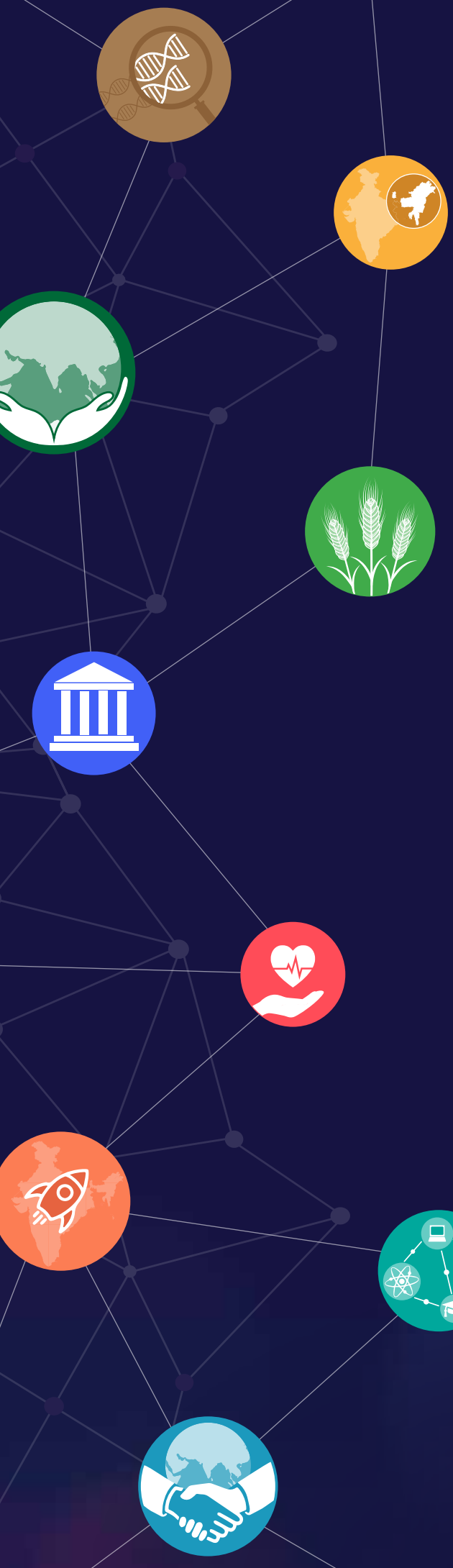


DEPARTMENT OF BIOTECHNOLOGY
Ministry of Science & Technology

Department of Biotechnology

Achievements 2014-2018

Department
of Biotechnology

Achievements

2014-2018

DEPARTMENT OF BIOTECHNOLOGY
Ministry of Science & Technology

Preface

Dr. Renu Swarup
Secretary, Department of Biotechnology
Ministry of Science & Technology,
Government of India

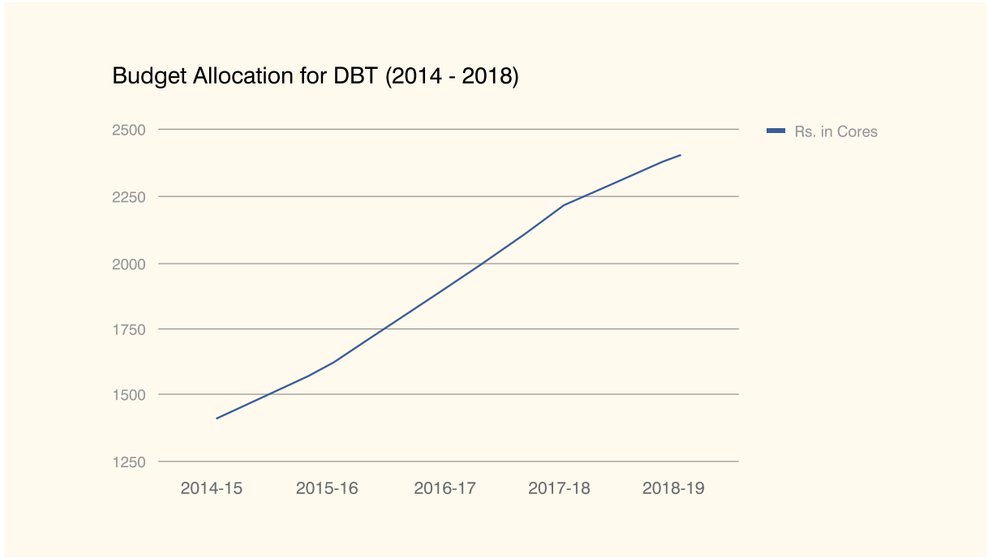
During the last four years the Department of Biotechnology has witnessed a major growth in promoting Bioscience Research, Education and Entrepreneurship. The National Biotechnology Development Strategy was announced in 2015 and the main focus has been on the generation of Biotech products, processes and technologies to enhance efficiency, productivity, safety and cost-effectiveness of agriculture, food and nutritional security; affordable health and wellness; environmental safety; clean energy and biofuel; and bio-manufacturing. There has been a major thrust on building a skilled work force to meet the requirements of our National Missions. The policies announced by the Government have strengthened the Institutional Mechanisms for empowering innovation and ensuring scale up and sustainability. The emphasis has been on technology-oriented research aimed at improving lives and living of millions.

There has been a paradigm shift in the relationship between Government, Academia, Industry, Startups and Civil Society. The Department has made special efforts to contribute through its various programme to the National Mission launched by Hon'ble Prime Minister-Swasth Bharat, Swatch Bharat, Startup India, Make in India and Digital India.

This report summarizes some of our success stories over the last four years. Department of Biotechnology remains committed to provide a special impetus to new knowledge generation and discovery, launch major strategically driven and directed Missions, empower the country's human resource scientifically and create a strong ecosystem for research, development, translation and commercialization in order to create a robust bioeconomy.

Department of Biotechnology, Achievements: 2014-2018

The Department of Biotechnology (DBT), under the Ministry of Science and Technology, established in 1986, has made outstanding contributions in promoting biology and biotechnology research and development in India. Over the last four eventful years, the department has brought about solutions to numerous problems of mankind through research and implementation of biosciences by guiding policy thinking, creating institutional infrastructure, forging industry partnerships, instituting regulatory capacity, developing talent pool, spear-heading cutting edge research, supporting key missions, & driving international collaborations. Building on the mantra *"Science for Society"*, provided by Hon'ble Prime Minister of India, Shri Narendra Modi, the Department of Biotechnology, Ministry of Science and Technology, Government of India, has over the last four years strategized and developed a blueprint for providing end-to-end solutions, from research to translation, creating large scale impact across multiple sectors.



1. Policy
2. Agriculture
3. Healthcare
4. Environment
5. Bioinformatics
6. North East Region
7. Science Outreach
8. Innovation and Translation and Start Up India
9. International Cooperation

Some statistics from the last four years, which are indicators of the critical components of the biotech innovation ecosystem, are:

10,537
Publications

183
Patent Applications filed

301
Technologies/Products developed/ commercialized

8266
Scientists supported

2575
Institutions supported

650
Start-ups/Entrepreneurs supported

>5000
Students trained in Industrial Programme

250
Scientists/Researchers who have returned to India under the Re-entry Programme

Biotechnology: Narrative for Economic Development

1. Policy Initiatives

DBT laid out its strategy through a carefully developed policy paper on the way forward for 2015-2020.

A. National Biotechnology Development Strategy 2015-2020

The key features of the strategy:

- Launch of four Major Missions - Education, Healthcare, Food and Nutrition and Clean Energy.
- Creation of technology development and translation networks across the country with global partnerships.
- Establishment of life sciences and biotechnology education council for strategic and focused investment in building the human resource.

During the last four years, from 2015 till date, much of the ambition of the strategy document has been achieved. The successes/achievements of the Department of Biotechnology in the last four years are provided herewith.

B. Regulations and Guidelines on Biosafety of Recombinant DNA Research & Biocontainment, 2017 Released

The Regulation and guildelines on boisafety of recombinant DNA research & boicontainment 2017 were released by Secertary, DBT, Prof K VijayRaghavan

The release took place during 2017- Meeting of States Parties of the Biological Weapons Convention (BWC) at Geneva, Switzerland on 5th December, 2017

The document specifies practices for handling hazardous biological material, recombinant nucleic acid molecules & cells, organisms & viruses

Adoption of this guideline shall be binding for all public and private organizations involved in research, development and handling of GE organisms

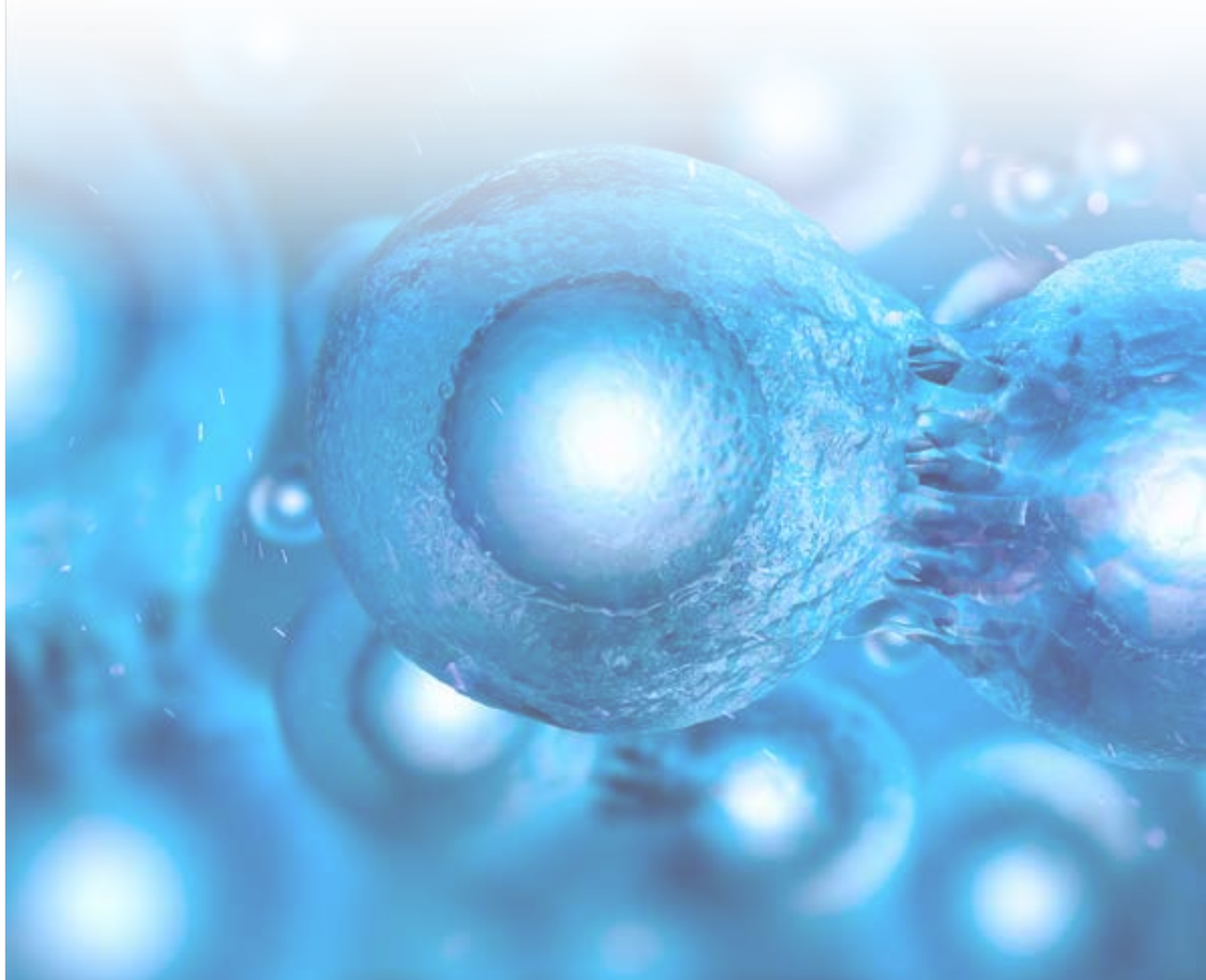
C. The Regional Centre for Biotechnology (RCB) Act, 2016

The Regional Centre for Biotechnology (RCB) Established by the Act of Parliament, July 2016

- The RCB bill was passed by both Houses of Parliament and was notified after the Presidential consent on 30th July 2016.
- The Bill seeks to establish a Regional Centre for Biotechnology, an institution of education, training and research, under the auspices of United Nations Educational, Scientific and Cultural Organization (UNESCO) in the National Capital.

D. National Guidelines for Stem Cell Research, 2017

The “National Guidelines for Stem Cell Research, 2017” was jointly formulated by Department of Biotechnology and the Indian Council of Medical Research to lay down standards for stem cell research and ensure that research with human stem cells is conducted in a responsible and ethically sensitive manner in the country. As per the Guidelines, all institutions carrying out research on human stem cells must constitute an Institutional Committee for Stem Cell Research (IC-SCR) and register with the National Apex Committee for Stem Cell Research and Therapy (NAC-SCRT). The registration of IC-SCR is mandatory and all the institutions working in the field are required to comply with the guidelines. The guidelines states that any stem cell use in patients is investigational and it must only be done within the purview of an approved and monitored clinical trial and not offering it as therapy. The guideline is available on DBT website: *http://www.dbtindia.nic.in/wp-content/uploads/National_Guidelines_StemCellResearch-2017.pdf.*



2. Agriculture & Allied Areas

Science Impacting farmers' income and ensuring food security.

A. Better Resilient Crops with Improved Yields

The department has developed several new varieties of crops resistant to biotic (pest, disease) and abiotic stress (temperature, water).

Crop	Variety developed	Trait
Maize	Vivek QPM-9 (improved)	Pro-vitamin A Rich Maize variety
Rice	PB 1121 'saltol' IWP 'saltol' ADT 43 'saltol'	Salinity tolerance rice variety
	Swarna- sub 1, IR64 – sub 1	Submergence tolerance rice variety
	Samba-Mahsuri- sub 1	
	Pusa Basmati 1728	Resistance against Xanthomonas
Wheat	Unnat PBW 347	Resistance against rust

Varieties developed in DBT sponsored projects

B. Wheat Genome Decoded through Indian Participation in 15 Country Partnership Research

India was part of a strong partnership in decoding the wheat genome in which 15 countries joined hands to complete this huge task of decoding 17,000 million bases. Indian scientists participated in decoding chromosome 2A. Bread wheat, with an estimated world harvest of more than 550 million tonnes, is one of the most important food crops in the world. Wheat breeders, however, had few genetic tools to help them select key agricultural traits for breeding and did not always know the genes responsible for the trait they need.

The analysis of the wheat genome, in which India played a crucial role, will give breeders the tools required to select traits for a healthy yield.

C. DBT Supporting Soil Health Improvement through Biotech Interventions

DBT supported Biotechnological interventions to improve soil fertility and biological health for high crop productivity in Jalandhar and Amritsar districts of Punjab, Kaithal and Karnal in Haryana.

- Vermicompost fortified with ABM's (Mycorrhiza, Acinetobacter, *Bacillus megaterium*, Pseudomonas spp.) increased 15% yield compared to chemical fertilizer.
- Use of farm waste for vermicomposting focused to improve soil health benefited more than 1100 farmers.

D. Four Virtual India-UK Joint Centres in Agricultural Nitrogen Setup

The aim of these four centres is the effective management of nitrogen use within farming systems.

- India-UK Nitrogen Fixation Centre (IUNFC): Indian Institute of Soil Science & Oxford University, UK.
- Cambridge-India Network for Translational Research in Nitrogen: ICRISAT & Cambridge University, UK.

- Indo-UK Centre for the Improvement of Nitrogen use Efficiency in Wheat (INEW): Indian Institute of Wheat and Barley Research, Karnal & Rothamstead Research.
- Newton-Bhabha Virtual Centre on Nitrogen Efficiency of Whole-cropping Systems for improved performance and resilience in agriculture (NEWS India-UK): Guru Gobind Singh Indraprastha University, Delhi & NERC CEH.

E. DBT Innovate UK Supporting Ideas to Reduce Post-harvest Loss

Post-harvest losses up to 30% occur between harvest and the moment of human consumption. They include on-farm losses, such as when grain is threshed, winnowed, and dried, as well as losses along the chain during transportation, storage, and processing.

- DBT and Innovate UK are investing £10 million (£5m from Innovate UK and £5m from DBT) towards funding of seven projects on biotech approaches for tackling challenges in agricultural food sector.
- The seven projects are focused on enhancing rice milling and maximized valorization of rice milling by-products, bio-based packaging for fresh food and electrolyzed water for post-harvest treatment.

F. FarmerZone, a Cloud-based Service with Curated Data Catering to all Needs of the Farmer

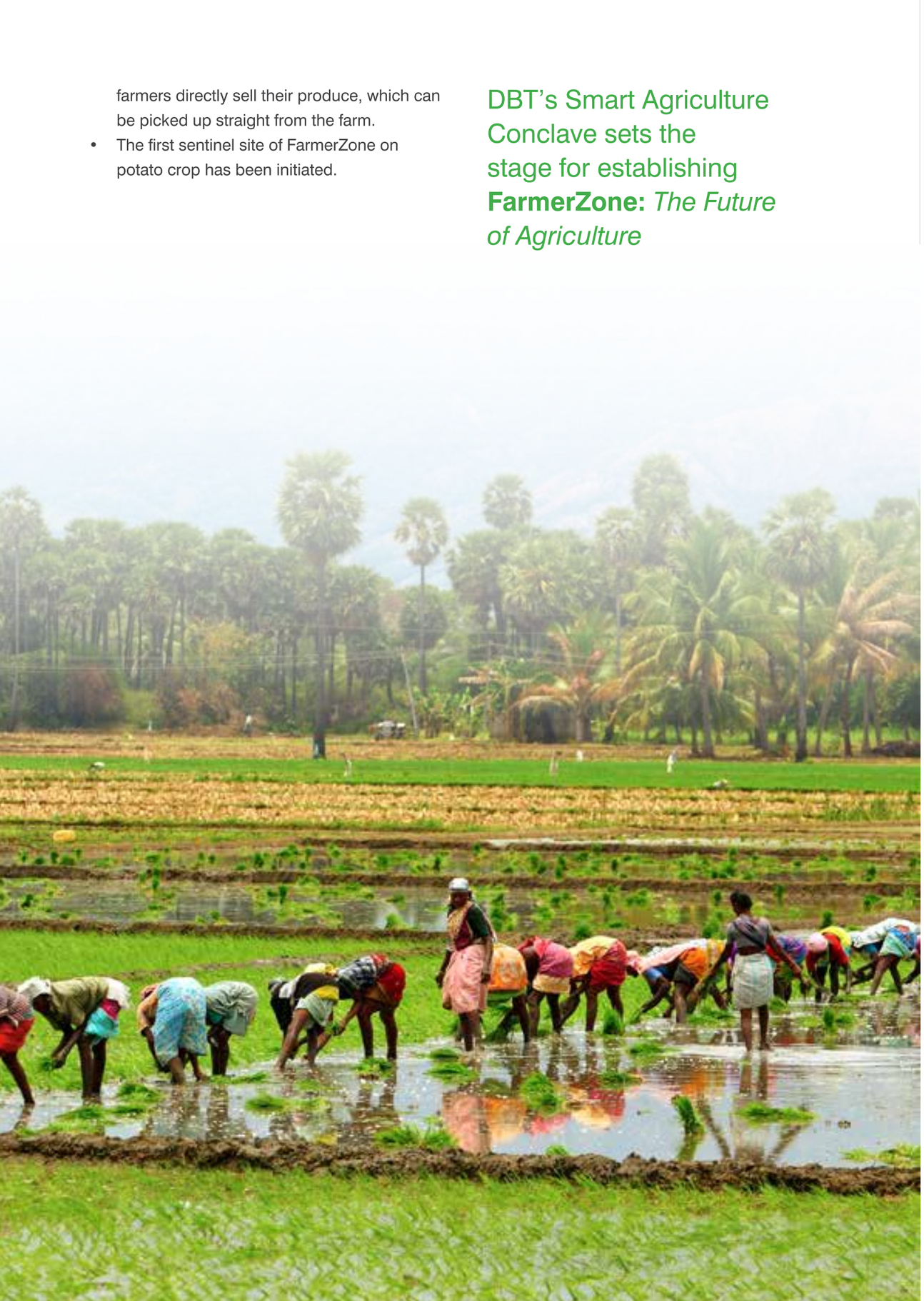
The Department is taking the lead to develop a commercial model for Indian farmers in what we call a "FarmerZone", a cloud-service with curated data catering to all the needs of farmers.

- This would be a multi-purpose window for solutions to farmers on climate change, weather predictions, land, soil, disease, pest, water, planting material and marketing available for farmers anywhere in India and perhaps around the globe.
- Farmers can access the service directly or through an intermediate structure such as local co-operatives. This service will help

farmers directly sell their produce, which can be picked up straight from the farm.

- The first sentinel site of FarmerZone on potato crop has been initiated.

DBT's Smart Agriculture Conclave sets the stage for establishing **FarmerZone:** *The Future of Agriculture*

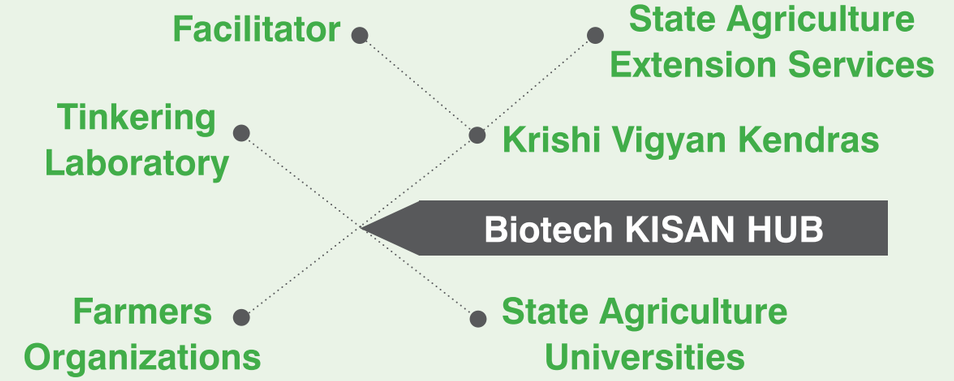


G. Biotech-KISAN Scheme Impacting Farmers Lives through Science

Biotech-KISAN empowers farmers. The Scheme is for farmers, developed by and with farmers, impacts locally, connects globally, having a hub-and-spoke model and stimulating agri-entrepreneurship and innovation in farmers.

- The programme provides solutions to challenges of small and marginal farmers.
- Strong Scientists-Farmers Interaction Platform created.
- Demonstrates and scales up programmes addressing water, soil, seed and marketing issues of local farmers with validated technologies.
- Seven hubs in different agro-climatic zones have been recommended for funding. Thematic Mahila Kisan Biotech Fellowships instituted in each zone so that women farmers can work with science laboratories to generate solutions for problems they identify.

Biotech-Krishi Innovation Science Application Network (Biotech-Kisan) Scheme



India's Farmers to Partner with Indian and Global Best in Science for India's Future

H. National Certification System for Tissue Culture Raised Plants (NCS-TCP)

"National Certification System for Tissue Culture Raised Plants (NCS-TCP)" a unique quality management system, by Department of Biotechnology, Ministry of Science & Technology in November 2017 created awareness among all the Stakeholders particularly key officials from Centre and State Government's Agriculture and Horticulture Departments.

- NCS-TCP made significant impact since its implementation.
- Currently, around 80 companies are recognized for getting their planting material certified from the Accredited Test Laboratories.
- 2 Referral Centres and 5 Test Laboratories are accredited under this system.
- So far, more than 275 million Tissue Culture plants have been certified through this system.
- Through the interaction Tissue Culture Industries, Farmers and Horticulture Department officials identified way forward towards realizing the full potential of the certification system.

I. Food and Nutrition

Addressal of micronutrient deficiencies, severe acute malnutrition, food fortification, probiotics for human health and well-being, food safety, development of low cost food/supplements and utilization of agricultural residues for value added products and capacity building in Food Science and Nutrition Biology.

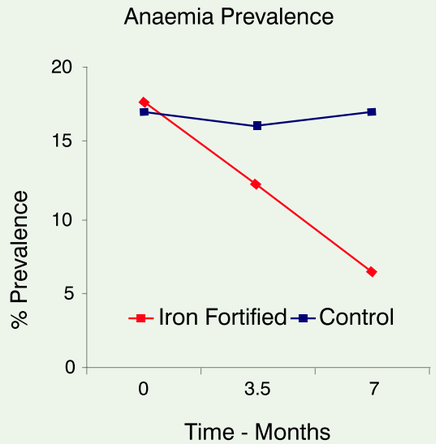
I. Addressal of Anemia through Iron Fortified Rice

Appropriate technology has been developed on Iron fortified rice premix from broken rice kernels through extrusion process. This iron fortified rice premix matches with the normal rice kernel in shape and size, and when mixed with normal rice in the ratio of 1:100 provide approximately 50% of recommended daily allowance (RDA) of Iron to the Children.

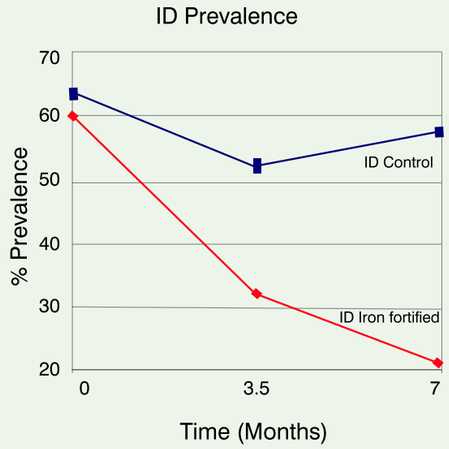
An indigenously designed and fabricated pilot scale demonstration facility with a production capacity of producing 100 kg/day iron fortified rice premix has been established at IIT Kharagpur. IIT Kharagpur developed a second version of the rice fortified with iron, vitamin B12 and folic acid as per FSSAI guidelines. Sensory studies are ongoing for the second version of the fortified rice.

II. Successful trial Conducted on Anaemic School Children Fed with Iron Fortified Wheat Flour

Wheat flour fortification with elemental iron is technically challenging, primarily due to poor absorption from elemental iron and the presence of phytic acid. Sodium iron ethylenediaminetetraacetic acid (NaFeEDTA) is a unique fortificant, allowing better uptake of iron.



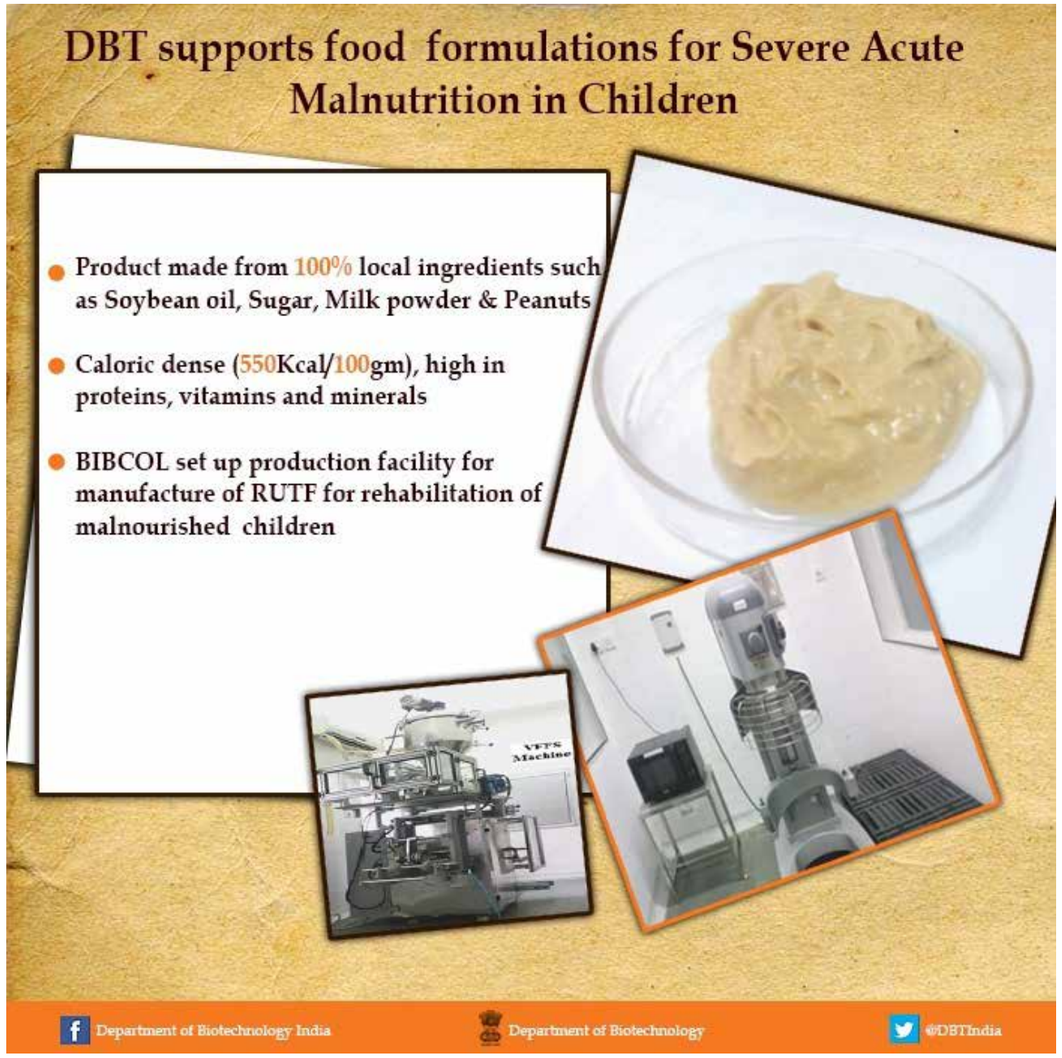
A randomized controlled study was carried out by St. John's Medical College, Bangalore in Iron deficient (ID) school children (6-12-year-old, n=401) who were randomly assigned to either a daily wheat-based lunch meal fortified with 6 mg of iron as NaFeEDTA (as chapatis or dosa), or an otherwise identical unfortified control meal. Over 7 months, the prevalence of ID and IDA in the treatment group significantly decreased from 62% to 21% and 18 % to 9%, respectively.



III. Severe Acute Malnutrition (SAM)

Severe acute malnutrition (excessive thinness) is listed as a priority condition for reducing childhood mortality through product-based nutrition intervention (Ready to Use Therapeutic Food or RUTF). However, this recommendation is primarily based on African data and the profile of malnutrition in South Asia is somewhat different. In collaboration with the Ministry of Health and Family Welfare and Indian Council of Medical Research, Department of Biotechnology led a National Alliance on SAM to generate scientific evidence to inform public health policy. Through this alliance, BIBCOL, a PSU under the Department of Biotechnology has developed RUTF under the brand name BIB POSHAN with financial support from the Department for the addressal of sever acute malnourishment in children.

The product is licensed and registered under Food Safety and Standards Authority of India (FSSAI). The product is made from 100% local ingredients such as Soybean oil, Sugar, Milk powder and Peanuts and is caloric dense (550Kcal/100g), high in proteins, vitamins and minerals. It is in the form of a paste. It is simple to deliver and administer, easy to use, fast acting, affordable and acceptable cost, does not require trained staff to administer (parents can deliver it to a child). Culturally acceptable, packed in single-serve packets (each packet contains fixed amount of calories i.e. 500 calories), requires little preparation before use, has adequate shelf life (2 years) and stability, can be stored in varied climatic conditions and temperature and is resistant to bacterial contamination.



IV. Addressing Micronutrient Deficiencies

Vitamin B12 is an essential micronutrient, which is a key constituent of the one-carbon metabolism pathway. It is almost exclusively sourced from animal products; thus, populations with predominant vegetarian dietary habits are particularly prone to develop Vitamin B12 deficiency. Scarce data from India indicates a high prevalence of Vitamin B12 deficiency in various parts of India and throughout the life cycle. Recent evidence indicates that deficiency of Vitamin B12 has profound implications for human health, notably anemia and cognitive decline, particularly in the elderly. The Department of Biotechnology has initiated a representative national survey, throughout the life course, to evaluate the magnitude of Vitamin B12 deficiency and evaluate its correlates including biological consequences and dietary factors. In addition, simpler diagnostic tests and public health preventive options are being explored.

J. Mission Programme on Brucella Free Villages

Brucella infects cows, buffalos, sheep, goats, deer, pigs, dogs and other animals and humans. Brucellosis is essentially a zoonotic disease and causes economic losses of about Rs.28000 crores/year in the veterinary sector. To address the problem, 'Brucellosis Free Villages' Mission was launched by the Department. During the first phase of the mission, implementation would be done in 50 villages of 10 states in phased manner. The Department has also launched three new Brucella diagnostic kits. Furthermore, 27 countries came together to discuss One Health approach for Brucella.

Brucellosis Free Villages

- Brucellosis Free Villages' mission launched.
- Pilot scale implementation in 50 villages.
- Brucella infects cow, buffalos, sheep, goats, deer, pigs, dogs and other animals & humans.
- Disease cause economic losses of about Rs 28000.00 Crores/year in the veterinary sector.
- Three new Brucella diagnostic Kits launched.
- 27 countries come together to tackle the Brucellosis challenge.

K. Cattle Genomics: Improving Indigenous Livestock

India has the largest repertoire of cattle in the world. Indian cattle population is highly heterogeneous. 69% of Indian cows are owned by the poor. The Department has initiated Phase-I of Cattle Genomics Programme at National Institute of Animal Biotechnology, Hyderabad. Under this programme, whole genome sequencing of five important milch breeds of cattle has been initiated. This will help in identifying pure elite animal of a particular cattle breed in its early age and also for conservation of breeds with economically important traits.

Genetic diversity study for selected cattle breeds viz. Sahiwal, Tharparkar, Gir and Vechurhave revealed a potential to differentiate these cattle populations. These breeds were also classified into small and large sized breeds indicating shared ancestry of large sized milch breeds (Gir, Tharparkar and Sahiwal).

L. Animal Reproduction Research for Better Semen Quality, Reproductive Efficiency

Availability of quality semen is a major constraint in successful implementation of artificial insemination programme in our country. Therefore, to address this issue and to predict the fertility status of bull, transcriptomic profiling of bull spermatozoa is being worked out based on sperm functional parameters such as motility, membrane integrity, and mitochondrial function. The transcript profile of spermatozoa varied depending on fertility status of animal that would pave way for development of a diagnostic tool for identification of semen quality of bulls selected for breeding purpose.

M. Translational Research Platform for Veterinary Biologicals in Tamil Nadu Veterinary and Animal Sciences University, Chennai

The platform has obtained NABL accreditation (IS/ ISO 17025:2005) for diagnosis of Bovine Trichomonosis, Brucellosis and initiation of CGMP licensing. Among various services, the platform is also offering OIE (The World Organisation for Animal Health) approved diagnostic services of Breeding Bulls for Brucellosis, Trichomonosis and IBR in lieu with regulatory needs. Five research papers have been published during the year in international journals with an average impact factor of 2 and above.

N. Animal Biotechnology Career Enhancement Program

- Five technologies have been developed; LEPTOLAT for the detection of leptospirosis, LFA kit for the detection of CPV maternal antibody level in pups, egg yolk semen extender for the cryopreservation of bull semen, KETOCHECK for the detection of Ketosis, and conductivity meter for the detection of subclinical mastitis.
- Apart from these two technologies, the devices Photolyser, and Portable incubator and LAMP device were commercialized to M/s. Endhiran Innovations LLP, Chennai.

LeptoLAT for diagnosis of Leptospirosis

Ketocheck for diagnosis of Ketosis

Rapid Parvo detect kit

Egg yolk semen extender for the cryopreservation

- A sub viral particle (SVPs) based infectious bursal disease virus (IBDV) vaccine for immunization in chickens has been developed. This vaccine induces protective immunity in specific pathogen free chicks against very virulent IBDV challenge. The vaccine has also been validated in a poultry vaccine company M/s Globion Pvt. Ltd., Hyderabad.

Sub viral particle IBD vaccine

3. Healthcare: Affordable Healthcare for all

Leveraging its focus on affordable healthcare for all, the Department of Biotechnology is working towards prevention, detection & treatment of numerous diseases that afflict Indians. DBT has been a front runner in reaching low cost vaccines to people and has been instrumental in levitating India to become a leader in vaccine development and manufacture. It has developed affordable devices to detect & manage diseases as well as for patient care and generating solutions for diseases.

A. National Biopharma Mission Launched

This Mission was approved by the Cabinet in May 2017 at a total cost of US$ 250 million for five years with 50% funding through World Bank Loan and is being implemented by Biotechnology Industry Research Assistance Council (BIRAC) - a Public Sector Undertaking of Department of Biotechnology (DBT). The overall aim is to make India a hub for design and development of novel, affordable and effective biopharmaceutical products such as vaccines, biologics and medical devices for combating public health concerns. This Programme would also strengthen translational capability of academic researchers; empower bio-entrepreneurs and SMEs by decreasing the cost and risk during early stages of product development and also elevate the innovation quotient of the industry.

Government Launched Mission for Indigenous Biopharma Product Development

This flagship program of the Department of Biotechnology, Government of India, in collaboration with the World Bank, will be implemented by the Biotechnology Industry Research Assistance Council (BIRAC) & DBT with a joint commitment of US $ 250 million.

B. India is a Leader in Vaccine Development and Manufacturing

- **Rotavirus Vaccine:** The first indigenous low-cost Rotavirus Vaccine from an Indian strain 116E was launched by Hon'ble Prime Minister in 2015. It is efficacious in preventing severe rotavirus diarrhea in low-resource settings in India. Introduced in 9 states namely Odisha, Andhra Pradesh, Haryana, Himachal Pradesh, Assam, Tripura, Tamil Nadu, Madhya Pradesh and Rajasthan and part of India's Universal immunization Programme, WHO prequalification for ROTAVAC® granted in 2018.
- **Malaria Vaccine:** Vaccine for falciparum malaria is under toxicology assessment (JAIVAC 2) and vaccine for vivax malaria has completed phase I trial (JAIVAC1).
- **Dengue Vaccine:** The International Centre for Genetic Engineering and Biotechnology (ICGEB) is collaborating with drug major Sun Pharma to use the recombinant EDIII-based sub-unit dengue vaccine candidate to develop an injectable vaccine that protects against all four dengue strains that are endemic to India. One out of every 6 children over the world receive vaccines manufactured in India.
- **Tuberculosis Vaccine:** r BCG vaccine is under preclinical development.
- **Cervical Cancer Vaccine:** This vaccine, developed with antigen SPAG9 at NII is in phase 2 trials.
- **Other Vaccine Targets:** Other vaccines being pursued are RSV, Chikungunya.

C. Affordable Monitoring and Diagnosis

Low cost diagnostic kits, technology for monitoring maternal and child health, products to ensure easy patient care in hospitals have been developed with support of DBT.

I. Technology for Rapid Diagnosis of Celiac Disease (CD) in Humans

Celiac Microlisa & Celiac Card kits have been developed through a collaborative, multi-institutional, inter-disciplinary approach funded by DBT. The kits have been made commercially available by M/s J. Mitra & Co. Pvt. Ltd, New Delhi. These indigenous kits are rapid, sensitive, specific and are much cheaper as compared to the imported kits.

II. Highly Sensitive and Specific Rapid 1-Day Dengue Diagnostic Kit has been Developed by DBT

This kit detects Dengue Virus (DENV) infection from Day 1 of fever. Cost of the test is Rs 145/ test to the distributors. Performance tested by Drug Controller Govt. of India and these kits are now being exported.

New
1-Day Dengue Diagnostic Kit, Developed by ICGEB, Supported by DBT

III. Innovative Devices to Nurture Mother & Child Health

1. Brun: Feto-maternal Parameter Monitoring System

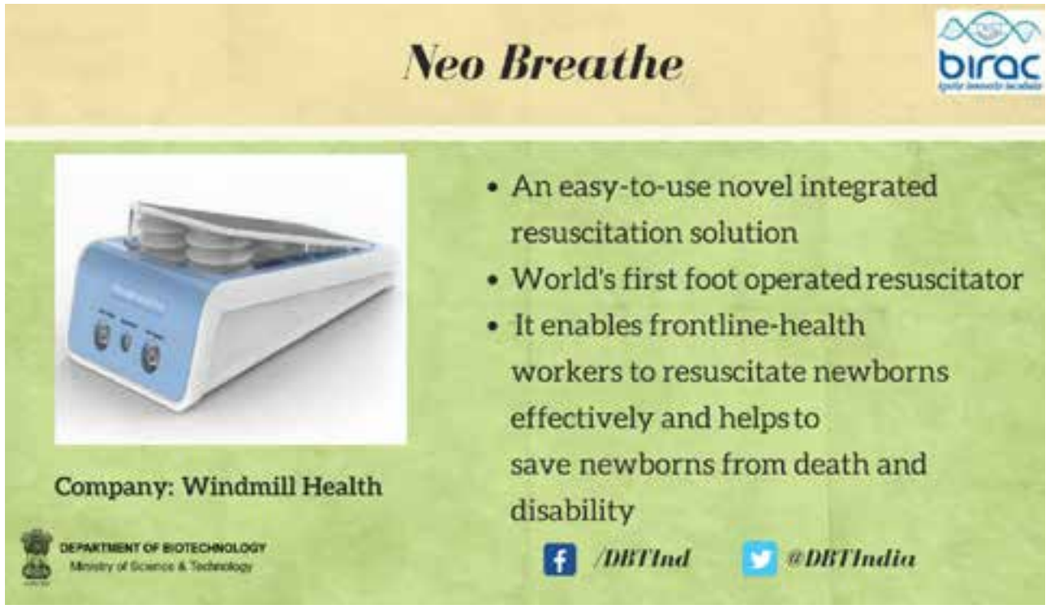
This device is a safe, easy and cost-effective way to continuously monitor feto-maternal vitals of pregnant women which helps to reduce neonatal mortality. The product is licensed to M/s. Brun Health Pvt. Limited, Telangana. The company has completed design for manufacturing for the product and is validating the technology at AIIMS, New Delhi. The product is yet to be commercialized.

2. Sishunetra

A first of its kind and a low cost wide field eye-screening device for neonates has been developed. The product has undergone extensive field trials and is ready to be launched in Indian Market by 2018.

3. Sohum Helping Early Detection of Hearing Impairment in Children

4. NeoBreath: Foot Operated Resuscitation Device helping Neonatal Care



5. Fetal Mom

The device works, as a fetal electrocardiogram and also as a uterine activity through signal extraction from maternal electrocardiogram thereby eliminating the need for the use of conventional transducers. The product has undergone clinical validation and is ready for launching.

IV. Innovative Technologies for Patient Care

1. Device to Manage Fecal Incontinence helps Patient Care in ICUs

The device provides a tool to manage fecal incontinence in aged and infirmed patients.
Company name: M/S Consure Medical Private Limited, Gujarat.

2. Soft Tissue Biopsy Device helps Collection of Tissue Samples with Minimum Skill for Diagnosis

The device provides a safer, easier and cost-effective way to perform percutaneous aspiration needle biopsy.
Company name: M/S Indolabs Private Limited, Bangalore

3. Device Developed to Provide for Concurrent Biopsy and Hemostasis

The device offers a safer, easier and cost-effective way to perform percutaneous aspiration needle biopsy. It reduces skill and helps obtain consistent tissue samples for definitive diagnosis, helps concurrent Biopsy and Hemostasis
Company name: M/S Indolabs Private Limited, Bangalore.

4. Portable Device for Hand Sanitization helps Patient Care

This simple, convenient and effective way for hand sanitization helps patient care, useful for hospital staff as well as patient care at home
Company name: M/S Observe Design Private Limited, Delhi.

5. Ostomy Management Appliance

This appliance is a safe, secure, bag-less solution for managing colostomy.
Company name: M/S Crimson Healthcare Private Limited, New Delhi.

6. Breathable and Customized Cast for Immobilization of Fractured Limb

D. Diagnosis & Treatment of Human Genetic Disorders Significantly Augmented

The Department of Biotechnology initiated a major programme on Human Genetics & Genome Analysis, which provides genetic diagnosis, and counseling to families affected by common genetic disorders in India; and help them with improved molecular medicine tools.

- Twenty-One Genetic Diagnosis cum Counseling Units established.
- More than five lakh affected families and more than one lakh tribal families benefited.
- DNA typing of twenty-five autosomal markers in fifty-three ethnic groups like tribal, caste and religious communities completed.
- Evidence of human migration from India to South East Asia revealed.

E. Major New Effort on Pre-Term Birth: Multi-institutional National Programme on Pre-term Birth Launched

The Pre-term Birth Program is program on maternal infant health and spontaneous pre-term birth sciences in India. This is a multidisciplinary research effort to predict & diagnose pre-term birth (PTB) by enhancing the knowledge of the underlying pathophysiological mechanisms.

- India accounts for 25 per cent of neonatal deaths globally.
- The programme stratifies women early in pregnancy into various levels of risk of PTB, identifying simple and better prediction tools to identify the presence of unusual microbes in these women that could serve as biomarkers for PTB and identify therapies to prevent PTB and subsequently reduce infant and maternal mortality rates.
- The cohort study aims to enroll 8,000 women early in their pregnancy and serially follow them through their pregnancy till childbirth and 42 days (6 weeks) post-partum.1108 women have been enrolled and the total number of babies born stands at 318.
- Early findings from cohort study involving 1000 mothers indicates indoor pollution is associated with early birth, early shortening of the cervix is a risk factor for PTB.

District Hospital Gurgaon: Study Site

Safdarjung Hospital, New Delhi: Referral Site

F. Affordable Medicines

Affordable medicines for treatment of a variety of diseases are a major focus of DBT and bringing scientific testing and rigorous development of herbal drugs is a continuous endeavor.

Herbal Drugs

1. Development of Herbal Drug for Dengue Infection

Technology Transfer Agreement signed between ICGEB and industry partner – M/s Sun Pharmaceuticals towards developing phytopharmaceutical drug from a medicinal plant.

2. Butea for Bone Health

A project at The Central Drug Research Institute (CDRI), Lucknow is being developed on regulatory studies of standardized extraction of *Butea monosperma* for bone health (osteoporosis), as phytopharmaceutical drug based on the research leads generated in earlier DBT funded project.

G. Research on Infectious Diseases

In India, the range and burden of infectious diseases are enormous and DBT has taken up the challenge of addressing prevention, detection & treatment of such diseases. The problems of infectious diseases are ever evolving and needs state of the art research for addressing them.

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H. Addressing Antimicrobial Resistance

DEPARTMENT OF BIOTECHNOLOGY
Ministry of Science & Technology

AMR

Newton Fund

UK - India Anti Microbial Resistance Sandpit Event

- Release of scooping report on “Anti Microbial Resistance in India” on 1 November 2017
- Addressing the challenge of Anti Microbial Resistance in India: A joint department of Biotechnology and Research Council UK (RCUK) initiative, a sandpit workshop designed and organised to develop radically innovative research proposal to combat AMR in India
- 7 application have been approved of about 200 application received

I. Programme for Developing Treatment for Sickle Cell Disease

Sickle cell anaemia is a hereditary disease, predominantly seen amongst tribal populations. Those with the sickle-cell trait have one normal HbA allele and one abnormal HbS allele, whereas affected individuals have both abnormal HbS alleles. If both the parents are the carriers, then there is a 25% chance of producing an affected offspring. Patients suffering from this disease have sickle-shaped red blood cells. The disease is manifested as hemolysis, microvascular occlusion, tissue damage, etc. For the current management of this disease; coordinated efforts are being made at several fronts in an integrated manner. The Ministry of Tribal Affairs (MoTAs), Department of Health (DHR), Ministry of Health and Family Welfare (MoHF&W) are working together for awareness programmes by conducting training and workshops, screening, and counseling. The stakeholders are working together to prepare a “Coordinated Action Plan” in this area.

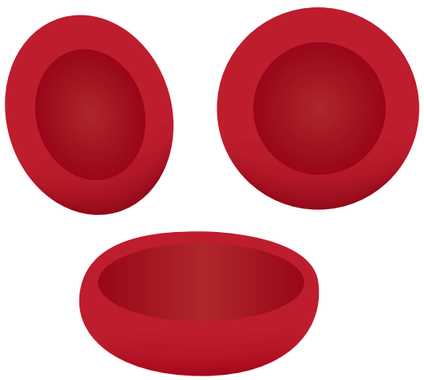
Launch of a National Tribal Belt Sickle Cell Anaemia Control Program

Aim: To reduce occurrence of childbirth with this disease and uplift quality of life of sufferers.

Existing: Solubility test, Electrophoresis & HPLC
Novel: Chip based

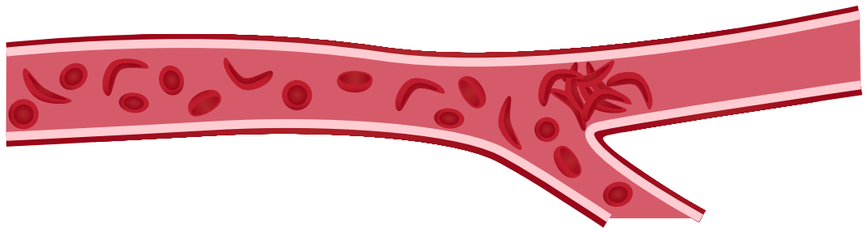
Existing: Drugs administration, Blood transfusion, Supplements
Novel: Stem Cell Research

WORLD SICKLE CELL ANAEMIA AWARENESS DAY - 19TH JUNE



NORMAL RED BLOOD CELLS

SICKLED RED BLOOD CELLS



4. Environment

DBT is participating in the Swachh Bharat Abhiyan through a range of initiatives like cleaning up waste water for reuse, river cleaning initiatives, supporting bio-toilets clean energy, technologies and a range of other waste management and utilization technologies.

Water Resources: Safe and Sustainable Water for All

International collaborations have been leveraged to develop technologies to provide clean water for various end uses like drinking and agriculture.

I. India-Europe Collaboration on Water4Crops Integrate Bio-treated Wastewater Reuse with Enhanced Water use Efficiency to Support Agriculture

The use of constructed wetland as decentralized wastewater treatment systems for both industrial and municipal wastewater has been successfully demonstrated. At the SAB Miller plant in Sangareddy, Telangana, and K.C.P. Sugar and Industries Corporation Ltd in Lakshmipuram, Andhra Pradesh, constructed wetlands were prepared to treat the effluent waste. Similarly, constructed wetlands were used to treat municipal wastewater at multiple locations in the Indian states of Telangana, Andhra Pradesh, Maharashtra, Uttar Pradesh, and Karnataka.

Architecture of DWAT system for treating wastewater

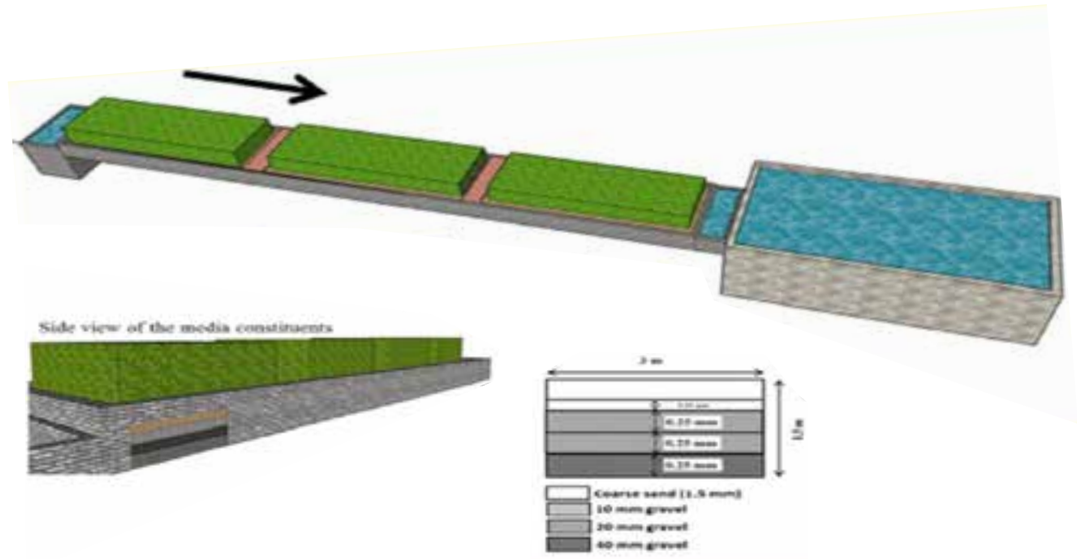


Fig: General layout of a typical DWAT unit and its media constituents

II. Cleaning of Water Bodies Containing Textile Industry Effluents through Macrophytes

Textile dye processing industries use a huge number of various classes of coloring agents, such as direct, reactive, sulfide, acid and cationic dyes, which are later found in the released effluents.

Phytoremediation possesses adsorption, accumulation, degradation and biotransformation of pollutant by the action of enzymes or metabolism of plants.

III. Collaboration with Netherlands Aggregates Technologies to Clean Delhi's Barapullah Drain

DBT has collaborated with Dutch for LOTUS[HR] (Local Treatment of Urban Sewage Streams for Healthy Reuse) project to help clean Delhi's Barapullah drain and thus finally initiate efforts to keep the Yamuna clean.

A wastewater treatment plant to make the filthy water potable is scheduled to be set up besides removing heavy metals from the water for reuse. Barapullah Nullah is a 12.5 km-long storm water drain responsible for about 30% of pollution in the Yamuna River collecting domestic sewage and polluting waste from small industry from Mehrauli in the south to Sarai Kale Khan in the east. Delhi Development Authority (DDA) is one of the active partners in the project.

The project supports high quality research and development programmes aiming at 'new' wastewater management to ensure good quality fresh water free of risk-causing contaminants and promote productive, safe reuse of water, thereby enhancing human and environmental health conditions.

Swacchh Barapullah Drain

Department of Biotechnology Partners with Government of the Netherlands and DDA to clean the open sewage water of Barapullah drain leading to river Yamuna.

Milestone Year 1-2 → **Milestone Year 2-5**

PROJECT LOTUS:
Local Treatment of Urban Sewage Streams for Healthy

- Reuse water for on-site toilets.
- Reuse water for water park on site Sun Dial park.
- Recover wealth: Metals, Organic compounds.
- Reuse water for irrigation, industrial purposes.
- Potable water.

The LOTUS[HR] is for the holistic development of the site like afforestation, setting up of Eram toilets etc. It is a DBT driven project.

IV. Empowered Septic Tank as Decentralized Wastewater Treatment System

This project by the Birla Institute of Technology and Science, Pilani Goa campus, aims to develop a financially affordable and simple-to-operate decentralized wastewater treatment system for a single household as well as for a gated community of 100 people equivalent (25 families) that will produce high quality effluent for safe disposal. The waste treatment system will involve the bio-electrolysis of wastewater to reduce its Chemical Oxygen Demand (COD) and odor. The project has constructed and is currently testing the decentralized wastewater treatment system for a community of 100 people equivalent and will undertake extensive testing of effluent.

V. Novel Bio-toilet Technologies Supported by DBT

Innovative bio-toilet ideas generated through Reinvent, the Toilet Challenge India was launched by the Grand Challenges India framework. These are off-grid, self-sustained, modular, electronic toilet for slums, with solar energy for Indian weather and integrated with mixed waste processing unit & water, energy/ fertilizer recovery.

Novel Bio-toilet Technologies Promises Cleaner India

- Novel Bio-toilet technologies supported through 'Reinvent the Toilet Challenge for India (RTTC)' programme by DBT & BIRAC in collaboration with Bill and Melinda Gates Foundation.
- 6 new bio-toilet technologies supported.
- 100 toilets have been set up to demonstrate by The Energy and Resources Institutes, with the Support of DBT.

VI. Bio-energy: Fueling India's Growth

Climate change and energy security are major issues that need to be urgently addressed. While the government is garnering efforts to make India the clean energy world capital, the Department of Biotechnology (DBT) has flagged clean energy and Swachh Bharat—waste to energy as two of its key missions.

First Biomass to Ethanol Plant & its Commercialization

The Institute of Chemical Technology (ICT), Mumbai has developed India's first home grown technology to convert biomass to ethanol with speed and efficiency.

- India develops its first home grown technology to convert biomass to ethanol with speed and efficiency.

- Rate of conversion is faster than other technologies currently available in the international market.
- Such technological breakthroughs can make India stand out as a leader in the world's struggle to save the earth from challenges of global warming.
- Technology transferred to BPCL and HPCL for building commercial scale biomass to ethanol plants expected by 2018.
- The country's first second-Generation (2G) Ethanol plant was inaugurated by Union Minister for Science and Technology and Earth Sciences Dr Harsh Vardhan at Kashipur in Uttarakhand.

Four Centres of Excellence each Specializing in their Own Areas

1. DBT-ICT Centre for Energy Biosciences, Mumbai: The 10 ton/day biomass demonstration facility has been developed using 'Hybrid Technology' for the treatment of municipal solid waste (MSW) and municipal liquid waste (MLW) and has commissioning of 1000L modular photobioreactors designed for autotrophy as well as mixotrophy growth of algae.

3000 Litre tubular algae photo bioreactor facility at dbt-ioc center faridabad.

2. DBT IOC Centre for Advanced Bioenergy Research, Faridabad is the finest example of collaboration of DBT with an industry. The Centre has established protocols for Life Cycle Assessment and GHG emission evaluation of all grades of biofuels. Unique process for CO_2 fermentation and conversion to lipids has been carried out and a pilot is under installation. Development of enzymes needed for cellulosic ethanol is a major programme of the centre. It is planning a 10 ton/day cellulosic ethanol green field plant to be operational by Q2 2019.

3. DBT-ICGEB Centre for Advanced Bioenergy Research has been extremely useful in taking science and technology in bioenergy area to a new height, as obvious from the technologies developed, patents filed, and articles published in high impact journals. Key technologies developed that are being in the process of scale-up are 'potent enzyme composition for biomass hydrolysis', 'engineered bacteria for C5 fermentation to ethanol' and 'engineered algae with enhanced CO_2 sequestration'. Deep synthetic biology intervention led to discovery of new pathway for fatty alcohol production and CRISPR/Cas9 based genome engineering led enhanced fungal enzyme production.

4. PAN IIT Bio-energy Centre constitutes a network of 32 investigators from 5 IITs working on 5 thematic areas.

PAN - IIT Bioenergy Center Stakeholders at DBT-ICGEB Center, New Delhi

Molasses Spent Wash Treatment Leading to Algal Biofuels

DBT is working to support research on some of these challenges.

- A new technology supported by BIRAC can remediate pollution from wastewater of sugar or distillery industry and use it for enhanced production of algal biofuel.
- The fungus that produces enzymes for decolourisation of the polluted water has been grown and other microbes to be used in this process have also been screened and isolated.

VII. India Participates in Mission Innovation, a Global Initiative to Double Clean Energy R&D

Mission Innovation (MI) is a global initiative of 22 countries and the European Union to dramatically accelerate global clean energy innovation. As part of the initiative, participating countries have committed to seek to double their governments' clean energy research and development (R&D) investments over five years, while encouraging greater levels of private sector investment in transformative clean energy technologies. These additional resources will dramatically accelerate the availability of the advanced technologies that will define a future global energy mix that is clean, affordable, and reliable.

- Mission Innovation (MI) is a global initiative of 22 countries and the European Union to accelerate global clean energy innovation.
- MI was announced on November 30th, 2015 as world leaders came together in Paris during COP-21.
- As part of the initiative, participating countries have committed to seek to double their government's clean energy research and development (R&D) investments over five years.
- India is a member of the Steering Committee and also member of all seven innovation challenges.
- DBT has been assigned responsibility for coordinating all Mission Innovation activities for India with regular interaction with 22 MI member countries.
- Country workshops were held for all above seven Innovation Challenges to take stock of current status of the technologies in terms of commercialization status, R&D gap areas, plans and timelines to address the identified gap areas.

Mission Innovation and Clean Energy Ministerial Meet 1-2 June, 2016, San Francisco, US

- **Dr. Harsh Vardhan, Hon'ble Minister Science & Technology and Earth Science** led the Indian Delegation.
- There is a concerted effort to **enhance the pace of innovation and scale of transformation** through clean energy revolution.

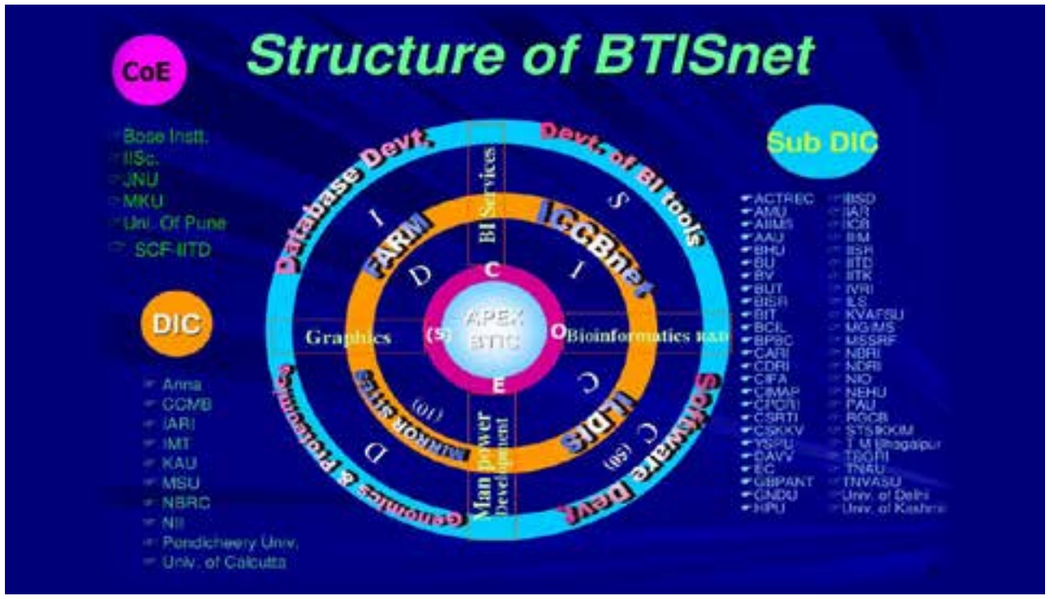
Indo-US Joint Clean Energy Research and Development Centre

DBT is supporting bio-fuel consortium led by IICT Hyderabad and University of Florida from the US. This programme is being coordinated by DBT along with US Department of Energy under an MoU signed between both countries in November 2010.

5. Bioinformatics: For Theoretical and Computational Biology

Bioinformatics programme has been the pioneering programme of the Department. Biotechnology Information System Network (BTISnet) was established in 1987 and was redesigned as Theoretical and Computational Biology in 2015-16 and has received major impetus since then. BTISnet today has 170 institutions and universities as part of it.

Components of BTISnet for Theoretical and Computational Biology:	Services Provided
• Total number of Centres- 170 • Super-Computing Facility-1 • Centres of Excellence (CoEs)-5 • Distributed Information Centres (DICs)- 12 • Distributed Information Sub Centres(DISCs)-49 • Bioinformatics Infrastructure Facility (BIF-BTBI) -103 • Apex BTIC-1 • Graphics Facility-6 • M.Sc/M.Tech/Diploma-6 • Short Term Trainings-100 • Bioinformatics Industrial Training Program • Bioinformatics National Certification Exam • DBT eLibrary Consortia (DeLCON) • R&D Projects -97 • Consortia Projects on Rice, Mango & TB involving 25 institutions	• Data retrieval • Sequence analysis • Microarray data analysis • Gene network analysis • Protein structure analysis • Molecular modelling and drug design • Ligand docking and virtual screening • Computer simulations of molecular dynamics • Consultancy to the industry • Summer training to UG/PG students



6. DBT's Special Initiatives in North Eastern Region (NER) of India

The last 4 years Science and technology in the NER has seen an exponential growth. The Hon'ble Minister for Science & Technology, Earth Sciences, Environment, Forests and Climate Change, Government of India Dr Harsh Vardhan visited all the research labs and faculties of 8 states providing huge impetus in the S&T ecosystem of the region.

Hon'ble Minister of S&T and ES: Biotechnology Programmes for the North Eastern Region

- Dr. Harsh Vardhan inaugurated Biotech Infrastructure Facility (BIF) at ICAR- National Research Center on Mithun at Jharnapani Nagaland.
- Foundation Stone of centre for Bio-Resources and Sustainable Development laid in Arunachal Pradesh.
- Fifty Biotech Laboratories to be established in Senior Secondary Schools of Arunachal Pradesh.
- Rural Technology Center under the aegis of Ministry of S & T.

A. Centres of Excellence (CoE)

Departments of Biotechnology Centres of Excellence in NER

The DBT - AAU Center for Agriculture Biotechnology at AUU Jorhat undertakes research in gene technology, molecular breeding and gene processing and train manpower.

The centre of excellence in Fisheries and Aquaculture Biotechnology (FAB-COE) at College of Fisheries, Agartala Tripura is promoting fisheries and aquaculture R&D.

1. Centre of Excellence in Agriculture Biotechnology named DBT-AAU Centre for Agri Biotech.
2. Centre of Excellence in Fisheries & Aquaculture Biotechnology (FAB) has been supported by DBT and is situated at Assam Agricultural University, Jorhat and College of Fisheries, CAU, Tripura respectively.

B. Facilities

1. "X-Ray Crystallography Facility" at IIT Guwahati under one of the twinning projects, "Studies on structure of enzymes and their interaction with nanostructure materials for bioelectronics devices and other applications".
2. Animal House facilities is being established at RMRC, Dibrugarh (Assam), which will be accessible to entire biomedical research community of NER for carrying out critical animal experiments in disease biology, molecular medicine, vaccinology and pharmacology.
3. DBT has established a network of 126 Biotech Hubs across NER, providing necessary infrastructure in universities/ colleges/ institutions and the required training in sophisticated technologies so as to support and promote biotechnology education and research. At this juncture, there are 6 State-Level and 120 Institutional Level vibrantly active Biotech Hubs spread across all the eight states of NER. These biotech hubs have:

- Conducted more than 600 training programmes.
- Supported more than 500 PG and PhD students.
- More than 250 research papers, published in peer reviewed journals, underline the quality of research being undertaken at some of the Biotech Hubs

C. R&D for Regional Impact

I. The Twinning R&D Programme

- The programme has made a huge impact by catalyzing vibrant collaborations between institutions from NER & those from the rest of India, evolving NER-specific projects & their implementation across all eight states of the region.
- These projects are addressing issues in Healthcare (Medical biotechnology), Agriculture (Agri-biotechnology), Livestock & Fisheries (Animal and Aquaculture Biotechnology), and in the areas of Environment, Medicinal and Aromatic Plants (MAP) with specific relevance to developmental needs of the region.

- Nearly 250 research papers have been published in peer-reviewed journals and more than 1000 young scientists of NER have been trained in advanced biotechnology.

II. Chemical Ecology of NER

A network research programme on Chemical Ecology of North Eastern Region has been launched. The programme focuses on identification of the origins and compositions of plant, insect and vertebrate pheromones and semio-chemicals analysis and (re) engineering of chemical communication mechanisms, molecular and structural mechanisms, behavioural and neural mechanisms, biochemical, genetic and physiological mechanisms, governing interactions between flora and fauna of NER.

Twinning R&D Programme

- It is a flagship program of DBT for NER.
- The goal of this program is to strengthen R&D in NER via Nation-wide collaborations.
- 480 projects have been implemented till now.

Network Programme on Chemical Ecology of the North East Region

The program involves scientists from Banglore and NER indentifying origins and compositions of plants, insect and vertebral phenomones and other naturally accuring chemicals

III. Integrating Herbal Medicine of NER with Contemporary Approaches to Develop Therapeutic Strategies for Metabolic Syndrome

It involves five institutes from NER and DDRC/ THSTI-Faridabad and has been implemented to harnessing the traditional herbal medicines of NER for developing novel therapeutic strategies for metabolic syndrome. The five collaborative Institutes from NER are: IASST-Guwahati, Gauhati University-Guwahati, Rajiv Gandhi University-Itanagar(Arunachal Pradesh), NEIGRIHMS-Shillong(Megahlaya), and NEHU-Shillong(Meghalaya).

IV. Integrated programmes for: NER-Scented Rice

Black Rice of Imphal valley is known to possess antioxidant and anti-diabetic properties. The aromatic rice of NER especially Joha and Black rice are of premium value because of their aroma and medicinal characteristics. But these are also poor yielders and susceptible to pest attacks. Hence, biotechnological intervention is required to ameliorate the agronomic characteristics of this aromatic rice. Twenty-eight projects involving 28 institutions including NER are part of mega consortia mode project initiated on the NER-Scented Rice.

V. NER-Banana

Another project in consortium mode on "NER-Banana" was initiated in 2018. Banana occupies the 4th slot right after rice, wheat and milk in the list of human food consumption. It is also the topmost horticultural crop in the North-Eastern parts of India especially Assam. However, the productivity in NER is well below the national average. In order to address the need to conserve, characterize and expand the germplasm stock, a consortium-based banana research program has been initiated to cater to the biotechnological needs of banana production in NER. The research aspects of the consortium are Banana Biodiversity, Pathogen detection and control, Tissue culture, Value addition, Post-harvest loss minimization and Down-streaming and processing. Forty-eight projects involving more than 80 scientists from NER and other parts of the country are running this mega consortium project in NER.

DBT supports Molecular Approach for Duck Production in NER

VI. NER Duck Improvement

"NER Duck Improvement" has been implemented in NER involving researchers from NER and other parts of the country. Six projects on duck improvement involving 20 scientists have been initiated in NER.

VII. Advanced Animal Disease Diagnostics and Management Consortium (ADMaC)

DBT has recently launched an ambitious programme named Advanced Animal Disease Diagnostics and Management Consortium (ADMaC) by involving NIVEDI, Bangalore; NRC on Equines, Hissar; NIHSAD, Bhopal and institutions from NER. The programme aims at surveillance and control of transboundary, exotic and zoonotic pathogens.

D. Initiatives for Promoting Agriculture and Food Productivity in NER

I. Jackfruit, Mushroom and Citrus Commercialization & Processing

The department has launched programmes for:

- Promoting Jackfruit processing and commercialization.
- Establishment of a technology incubation center for entrepreneurship development in mushroom culture.
- Production facility for value chain development in Citrus.

II. Eco-friendly Agriculture Practices

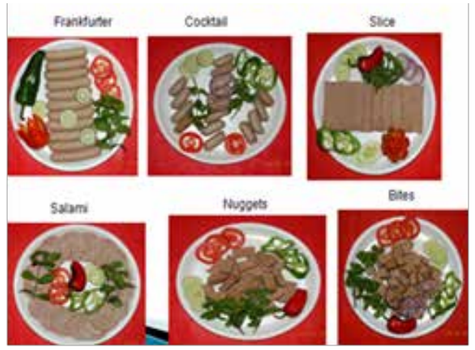
The programme has provided training to nearly 1400 farmers in the use of bio inputs in organic farming of 9 target crops (5 spices, 2 fruits and 2 vegetable crops). An area of 156 hectare was developed and certified for organic farming. The programme has shown success of technology in field demonstrations with some target crops such as Tomato, King Chilli, French bean, Turmeric, Ginger, Pineapple and Mandarin Orange. Results from these field demonstrations have indicated high possibility of substituting chemical fertilizers and synthetic pesticides with safe and effective bio-inputs. A considerable yield increment has been reported during bio inputs under the project.

III. Multicentric Programme on Assessment of Impact of Jhum Cultivation

This programme is aimed at amelioration and eco-restoration of Jhum lands in North East India.

IV. Augmenting Clean Pork Production and Value Addition

A DBT-supported programme on Augmenting Clean Pork Production and Value Addition, being implemented at the National Research Centre for Pig, Guwahati (Assam) is designed to develop & standardize technology for value added , shelf stable pork products (namely nuggets and bites, sausages, patties, kebabs, samosa, momo, slices etc.) to provide variety to the pork consumers.



Value Added Processed Pork Products

E. HRD in NER

I. Unit of Excellence

With a view to recognize promising mid-career scientists in NER, a programme of awarding Unit of Excellence (U-Excel) grant to them has been initiated so as to enable them to pursue their innovative research in frontier areas of biotechnology. So far, 22 Units of Excellence have been established.

II. Overseas Associateship Scheme for NER Scientists

Overseas Associateship Scheme

USA 50%	• Boston Children Hospital, Harvard Medical School • Cornell University • Washington State University • University of Texas • United States Department of Agriculture (USDA) • University of California • University of Wisconsin • The Vaccine Research Institute of San Diego • National Institute of Health (NIH)
UK 20%	• University of Glasgow • University of Strathclyde Science • The Food and Environment Research Agency • University of Aberdeen • University of Wolverhampton
EU 17.1%	• Uppsala University, Sweden • Gent University, Belgium • University of Regensburg, Germany • Institute of farm Animal Genetics, Germany • IFAPA Centre, Alameda del Obispo, Spain • Labratorire Interactions Plantes Microbes, • CNRS-INRA, France
Canada 5%	• Lakehead University • Concordia University • University of British Columbia
Others 8%	• National Institute of Biomedical Innovation, Japan • CSIRO, Canberra, Australia • Yat-sen University Cancer Centre, China • University of Southern Queensland, Australia

The Overseas Associateship Scheme for NER Scientists aims to promote capacity building in cutting edge areas of biotechnology and life sciences. The Award promotes and supports scientists of merit in their pursuit of skill enhancement in scientific research/training in overseas laboratories for short term as well as long term. So far, 205 scientists have been awarded the Associateship.

III. Biotechnology Labs in Senior Secondary Schools (BLiSS)

Unprecedented growth in the field of biotechnology makes it imperative to create awareness about it at the school level and also to provide an environment of access to a well-equipped laboratory. Recognizing this need, DBT has initiated a scheme for establishing "Biotechnology Labs in Senior Secondary schools (BLiSS)" across all 8 states of NER.

- 88 Senior Secondary Schools from NER have been selected by DBT for support under the BLiSS scheme, with financial supported upto Rs. 18.00 lakhs for 3 years.
- Around 100 such labs under BLiSS are under pipeline for establishment.

IV. Centre for Empowerment of Human Resources at NEHU

DBT has established a Centre for empowerment of human resources at NEHU, for conducting trainings/workshops for faculty/research students of the region in niche areas of Biotechnology for undertaking R&D activities.

Students of school of Meghalaya being explained the functioning of different equipment

V. North Eastern Bioinformatics Network (NEBINet)

Twenty-nine bioinformatics centers have been established in all the 8 states of the NER and are networked as the North Eastern Bioinformatics Network (NEBINet). These Bioinformatics centres are provided with latest IT equipments to support the research activities of the host institutions in NER. Two new bioinformatics centres were established during the last year, at College of Fisheries, Central Agricultural University, Lembucherra, Tripura and National Research Centre on Mithun (ICAR), Nagaland.

VI. DBT Biotechnology/ Bioinformatics Training Centre

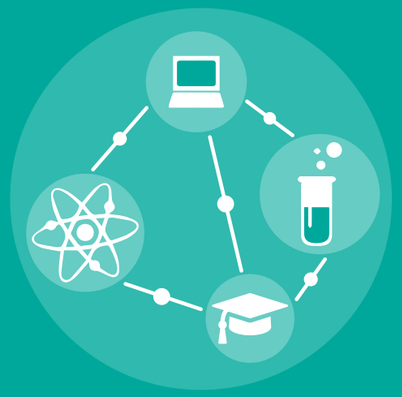
Recently DBT has established a "DBT Biotechnology/Bioinformatics training centre for teachers & research scholars from the North Eastern Region of India" at ACTREC, Mumbai. This centre will provide high end hands on training to NER researchers on cancer biology. Presently 15 researchers from NER are being trained at ACTREC.

VII. Comprehensive Training of Biomedical Research

Comprehensive training to scientists, research students and clinicians belonging to the North Eastern Region (NER) of India, who are engaged in "Biomedical Research", to better equip them to undertake focused research leading towards understanding the molecular basis of diseases prevalent in NER of India at NIBMG, Kalyani. So far 60 researchers from NER (2 batches) have been trained in workshops held at Assam University, Silchar and Tezpur University, Tezpur.

F. Biotech Park at Guwahati

In collaboration with the Govt. of Assam, DBT has established a Biotech Park at Guwahati, Assam, as a meeting point of technological innovation for knowledge-based biotechnology enterprises and to provide sustainable linkages between the industry, research institutions and academia to boost the region's competitiveness.



7. Science Outreach

For a developing nation with limited financial resources, human capital is the most crucial asset. The DBT has helped nourish many talents who have been appreciated globally as some of the most brilliant minds. DBT is implementing an Integrated Human Resource Development Programme in multidisciplinary areas of biotechnology comprising of Post Graduate Teaching Programme, star college programme, fellowships for different levels, finishing school and industrial training for biotech students.

The Department has significantly augmented capacity for carrying out cutting edge science and technology among the future generations through fellowships & training at different levels. It has excited the best of talents in the science and attracted and retained them in India to amplify the scientific output of the country. At the same time, it has also exposed them to the best facilities abroad so that they are trained into them and can use them in their pursuit of science.

DBT's Star College Scheme Transforms Undergraduate Science Education

- Aims to brand and nurture excellence in **undergraduate** science education
- **150** colleges supported under star college scheme since 2008
- **26** colleges given star status with **double** budget provision
- Proposals invited from **more** colleges
- Support for laboratories, library, teaching aids, networking with neighboring institutes, **hands-on training** & minor research projects to undergraduate science students
- **48** colleges discontinued after successful completion of one tenure

A. Support at Different Educational Levels Encouraging Biotech Education & Research

- Post Graduate Teaching Programme: Expanded to over 65 universities.
- Department developed a web-based dynamic portal PROMPT (Review of Mechanism & Protocols of Teaching) for effectively capturing feedback of postgraduate students admitted under DBT supported teaching programmes.
- DBT-JRF Programme for Doctoral Research: around 90 students completed PhD program.
- 289 students selected for award of DBT-RA for Post-Doctoral Research.
- New skill development programme initiated to provide high quality hands on training (postgraduate Diploma/Certificate) in tools and techniques in Medical Biotechnology, Agricultural Biotechnology and Computational Biology for jobs in industries, hospitals, medical colleges, R&D laboratories, diagnostic laboratories.
- 398 students trained under Biotechnology Finishing School Programme.
- 2439 Biotechnology students placed in industries for training under Biotechnology Industrial Training Programme.
- DBT-British Council Ph.D. placement programme initiated: 65 Ph.D. students from India and 17 Ph.D. students from the UK have availed this prestigious programme, which allows Indian students to access the best UK resources and promoting India-UK research collaboration, in its first year of inception.
- Biotechnology career advancement and re-orientation programme (Bio-CARe) to enhance the participation of Women Scientists in biotechnology research mainly to support their career development in all areas of Life Science have so far supported more than 250 young women scientists.

B. Partnerships Exposing Indians to International Biotech Facilities

- DBT-European Molecular Biology Organisation (EMBO) collaboration allows Indian scientists to submit proposals to the EMBO to hold prestigious meetings and workshops in India & compete for EMBO short- and long-term fellowships, thereby providing training and learning opportunities to the students on an unprecedented scale in globally competitive high-end research.
- DBT's partnership with Heidelberg University, Germany on 'Big Data Research' is exposing Masters'& Doctoral students from six Indian partner institutes- IIT Madras, IIT Kanpur, IIT Guwahati, Jawaharlal Nehru University, Allahabad University and Delhi University to short-term training to Heidelberg University, Germany.

C. Fellowships for Students, Scientists & Researchers: Nurturing Talents

I. DBT – JRF for Doctoral Research

The department provides fellowships to biotechnology students to pursue doctoral research in universities/research institutions across the country. The students are selected through Biotechnology Eligibility Test (BET) now being co-ordinated by the National Centre for Cell Sciences.

II. DBT-Research Associateship (DBT – RA) for Post-doctoral Research

The department provides fellowships for post-doctoral research in frontier areas of biotechnology and life sciences at premier institutions in India. The DBT-RA programme is being implemented by the Indian Institute of Science, Bangalore. The fellowship is initially awarded for a period of two years and the support can be extended for 1 to 2 years based on review of progress.

III. TATA Innovation Fellowships

The Department of Biotechnology (DBT) awards Tata Innovation Fellowship to promote innovation in science, especially in Biotechnology in finding path-breaking solutions to the major challenges.

IV. National Bioscience Awards for Career Development for of Young Bio-scientists Below 45 Years through a Grant for Research Projects to Help in their Career Development

National Bioscience Award for Career Development (NBACD) recognizes outstanding contributions of young bio-scientists below 45 years through a grant for research projects to help in their career development. The award aims to boost outstanding research in basic and applied biosciences and can be granted to 10 candidates for a given financial year. It carries a cash prize of Rs 1 Lakh, a citation and Rs 3 Lakhs/year as research grant for three years.

V. National Women Bio-scientist Awards

DBT recognizes the contributions of senior and young women scientists in the country who are working in the areas of biology and biotechnology.

VI. Biotech Product and Process Development and Commercialisation Awards

This award is for biotech products and process development and commercialisation.

VII. The Innovative Young Biotechnologist Award (IYBA)

This award is a career-oriented prize to identify and nurture outstanding young scientists with innovative ideas and desire of pursuing research in biotechnology. The prize is for those below 35 years of age. This includes scientists without regular employment.

VIII. Biotechnology Entrepreneurship Student Teams (BEST)

BEST-India is a programme aimed at encouraging young postgraduates and doctoral students in developing biotechnology entrepreneurship by exposing them to issues involved in commercialisation of bio-science.

IX. Distinguished Biotechnology Research Professorship Award Scheme

To recognise eminent scientists who have made outstanding contribution in Biological Sciences and have superannuated.

X. Khorana Program for Scholars

This is an Indo-US collaborative effort. The scholarship allows Indian students of B Tech, M Tech and M Sc to undertake research internship in Wisconsin-Madison University of USA.

XI. Indo-Australian Career Boosting Gold Fellowships

Indo-Australian Career Boosting Gold Fellowships (IACBGF) is announced each year, under which up to ten Indian fellowships are provided for training at various institutes in Australia.

XII. Post Graduate Teaching Programme

During 2017-18, Department completed the exercise for framing model course curriculum for 13 postgraduate degree courses. The book highlights career opportunities for students; training options for bridging skill gaps, fellowships for Ph.D. and post-doctoral training, independent evaluation of teaching programmes have also been mapped.

XIII. DBT-British Council Ph.D. Placement Programme

Under this programme, 65 Ph.D. students from India and 17 Ph.D. students from the UK have been exchanged in the first year of the programme. This programme, allowing access to the best UK resources by Indian students bring in UK students to India in a significant manner.

XIV. Women Agriculture Scientists Leadership Programme

- Twenty-three female leaders in crop and agricultural sciences from different parts of India attended the five-day workshop at University of Cambridge.
- The female leadership programme in science course was organized by University of Cambridge and DBT under Newton Bhabha fund.
- The programme involved on-site visits to Farm Innovation Park at National Institute of Agriculture Botany (NIAB) and Botanical Garden and John Innes Centre, Norwich.

XV. Indian Biological Engineering Competition (iBEC) PRE- iGEM Competition Encouraging Talents to Participate in the International Competition

- The Indian Biological Engineering Competition (iBEC) was launched in 2016 to select and support best Indian student teams to participate in the international contest iGEM (International Genetic Engineered Machine), held every year in Boston, USA.
- Selected five teams to provide them support to participate in iGEM 2017.
- These teams performed extremely well, and four team secured Gold and Bronze medals.

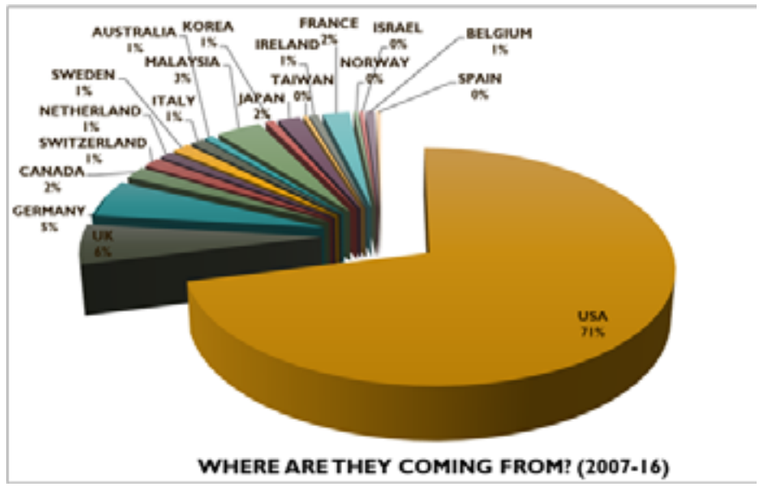
D. Attractive Fellowships Helping Brain Gain

- **Ramalingaswami Re-entry Fellowship** has encouraged 283 Indian scientists working abroad to taken up positions and pursue cutting edge research in Indian Laboratories.
- **DBT India Alliance fellowships** have encouraged talented researchers from early career, intermediate and senior levels from India & abroad to address interesting research questions on Biomedical Research relevant to India and aboard.

I. Ramalingaswami Re-entry Fellowship

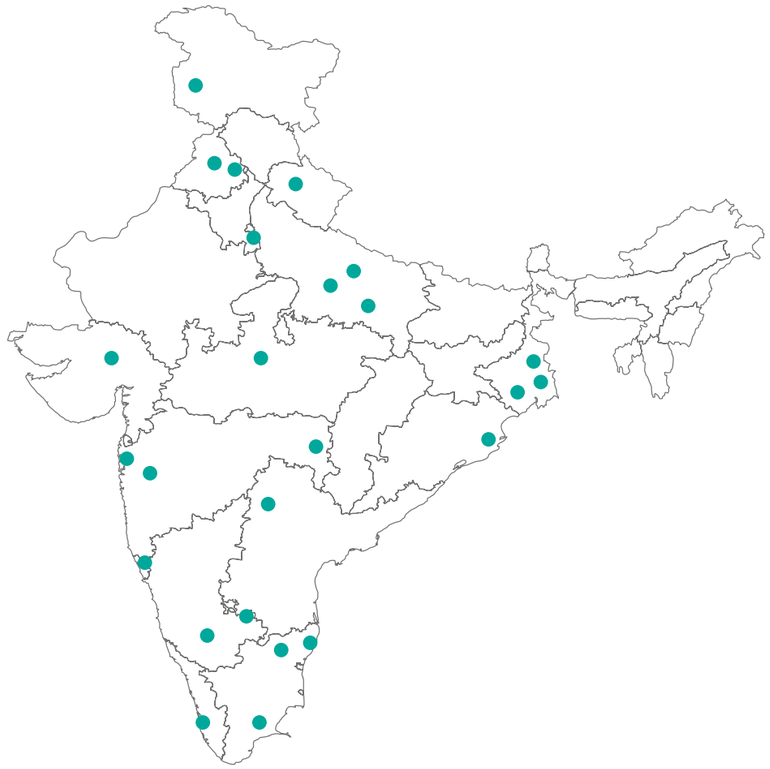
The Ramalingaswami Re-entry Fellowship scheme was conceived in the year 2006-07 with the idea of encouraging scientists (Indian Nationals) working outside the country, who would like to return to their home country to pursue their research interests in life sciences, biotechnology, and other related areas.

A decade since its inception, the Ramalingaswami Re-entry Fellowship programme has come a long way. During the last ten years, 1492 applications were received and out of these 396 were offered fellowship and 295 have already taken up positions in Indian Laboratories. So far, 200 fellows have already been able to seek permanent faculty positions in various host institutes in India. The fellowship over the years has picked up the momentum and resulted in creating a brand value in itself.



II. Welcome Trust DBT India Alliance

Enables Biomedical Research in Basic, Clinical and Public Health through Funding and Engagement



Fellowship grant	Number of Awards (2014-18)
Early Career	47
Intermediate	87
Senior	23
Margdarshi	4
RTF	16
Total	177

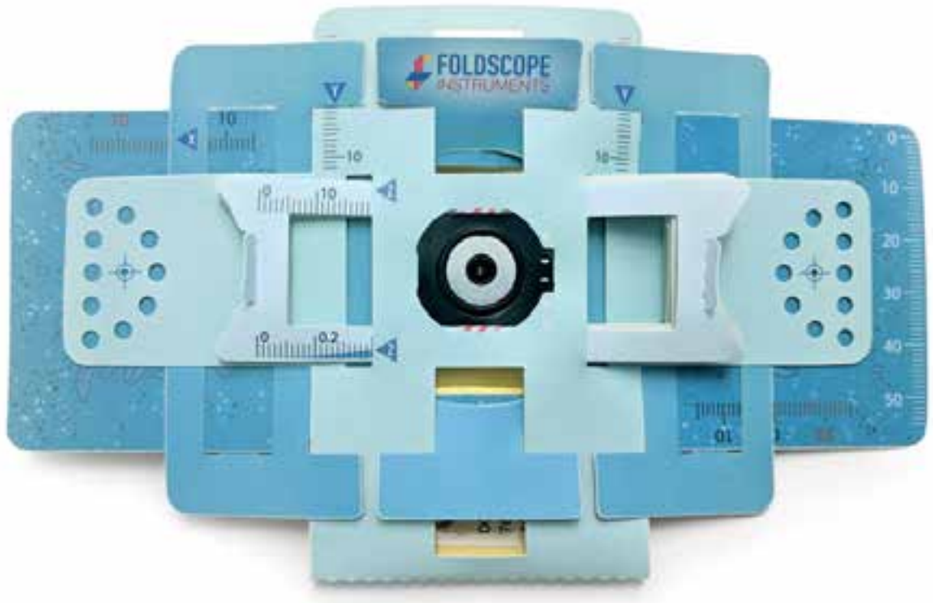
- **£160** million partnership
- **2008-09** to **2018-19**
- **66** Institutions

- **~2600** applications; average funding rate **~10%**
- Fellows at **79** institutions (**25** cities) in India

E. DBT Reaches Out to Children, Students, Teachers & Researchers - Foldscope Access, Democratisation of Science

The Department of Biotechnology (DBT), Government of India and Prakash Lab at Stanford University, USA signed an agreement in September 2015 to bring the Foldscope developed by Dr Manu Prakash working at Stanford University to India to encourage curiosity in science. Following an understanding between DBT and Prakash Lab, Foldscopes have been distributed to several college students and a series of workshops held across India to popularize the origami paper microscope. They reached out to school students, teachers, scientists & citizen-scientists from across India to support use of origami paper Foldscope to popularize science and trigger excitement in it.

- Low cost origami microscope making the instrument accessible to colleges in remote places in India.
- Exposing students to the microscopic world triggering interest in research.
- 328 government colleges, 117 government schools including those in low resource areas and in the North East benefitted.
- 445 teachers from all over India received training on Foldscopes in a workshop in Delhi.
- More than 11 Foldscope workshops conducted.



Microscopy for all:

DBT Brings Foldscope to Underprivileged Children

- 525 applications received from 112 schools, 357 colleges and citizen scientists for using foldscope to trigger scientific excitement.
- Preferences given to government schools & colleges in resource constrained environments.
- Selected applications twinned with the North Eastern region of India for exchange of idea.
- School students and teachers from Maharashtra, Tamil Nadu and North Eastern states of India participated in interactive workshop.
- Scientists and officials of DBT engaged with the students of Dharavi and told them stories about the wonders of science.

F. EduTech: Model for Future Education

DBT has collaborated with Finland, the country with the best education system, in the area of EduTech to develop futuristic education based on EduGames and EduTech. The long-term strategic objective of this project is to integrate the Finnish educational excellence and the expansive education system with Indian system of education to "Reboot education for Indian schools."

The programme will be carried on a pilot scale and will be based on a co-creation model to reboot higher education in life sciences and conduct a pilot study for EduGaming and EduTech for life sciences. The pilot study on life science EduGaming can be a model for future education in India.

Indo-Finnish Edutech and Edugaming: The Future of Education Reboot Indian Education System

A programme to leverage best education system of the world - the Finnish Education, through EduTech and EduGaming, to prepare our education system for the skill sets needed in the 21st century.

Edutech and Coding workshop at AIM Tinkering Lab at Kendriya Vidyalaya, IISc, Bengaluru

G. Nobel Prize Series Inspires Students & Researchers

Two editions of the Nobel Prize Series were organized by the Department of Biotechnology in partnership with the Nobel Foundation in Ahmedabad & Goa in 2017 and 2018 respectively. Through interactive dialogues Nobel Laureates in various fields of science engaged with students, researchers, teachers and industry in a vibrant dialogue on science and innovation.

The series also featured science exhibitions that offered an engaging and interactive way for students to explore science. In the exhibition "The Nobel Prize: Ideas Changing the World" the history of the 20th century was seen through the history of the Nobel Prize, how discoveries, conflicts and other important events have influenced the way we live and how a number

of brave and imaginative Nobel Laureates changed the course of history at a number of decisive moments. The DBT brought together nearly 300 teachers and students from government schools from all parts of India including from the Kendriya Vidyalaya, Navodalya and Atal Tinkering labs to attend the Nobel Prize Series. The enthusiastic participation from teachers and students representing almost all states in India revealed the eagerness for science-based learning and education in the country.

- Nobel Prize series, an annual lecture series was instituted to expose students & researchers to direct interaction with Nobel Laureates & their work.
- Two editions of the Nobel series In Ahmedabad & Goa generated huge interest among the general public.
- Swedish Nobel exhibition brought to India attracted the attention of 1000s to students and general public.
- Interaction with the global best in scientific talents triggers interest in science.

2018 Goa, Mumbai & New Delhi

300+
Scientists at Rashtrapati Bhavan

1000+
Teachers at Goa

2000+
Students at Goa

2017 Gujarat

1200+
Scientists, Researchers & Young Students attended the Nobel Dialogue

1500+
Schools and Colleges visited the Nobel Science Exhibition

3,05,000+
Students, Teachers and General Visitors

G. Smart India Hackathon: Encouraging Inclusive Participation in Biotech Research & Development through Digital India

DBT, along with 28 other departments, participated in the Smart India Hackathon 2017 organized by the Government of India under Digital India initiative.

- About 17 problems were proposed for students to provide digital based solutions.
- Student teams provided web-based and mobile-based apps for manpower management, detecting impersonation in exams linked to Aadhar cards, keyword-based searching to avoid duplication of projects in different funding agencies, segregation of lectures by Nobel Laureates, Padma awardees, TED talks, biotech history, marine resources and utilization, etc.
- The software prototype created by students' teams in Hackathon were evaluated by judges drawn from the respective ministry, industry and academic experts and the best solutions were awarded @ Rs. 1 lakh, Rs. 75,000 and Rs. 50,000 for the top three teams respectively.
- DBT selected two prototypes proven by student teams in digital competition for further support.

H. Biotech Industrial Training Programme (BITP)

On behalf of Department of Biotechnology (DBT), Ministry of Science and Technology, Government of India, Biotech Consortium India Limited (BCIL) is implementing since 1993-94, a scheme of practical industrial training for M.Sc./M.Tech./B.E./B.Tech/MBA Biotechnology students. The objective of this programme is to provide industry-specific training to Biotech students for skill development and enhancing their job opportunities in biotech industry.

This programme provides an opportunity to Biotech Industry for training and selecting suitable manpower. The training period is for six months during which a trainee is paid stipend of Rs10,000/- per month and trainer company is paid a bench fee to cover the expenses for providing training. The advertisement for the programme is published in national newspapers once in a year in the month of April-May and online application forms for students and requisition forms for companies are available on website for submission. The final placement for training is done in October-November.

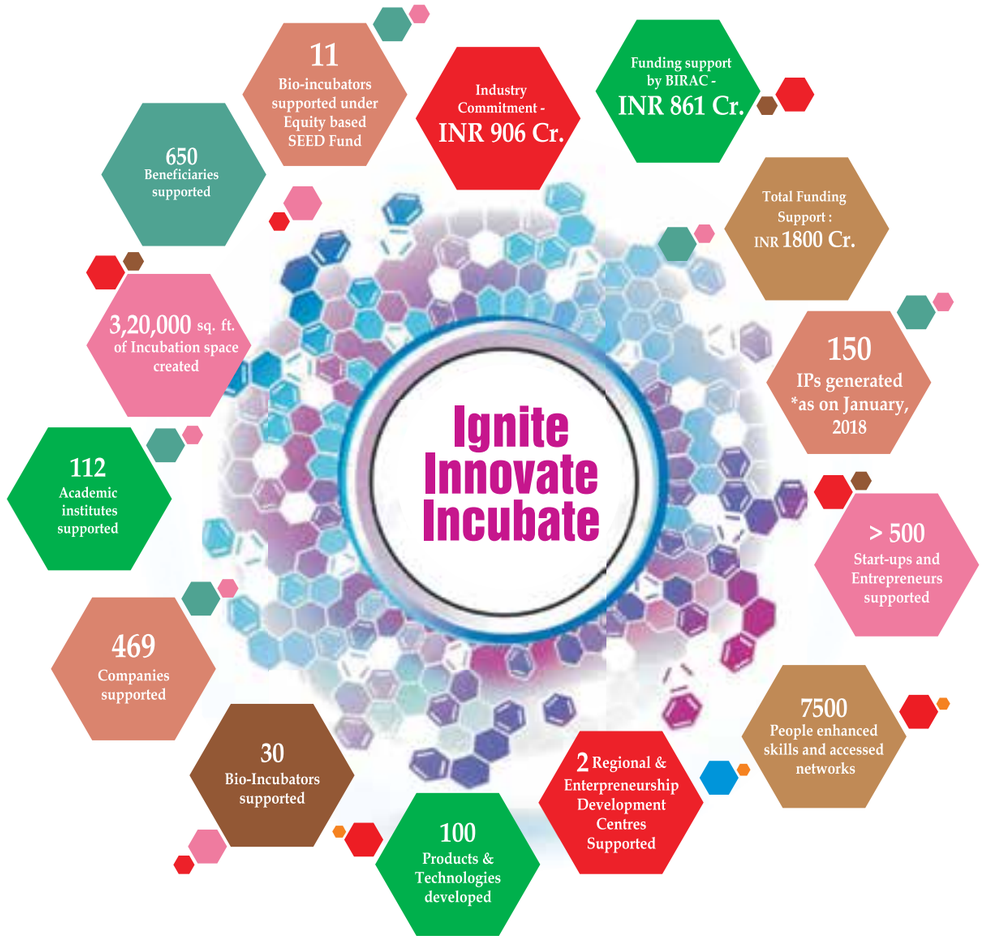
8. Translation, Innovation and Startups

A. Fostering and Nurturing Entrepreneurs

The Biotechnology Industry Research Assistance Council (BIRAC), a public-sector undertaking of the DBT, has been supporting over 700 biotech companies, research institutes, small and medium scale enterprises (SMEs), which includes 500 start-ups and entrepreneurs.

- Supports from BIRAC have generated 150 Intellectual Property Rights (IPs) till January 2018.
- In addition, 30 bio-incubators are supported across India and around 100 products and technologies were developed.
- Creating Vibrant Ecosystems in India.
- BIRAC, through its flagship programme BioNEST, has created 20 world-class bio-incubators that provide a wide range of support from office space to top end instrumentation & mentor networks. Some aspects of the program include:

1. Twenty bio-incubators with incubation space of 2,00,000 sq.ft that provide office space, wet lab facilities as well as tinkering labs.



2. More than 200 startups/entrepreneurial individuals have received support and are strategizing for global impact.
3. High-tech instrumentation includes NMR, LCMS, next generation sequencing, chromatography, 3D Printers, confocal microscopy, CNC machines and cell culture labs etc.
4. The first BioNEST Conclave was held in January 2017 involving stakeholders, experts from NITI Aayog, funding agencies & venture capitalists.

B. BIRAC Bio-innovations: Propelling the Bio-economy

A number of successful entrepreneurs have been supported who have brought out useful technologies:

Pandorum Technologies - A Distinct Synergy of Life Science and Engineering Competencies:

- The in-vitro 3D human liver tissues were designed and are undergoing validations. This product can be used for in-vitro medical research – hepatotoxicity & drug metabolism.

Bugworks Research India - Strategy by which Antibiotics can Successfully Bypass Efflux Pumps:

- The company is developing a first-in-class novel chemical entity (NCE) that exhibits potential of killing superbugs resistant to colistin, beta-lactams, cephalosporins, carbapenems, fluoroquinolones and other pathogens difficult to treat.
- It is now under preclinical development and is planned to enter clinical development in 2019.

Aarna Biomedical Products--affordable High-quality Post-mastectomy kit:

- An affordable high-quality post mastectomy kit was designed which comprises of lightweight, external, silicone gel breast prosthesis, two-pocketed brassieres with two prosthesis covers, a prosthesis holder, a usage manual and an outer waterproof kit.
- This product can be used by breast cancer patients, who have lost their breast as part of surgical intervention and benefits their physical and mental wellbeing as it boosts their confidence and dignity and prevents postural and gait issues.

Jeevtronics - a Low-cost Defibrillator that Works without Electricity:

- The company has developed the world's first dual powered defibrillator that works in areas without electricity and will be priced at 1/4th the price of big brands, while maintaining similar or better-quality levels.

SwastiAgro and Bioproducts – Developed Preventive "Vaccines", Eco-friendly Sustainable Technology

- The techniques can also predict disease pattern and attack of certain key pathogens. These completely organic, sprayable biotechnology-based products de-risk the farmers by preventing diseases with a three-pronged approach. Plant vaccines have been extensively validated on selected crops and are market ready.

Aristogen Bioscience Pvt. Ltd Developed Bacteriophage-based Control of Vibrio Harveyi Infection in Shrimp called Vibriosheild

- The product works specifically to kill the infective agent and works even on ant-biotic resistant strains. The product is commercialized and so far, nearly 1000 Kg of the product has been sold to more than 50 shrimp hatcheries in Andhra Pradesh and Tamil Nadu.

Kwaklei and Khonggunmelei Orchids Pvt. Ltd, Located at Imphal, Manipur

- The organization has more than 100 elite orchid species for commercial breeding of orchids. Eight hybrid orchids have been registered with the Royal Horticultural Society, London. Micropropogation of orchids for production of elite genotypes is the main activity carried out at the company. Micropropagated plants of Renanatanda Kebisana Shija, Renantanda Momon Shija and Papilaenopsis Crestwood Rose etc. have been sold to some growers based in Kerala, Karnataka, Maharashtra, Sikkim and Assam.

C. Promoting Women Scientists & Entrepreneurs

As an initiative for promoting science and entrepreneurship among the young women, a conclave on ‘Women Scientist & Entrepreneurs’ was inaugurated by the Hon’ble Union Minister Dr. Harsh Vardhan as a part of the Indian International Science Festival (IISF, 2017).

- The conclave brought together around 350 scientists, researchers and entrepreneurs from across the country.
- Also, the BIRAC Women Bio-Incubator was inaugurated at the Golden Jubilee Women Biotech Park, Chennai.

The Future Roadmap

- Deepen and densify industry–academia linkages through multiple modes including creating new pathways for early discoveries and its validation and translation in a collaborative mode between the two stakeholders.
- Explore new partnerships to strengthen Indian biotech sector and address national and global challenges affecting human development.
- Grow and create new platforms for biotech startups to connect and leverage national and global stakeholders. Catalyze and connect biotech startups for bridging organizations for accessing validation test beds.
- Support and Strengthen world-class incubation infrastructure for biotech startups and innovators. Align incubator policy with the National Biotechnology Development Strategy 2015- 2020 to support 50 biotech incubators and 150 TTOs.
- Amplify and deepen entrepreneurial activities to seed multitudes of innovative biotech startup ideas for impact in healthcare, food & nutrition, energy and environment. Aim to foster 2000 startups by 2020 and implement stated policy goals in Startup India.

9. International Collaboration: Reaching out to the Best in the World

As India is emerging as a major biotechnology hub in the Asian region, there is a need for scientific capacity building to match the global standards and for facing new challenges. The Department of Biotechnology has strategically developed strong international collaborations with numerous countries and non-governmental organizations over the last decade. DBT has also initiated the process of constant dialogue with the scientific communities across the globe for generation of new ideas and concepts in all areas of biotechnology and life sciences. Few recent developments in international collaboration are summarized below:

Memorandum of Understanding being signed by Prof K. VijayRaghavan, Secretary, DBT, Prof. Jean Chambaz, President UPMC and Prof Alain Fuchs, President CNRS, in the presence of the Hon'ble Prime Minister of India Shri Narender Modi and the Hon'ble President of France Mr. François Hollande on April 10, 2015.

DBT - International Collaborations*

Australia: 53
Brazil: 11
Canada:17
Denmark: 9
Finland:40
Germany: 53
France:1
Japan: 5
Netherlands: 6
Russia: 5
Spain: 5
Switzerland: 11
Sweden: 13
South Africa: 4
UK: 47
US: 9
Vietnam: 5
EU: 28

Partnership with Non-governmental Organization

Welcome Trust (WT)
Bill & Melinda Gates Foundation (BMGF)
European Molecular Biology Organization (EMBO)
Prakash Lab, Stanford University
Nobel Media AB the Nobel Foundation

*Ongoing Projects

Future Roadmap

During the last four years there has been a special focus on converging and bringing science to society. Keeping with the call of our Prime Minister of **Sankalp se Siddhi** - Making of a New India 2022, the Ministry of Science & Technology and Earth Sciences will strive to ensure that **science and technology** continues to **impact society.**

We will deepen our engagement with society and continue with our efforts to provide quality education and attract and encourage youth to Science. Cutting edge new applications of science for global competitiveness, science for national missions, encouraging start ups and entrepreneurs, promoting indigenous, affordable and accessible products under 'Make in India' will be the endeavor of the Ministries.

Our Motto:

विज्ञान से विकास

Science Impacting Society

Department of Biotechnology

India's biotechnology industry has been built on four core beliefs: entrepreneurship, innovation, developing local talent and demonstrating high quality value-based care. The country is amongst the top 12 biotech destinations in the world and ranks third in the Asia-Pacific region.

The industry includes 500 companies, records the second highest number of USFDA–approved plants (only after the United States). Continued support to the biotech industry to reach the target USD 100 Billion by 2025 will be the endeavor.

1. Development of a translational ecosystem connecting Industry-Academia-Research to take advanced leads from our research labs to commercialization especially in the health, agriculture and energy sector.

2. Mission on application of big data on computational biology and biotechnology.

3. Building and strengthening partnerships with national and international stakeholders. Will collaborate across ministries, state governments and build robust biotech capacity across the country.

4. International Bioconnect offices will be established to leverage International strengths for national impact. Vibrant translational ecosystems for cutting edge science for maximum social development.

"Attaining new heights in biotechnology research, shaping biotechnology into a premier precision tool of the future for creation of wealth and ensuring social justice - specially for the welfare of the poor."

DEPARTMENT OF BIOTECHNOLOGY
Ministry of Science & Technology

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DEPARTMENT OF BIOTECHNOLOGY
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