Jai Vigyan Science & Technology Mission for Genomic Research at: The Indian Institute of Science (IISc), Bangalore; University of Pune, Pune; Jawaharlal Nehru University (JNU), New Delhi; and Institute of Microbial Technology (IMTECH), Chandigarh. The Databases will be in the form of Mirror Sites, such as Genome Databank (GDB), Protein Database (PDB), Plant Genome Databases and Databases and Software hosted at European Bioinformatics Institute (EBI).

Technology Transfer

Approximately 40 technologies have been transferred to different industries. These include, diagnostic kits for HIV, Hepatitis, Dengue, assessment of reproductive hormones, Japanese Encephalitis, Vaccines for leprosy, drug formulation for septic shock, plant tissue culture protocols, formulation of biofertilizers, high protein gene from *Amaranthus* and bioremediation technology for mine spilled dumps and crude oil spillage.

Biosafety and IPR

The Department with the help of senior scientists and experts has evolved very effective biosafety guidelines which have been widely circulated across the country. A three tier biosafety mechanism has been created- Institutional Biosafety Committee (IBSC), Review Committee on Genetic Manipulation (RCGM), and Genetic Engineering Approval Committee (GEAC).

A Biotechnology Patent Facilitating Cell has been established with the objective of creating awareness and understanding relating to patenting.

Bio-Medical Technologies Transferred and Launched in the Market

Technology	Developed By	Launched By
Leprosy immunomodulator	NII, New Delhi	M/s Cadila Pharmaceuticals, Ahmedabad
Leshmaniasis detection kit	CDRI, Lucknow	M/s Span Diagnostics Ltd., Surat
Western Blot for HIV-I & II	CRI, Mumbai	M/s J.Mitra & Co., New Delhi
Naked Eye agglutination System for HIV-I & II	University of Delhi, South Campus	M/s Cadila Pharmaceuticals, Ahmedabad
Hepatitis C Diagnostics ELISA Based	ICGEB, New Delhi	Xeytron, Bangalore

Bio-Medical Technologies Transferred (not yet launched)

S.No.	Technology	Developed by	Transferred to
1.	The 1gM Mac ELISA for the detection of Dengue	NIV, Pune	Zydus Cadila Health Care, Ahmedabad
2.	The 1gM Mac ELISA for the detection of Japanese Encephalitis	-do-	-do-
3.	The 1gM MacELISA for the detection of West Nile	-do-	-do-
4.	ELISA system to measure alpha-feto protein levels in pregnant women	IICB, Kolkata	M/s Shantha Electronics, Hyderabad
5.	An 1gM based system for the detection of Hepatitis A virus using monoclonal/polyclonal antibodies	NIV, Pune	M/s Bharat Biotech.Ltd, Hyderabad
6-9	Urine based systems (ELISA) for the detection of four Reproductive Hormones i.e.(PDG) Pregnandiol Glucuronide Oestrogen Glucuronide (EIG), Folicle Stimulating Hormone (FSH) & Luteinizing Hormone (LH) (four separate systems)	IRR, Mumbai	Zydus Cadila Health Care, Hyderabad
10.	A technology utilizing Yarrowia liplytica expressing Hepatitis E surface and pre S genes (yielding high level of proteins/single step purification)	University of Baroda, Baroda	Biological Evans Ltd., Hyderabad
11.	A technology for expressing hCG using Pichia pastoris system	IISc, Bangalore	Cadila Pharmaceuticals, Ahmedabad

So far 90 patents have been filed by the Department. A patent database has also been prepared.

Biotech Facilities and Centres of Excellence

The Department has supported a large number of facilities, repositories, and Centres of Excellence across the country. Nineteen such facilities so far established have an overall objective of facilitating research and providing services across the country.

An International Depository Authority has been recently set up at IMTECH, Chandigarh for Conservation of Microbial Biodiversity in accordance with the Budapest Treaty. Other new facilities established are the National Containment Facility for Transgenic Plant Material and the National facility for Virus Diagnosis and Quality Control of tissue culture raised plants at IARI, New Delhi.

Bioinformatics

Biology has become more computationally intensive. Bioinformatics has acquired significance owing to its potential applications for identification of useful genes, leading to the development of new gene products, drugs and diagnostics. The Department has expanded the bioinformatics network in the country for easy access and dissemination of data information resources through its distributed information centre; establishing International databases; establishing new centres; and training. Fifty five centres, established under the BTIS net are continuing to serve these objectives. Six interactive computer graphic facilities and four diploma courses in Bioinformatics have made commendable progress.

Human Resource Development

The main focus of the HRD programme supported by the Department has been to generate large numbers of highly trained scientists/students. The Department has supported programmes in 51 universities across the country. The main programmes being supported are PG/PD/one year diploma courses. The approximate annual intake of the students is 500-600. The Department has recently initiated a restructured post-doctoral fellowship programme. Biotechnology Associateships are offered - both national and overseas - to train scientists in the fron-

Technologies under Negotiation

S.No.	Technology	Developed by
1	LDH based ELISA for Malaria	CDRI, Lucknow
2	DAT for Toxoplaenosis	AIIMS, New Delhi
3	Reagents for thyroid and steroid hormones	AIIMS, New Delhi, IICB, Kolkata
4	Peptide based ELISA system for protection of HIV-I & II	NII, New Delhi
5	Skin culture technology for use in burn cases	NCCS,Pune
6	Medium for preservation of Cornea	NCCS, Pune
7	Haemagglutination for Kala-azar	CDRI, Lucknow
8	IFA for Rabies	AIIMS, New Delhi
9	Systems for Steroids	IICB, Kolkata
10	Tests for Species Specific Snake Bite	VM Scientific Research Foundation, Bangalore

tier research areas of Biotechnology and also for upgrading the knowledge in advanced areas of research. Short-term, long-term and industrial training programmes are also being supported for mid-career scientists to enhance their career opportunities. Numerous awards have been instituted at all levels to recognize and encourage excellence. These include Biology Scholarships for college students, National Bioscience Award for Career Development for mid-career scientists, a National Woman Bioscientist Award and a Biotech Process Development Award. A Biotech Chair has been instituted in honour of G.N.Ramachandran, at IISc, Bangalore.

International Linkages

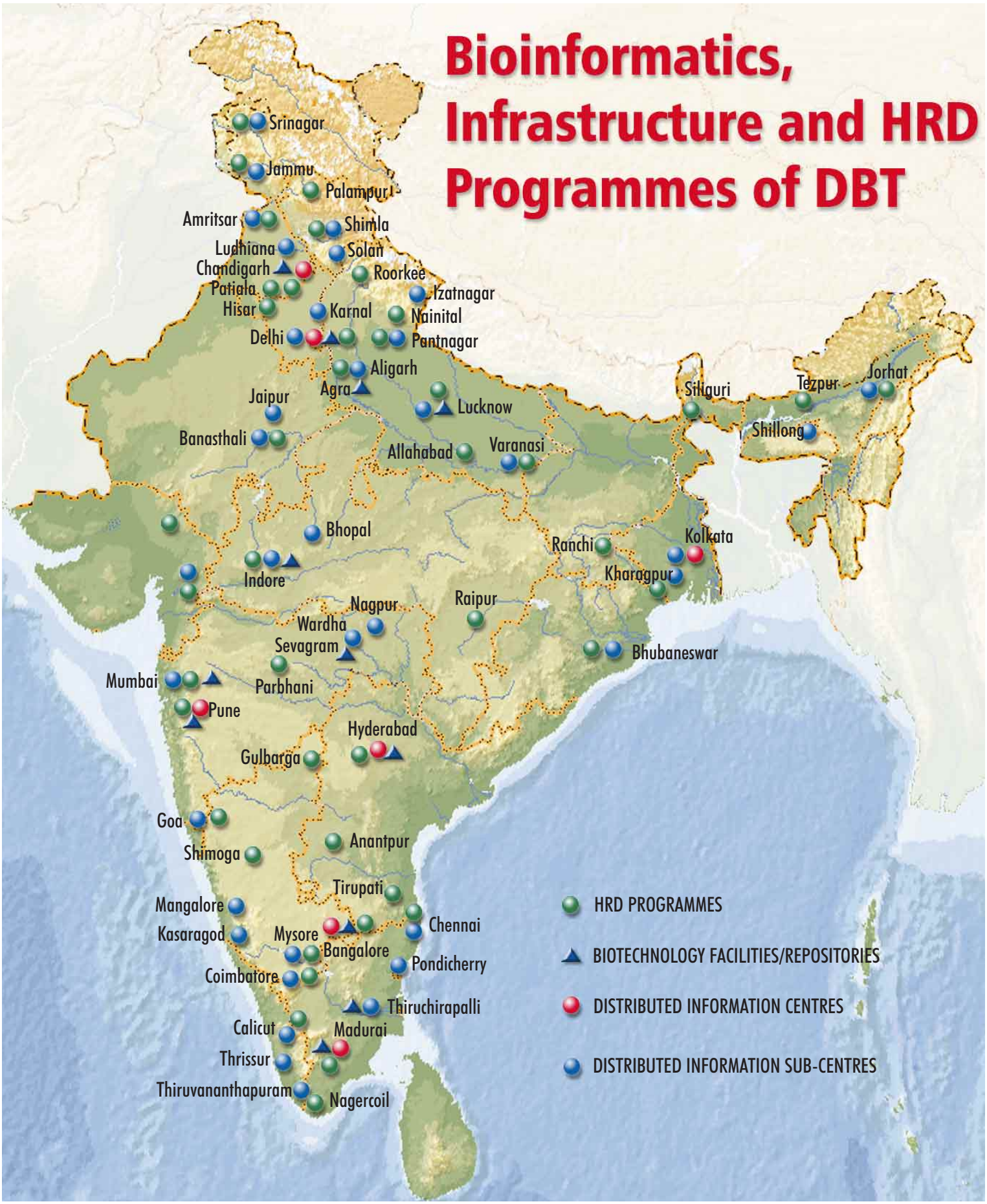
A new direction has been given to the ongoing international bilateral and multilateral cooperation. A number of programmes of S&T priority of national interest have been identified/implemented for further collaboration with developed and developing countries. These are focussed on issues of national concern such as human reproduction, environment, genetic disorders, agriculture, health and industrial applications. Programmes have been established with Belarus, China, Cuba, France, Germany, Israel, Italy, Japan, Myanmar, Poland, Russia, Sri Lanka, Sweden, Switzerland, Tunisia, UK, USA and Vietnam. Interactions have also been initiated with S&T agencies in Australia, Hungary and the Philippines. Multilateral collaborations involve countries of SAARC, G-15 and the ASEAN.

Autonomous Institutes

The Department has established a number of autonomous institutes with the objective of carrying out excellent work in highly relevant areas and provide leadership in selected areas.

National Institute of Immunology (NII), New Delhi: NII was set up by DST at a time when immunology as a discipline was at its infancy in the country. It was later transferred to DBT and has presently developed into a centre of excellence. Researches carried out here have yielded several products and innovations for which one Australian, two American and one Canadian patents have already been granted. Over 150 research papers have been published on gene regulation, molecular mimicry, reproduction and development as well as immunity and infection.

National Centre for Cell Science (NCCS), PUNE.: The NCCS which started as a National facility for animal cell and tissue culture has broadened its goals from a repository into a Research and Development Centre. Beginning with over 100 odd cell lines at the time of its inception, it presently has 1000 various cultures and hybridomas. Over 200 researchers from across the country have been trained so far. The efforts of NCCS have resulted in the development of biocompatible synthetic matrices suitable for controlled drug release and immuno


Bioinformatics, Infrastructure and HRD Programmes of DBT
Srinagar
Jammu
Palampur
Amritsar
Shimla
Ludhiana
Solan
Chandigarh
Roorkee
Patiala
Izatnagar
Hisar
Karnal
Nainital
Delhi
Pantnagar
Aligarh
Agra
Jaipur
Lucknow
Banasthali
Allahabad
Varanasi
Siliguri
Tezpur
Jorhat
Shillong
Bhopal
Ranchi
Kolkata
Kharagpur
Indore
Nagpur
Raipur
Wardha
Sevagram
Bhubaneswar
Mumbai
Parbhani
Pune
Hyderabad
Gulbarga
Goa
Anantpur
Shimoga
Tirupati
Mangalore
Chennai
Kasaragod
Mysore
Bangalore
Pondicherry
Coimbatore
Thiruchirapalli
Calicut
Madurai
Thrissur
Thiruvananthapuram
Nagercoil
HRD PROGRAMMES
BIOTECHNOLOGY FACILITIES/REPOSITORIES
DISTRIBUTED INFORMATION CENTRES
DISTRIBUTED INFORMATION SUB-CENTRES

isolation of islet cells. The centre has started three skin culture and production centres across the country.

Centre for DNA Fingerprinting and Diagnostics (CDFD), Hyderabad: CDFD is handling cases of DNA fingerprinting received from crime investigation agencies and the judiciary in the country, and also specimens sent by international agencies such as Interpol, Governments of Bangladesh, New Zealand, Australia. The Centre started a screening programme for diagnosing inborn errors of metabolism among the new born babies. The Centre provides genetic counselling to the families and follow up services to affected children. The automated genome facility of the Centre has synthesised more than 820 oligonucleotide primers for service and R&D uses. Over 800,000 nucleotides have been sequenced during the last year as part of the efforts to characterise mutations, genetic susceptibility factors and molecular epidemiology.

National Centre for Plant Genome Research (NCPGR), New Delhi: The Centre started functioning with effect from 1 April, 1998. It is utilizing molecular biology approaches alongwith tissue culture and genetic engineering technology to identify important genes and manipulate them for generating transgenic plants with improved agronomic traits and pathogen/stress resistance. A novel gene, *AmA1* from *Amaranthus hyprochondriacus* has been used for generating transgenic plants of agronomic importance. Transgenic potato with high nutritional quality has been developed with the introduction of *AmA1* gene. The technology for over expressing *AmA1* in the yeast cell system has been transferred to Cadila Pharmaceuticals for industrial production of animal feed supplement.

National Brain Research Centre (NBRC), New Delhi : NBRC was established in 1999 with the main aim to undertake, aid, promote, guide and coordinate research of high calibre in basic and clinical neuroscience and to encourage and augment effective linkages between various scientific and research agencies/laboratories and other organizations working in the field of brain research.

Institute of Bioresources and Sustainable Development (IBSD), Imphal: The Department is in the process of establishing the Institute of Bioresources and Sustainable Development in the North-Eastern region of India at Imphal with the objectives of development of bioresources and their sustainable use through biotechnological interventions for the socio-economic growth of the region.

National Bioresource Development Board (NBDB)

NBDB has been set up with the main purpose of developing a broad policy framework for effective application of biotechnological and related scientific approaches for R&D and sustainable utilization of bioresources. Two broad groups of activities have been identified: (a) preparation of digitized inventories of plant, animal, microbial, and marine resources, and (b) R&D projects, programme support, establishment of centres of excellence, training and demonstrations, for the development of bioresources of north-eastern region, Himalaya, coastal and island ecosystems, deserts, Indo-Gangetic plain and Peninsular India.

Biotechnology for Societal Development

Several special biotechnological programmes for the benefit of underprivileged (SC/ST population, women and rural people) have been implemented in the areas of biopesticides, biofertilizers, vermicompost and vermiculture, sericulture, floriculture, mushroom cultivation and medicinal plant production, poultry and fish farming and improvement of human health. Universities, national laboratories, state government institutions, krishi vigyan kendras and NGOs have been involved for implementing these projects. 52,000 families have been trained in various biotechnology related areas through 102 projects.

A Biovillage has been established at Mocha, near Porbandar in Gujarat for extension of technologies which are pro-poor, pro-women and pro-nature to the grassroot level. A Women's Biotechnology park has been established in Chennai. It aims to provide opportunities to professionally qualified women for setting up self-employment ventures using various biotechnologies. The park has twenty industrial modules and an equal number of land modules for agro-biotechnology activities.

Development of Biotechnology

During the last two years, with revolution in information technology, awareness regarding utilization of biotechnology potential has increased many-fold. As a result several State Governments are formulating proposals, particularly for establishing Biotechnology Parks, Biotechnology City/ Knowledge Parks etc. The Department is providing scientific and organizational advice to the states in these endeavours.

Major achievements of the Department in terms of research leads, products and technologies other than those already mentioned are given below:

Research leads

- Three dimensional structure of Lactoferritin determined and the protein used as anti-bacterial or anti-fungal agent.
- A novel target gene delivery system dedicated for liver cells developed and patented in USA.
- Identification of mutation conferring resistance to HIV infection in Indian population.
- Cloning and sequencing of at least six genes achieved, specially for the seed storage protein, amino acid biosynthesis and genes for plant defense and for enhancing the nutritional quality. A US Patent has been granted for the seed storage protein gene.
- Genes encoding for two endotoxins designed, chemically synthesised and successfully assembled, to be used for transformation in important crops.
- Three major fruit ripening genes of banana have been cloned at NBRI, Lucknow.
- By using polymerase chain reaction (PCR), three genes for quality traits in wheat have been identified at the Punjab Agriculture University, Ludhiana, Department of Agricultural Botany, Ch. Charan Singh University, Meerut, and Department of Biotechnology, GBPUT&A, Pantnagar.
- A cold resistant gene has been identified from a plant of the cold desert region as part of the bioprospecting of biological resources at the IHBR&T, Palampur.
- Transgenic silkworm with luciferase gene produced. The mori silkworm larvae can act as bioreactors for producing proteins of agricultural and therapeutic importance.
- For transfer of targeted genes into silkworm (*Bombyx mori*), a system using *Bombyx mori* nuclear polyhedrosis virus (BmNPV) has successfully demonstrated the expression of ORF-3 of Hepatitis E viral antigen at the IISc, Bangalore.
- A process for degumming of silk with fungal proteases (enzymatic treatment) has been developed as an alternative method for improvement in the quality of fabric.
- After successful cloning and expression of glycoprotein-2 and 3 of dog zona pellucida in *E.coli*, these recombinant products have been evaluated for their implication in regulating fertility in female dogs at the Central Military Laboratory, Meerut.
- A Pregnancy Diagnostic Kit in cattle and buffalo using milk as the test material is being refined to increase sensitivity and specificity.
- Vaccines against fish pathogens (*Aeromonas sp*.and *Pseudomonas sp*.) have been developed.
- A highly effective agent for inducing fish spawning developed.
- Hylauronic acid as a marker for infertility in male has been assessed at JNU, New Delhi.

- First indigenous recombinant vaccine strain for oral cholera, VA 1.3, and Rotaviral diarrhoea enter clinical trials.
- A Network programme on human genome diversity was initiated to assess the linkages of different tribes/ castes and to identify genes responsible for diseases/ disorders.

Technology Transfers & Demonstrations

- A total of 40 Technologies transferred.
- Five technologies for large-scale production through tissue culture transferred to industry.
- Tissue culture of vanilla plants are under demonstration in the states of Kerala, Karnataka and Tamil Nadu. Elite tissue culture of greater cardamom (*Amomum*) is under demonstration in Sikkim.
- Tissue culture-raised lesser cardamom (*Elettaria cardamomum*) demonstrated in 100 ha; 40% increase in the yield achieved.
- Biobeneficiation and desulphurization technologies perfected and transferred to industry
- Bioremediation field tested for wasteland recovery; more than 50 acres land recovered with biomass.
- Cost effective, environmentally sound bacterial isolates identified and demonstrated to industry for crude oil remediation.
- Immunodiagnostic kits for detection of pebrine disease and Nuclear Polyhedrosis Virus (NPV) in mulberry silk worm successfully used.
- Tissue culture based vaccines for poultry being transferred to the industry.
- An isoquinoline alkaloid was isolated from *Berberis aristata* which showed potency in preventing systemic infection leading to septic shock, tissue damage and organ dysfunction in burn cases has been transferred to Industry.