सत्यमेव जयते

DEPARTMENT OF BIOTECHNOLOGY
Ministry of Science & Technology
Government of India

Biotechnology in Focus:

INNOVATING FOR INDIA'S PROGRESS

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INNOVATING FOR INDIA'S PROGRESS

Message by
Dr. Jitendra Singh

Hon'ble Minister of State (IC) for Science & Technology

I congratulate the Department of Biotechnology (DBT) for bringing out this Coffee Table Book showcasing its achievements over the last 10 years in various cutting-edge areas of Biotechnology. DBT has created a firm niche in the Biotechnology space and is promoting R&D and technological development through Biotechnology Research and Innovation Council (BRIC) New Delhi, International Centre for Genetic Engineering and Biotechnology (ICGEB) New Delhi, Regional Centre for Biotechnology (RCB) Faridabad and PSUs Biotechnology Industry Research Assistance Council (BIRAC) New Delhi, Bharat Immunologicals and Biologicals Corporation (BIBCOL) Limited Bulandshahar and Indian Vaccine Corporation (IVCOL) Limited New Delhi and extramural research grants. DBT through BIRAC has transformed the biotech innovation ecosystem across the country. Rising to the Hon'ble Prime Minister's call for Start Up India, the number of Biotech based start-ups have increased to more than 6000. The entrepreneurship ecosystem nurtured by DBT has facilitated our response for the mitigation of the COVID-19 pandemic.

There are several success stories which have made tremendous contribution to India's bioeconomy. The Mission COVID Suraksha has churned out five vaccines against COVID-19. Indian Biological Data Centre is the first repository of life sciences data established in the Regional Centre for Biotechnology, Faridabad. Indian SARS-CoV-2 Genomic Consortium (INSACOG) has facilitated the surveillance of SARS-COV-2. Biotechnology has the potential to become an important instrument of global trade and bio-economy contributing to India's overall economy. Further, India is poised to be among top five Global Bio-manufacturing Hubs by 2025 and DBT is going to play a key role by bringing all the stakeholders together. India's Bioeconomy witnessed double digit growth rate year-on-year in the last 9 years under the leadership of Prime Minister Shri Narendra Modi. India is now being rated among top 12 biotechnology destinations. In 2014, India's bioeconomy stood at just about $10 Billion, today it is $137.5 Billion. In just 10 years it has gone (up) 13 times and we look forward to reaching $300 Billion by 2030.

I wish the Department all the best in their future endeavours.

Message by
Dr Rajesh S Gokhale

Secretary, Department of Biotechnology

Innovation is one of the major drivers of India's economic progress and DBT constantly strives for novel innovations and scientific advancements. On the other hand, DBT's mandate is aligned with National Development Goals (NDPs) and Sustainable Development Goals (SDGs). India's accelerated response during COVID-19 has been one of the landmark achievements of our nation showcasing India's brilliant scientific temper. India has established itself as a leading global vaccine manufacturer and is sufficiently well-placed in terms of infrastructural capacities. The Department along with its Public Sector Undertaking, Biotechnology Industry Research Assistance Council (BIRAC) has been instrumental in creation of Pandemic Preparedness Ecosystem with a focus on Vaccine Research and Development. DBT has operationalised "One Nation, One Portal," BioRRAP which is a 1st step in enabling ease of doing scientific research in India. DBT launched a new programme, Dare2eraD TB which is basically a genome based surveillance of TB. Multi drug resistance and host directed therapies to reduce the dosage interval from 3 to 6 months.

This report gives a glimpse of some of the success stories over the last 10 years highlighting their contribution to the Government's Mission programmes. Department of Biotechnology envisages to bring together scientific & technological advancement by fostering 'High-Performance Biomanufacturing' initiative in the country where biological systems, including microbes, cells, and enzymes, will be explored to produce commercially relevant products used in diverse sectors (food, therapeutics, materials, chemicals etc). DBT is committed to continue its engagements with all the stake holders both at the national and international level to contribute towards a vibrant bioeconomy.

Contents

About DBT

The independence of India took policymakers' collective attention towards the development of the nation's scientific infrastructure and capabilities. From thereon until the 1980s, substantial scientific progress was achieved in areas such as space and agriculture.

However, formally, the focus on biological sciences shifted with the initiation of deliberations in 1982 with the scientific community to establish a separate department of biotechnology. The same year, a National Biotechnology Board (NBTB) was constituted on the recommendations of the Scientific Advisory Committee to the Cabinet. Established to identify priority areas and evolve a long-term perspective for biotechnology in India, it paved the way for the constitution of the Department of Biotechnology in February 1986.

Vision

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.

Mission

Biotechnology is a frontline area of science with immense potential for human kind. The mission is:

- Realising full potential of biotechnology.
- A well directed effort, significant investment for generation of products, processes and technologies.
- Enhance efficiency and productivity and cost-effectiveness of agriculture, nutritional security, molecular medicine, environmentally sustainable technologies, scientific and technological empowerment of human resource, a strong infrastructure for research and commercialization, enhance the knowledge base, nurturing the leads of potential utility, bringing the bioproducts to the market place.
- Socio-economic development / applications of biotech for upliftment of women, rural, SC & ST population.
- Promote biotech industry.

Core Values

The core values of Department of Biotechnology are:

- Integrity
- Transparency and Accountability
- Team work
- Commitment
- Excellence

Inception to Innovation

1986

The origin of DBT

1988–2004

DBT expands its ecosystem with

Set up of ICGEB & NCCS in 1988

Set up of BIBCOL & IVCOL in 1989

Set up of 16 Autonomous Institutes

2012

Establishment of BIRAC

An industry-academia interface to foster innovation and entrepreneurship

Promote affordable innovation in key social sectors

2016

Establishment of Regional Centre for Biotechnology

As a premier institution of education, training and research under UNESCO

2023

Establishment of Biotechnology Research and Innovation Council (BRIC)

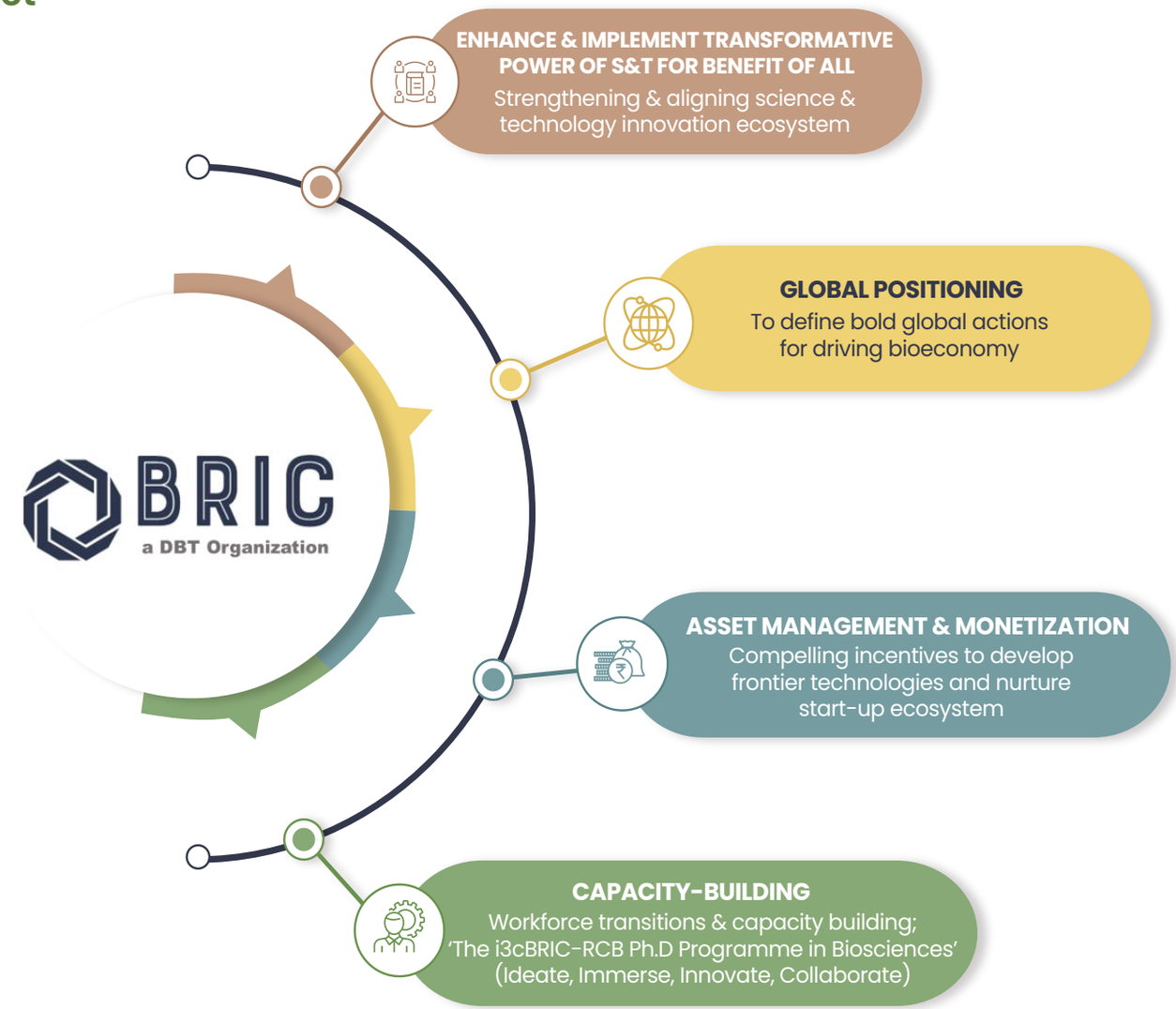
What will BRIC do?

Restructuring for Value and Impact

Rationalisation of DBT autonomous bodies

» DBT has subsumed its 14 Autonomous Institutions to create one Apex autonomous body, Biotechnology Research and Innovation Council (BRIC) for "Minimum Government, Maximum Governance."

» BRIC institutes will undertake cutting edge research addressing national priorities and initiate new education programs in line with National Education Policy (NEP).



Statistical Snapshot

2014 onwards

5163

Projects Sanctioned

6518

Institutes Supported

2430

NGOs Supported

18401

Publications

1044

Patents Filed/Granted

1038

Products/Technology Developed/Commercialized

108936

Manpower Supported

Collaborative Canvas

MoUs Signed

MoU between Ministry of Ayush and Department of Biotechnology, Govt. of India for evidence based biotechnological interventions in Ayush sector.

Pact between Armed Forces Medical Services (AFMS) and Department of Biotechnology, Govt. of India to promote healthcare research.

Renewal of MoU between Bill & Melinda Gates Foundation and Department of Biotechnology, Govt. of India to support innovative approaches to address health, food and nutritional inequities.

Department of Biotechnology and the United States-National Science Foundation signed 'Implementation Arrangement' towards the creation of a 'future-ready' technology platform for bio-manufacturing and enhanced biosafety and biosecurity innovation, practices, and norms.

DBT and WIPO signed MoU in presence of Hon'ble Union Minister of State (IC) Dr. Jitendra Singh for supporting international young professionals to design and create medical devices at the DBT Biodesign centers.

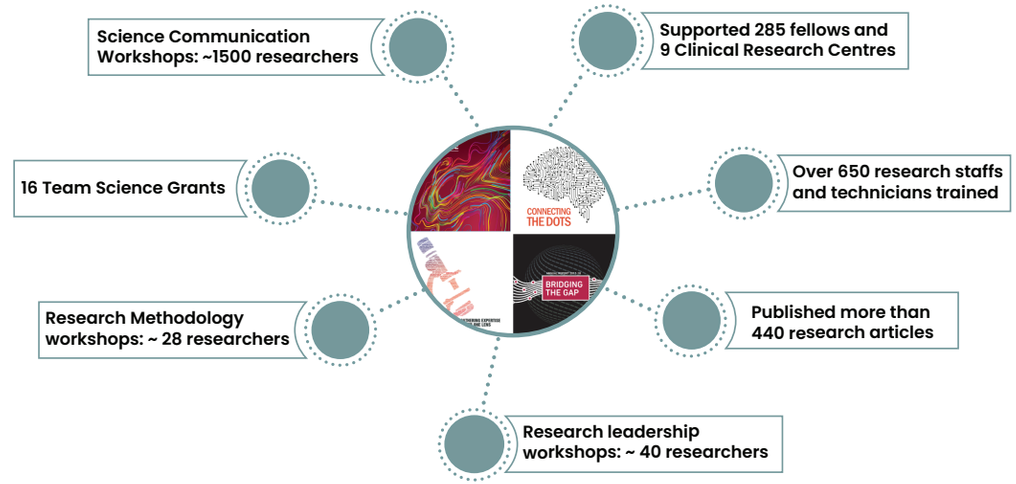
Bilateral and Multilateral Collaborations

Biomedical Research Career Programme (BRCP)

IndiaAlliance
DBT wellcome

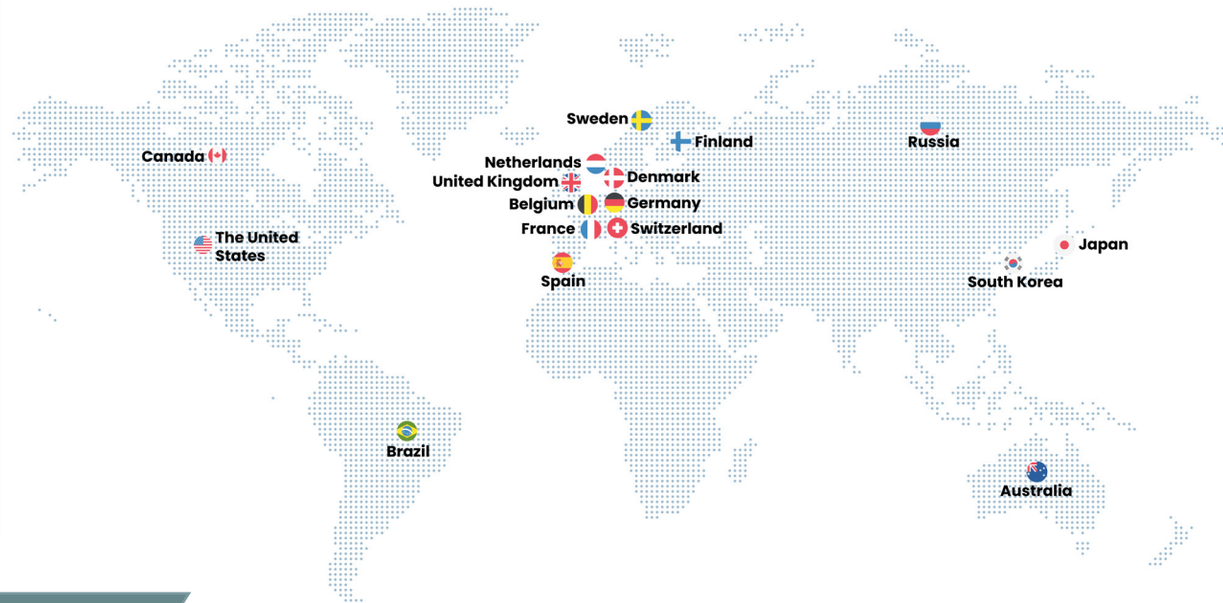
Enabling Biomedical Research in Basic, Clinical and Public Health through Funding and Engagement.

Funded by the Department of Biotechnology, Govt. of India and Wellcome Trust, UK, continues to build a strong biomedical research ecosystem in India by nurturing scientific talent and driving innovations to tackle health challenges.



Partnership with EMBO

EMBO Young Investigators: 3	**Partnership with HFSPO**
EMBO Long-Term Fellowships: 7	• Research Grant awardee based in India: **2** • Postdoctoral Fellowships awardee: **14** • Career Development Awards (CDA): **36**
Short-Term Fellowships: 82	
EMBO Global Investigators: 3	
EMBO Laboratory Leadership Courses: 4	
Childcare grants for scientists to attend EMBO Courses and Workshops: 2	
Indian Scientists attending EMBO Courses & Workshops: 1930	
Travel stipends for Scientists to attend EMBO Courses and Workshops: 266	



17 ongoing Bilateral Partnerships

» Multilateral Cooperation: EU, BRICS, MI, G20, QUAD, Eureka

Innovations from the Lab: Transforming Lives

Nutrition Biology Team - NABI Mohali

NCCS FAME Analysis Facility

Societal Women Self Help Group

DBT Supporting Self Help Groups

Biotech-KISAN Hub at Bodoland Territorial Region of Assam

Mushroom Training

Pioneering Health Solutions for a Healthier India

Vaccines for impending epidemics to provide affordable healthcare solutions to every citizen of India

Vaccines for Swasth Bharat

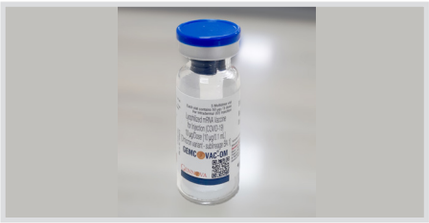
Five COVID-19 vaccines supported under "Mission COVID Suraksha-The Indian COVID-19 Vaccine Development Mission", received Emergency Use Authorization (EUA). These are:

- World's 1st and India's indigenously developed DNA Vaccine, ZyCoV-D

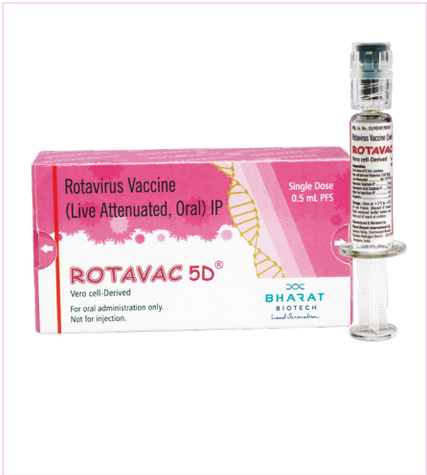
- Protein subunit vaccine, CORBEVAX™

- mRNA vaccine, GEMCOVAC-19™

World's 1st Intranasal COVID-19 Vaccine, (iNCOVACC)



mRNA Vaccine, GEMCOVAC^{R}-OM



- » Developed from an Indian strain, 116E, identified at AIIMS and manufactured by Bharat Biotech International Limited (BBIL).
- » WHO Prequalified and expanded across the country in 2019-20.

India's 1st indigenously developed quadrivalent Human Papilloma Virus (qHPV) vaccine against cervical cancer (Cervavac) supported by DBT and BIRAC received market authorization from DCGI in July, 2022.

Dr. Jitendra Singh, Hon'ble Union Minister of State (IC) Science & Technology announcing India's First Cervical Cancer Vaccine

15-valent Pneumococcal Polysaccharide conjugate vaccine received market authorisation for manufacturing in December 2022.

Multi-domain Self assembled Nanoparticle (MSN) vaccine platform:

» Versatile platform technology developed by THSTI Faridabad comprises of a viral non-structural protein (NSP).

» The proof-of-concept, has been successfully demonstrated in developing multivalent vaccine candidates for SARS-CoV-2 variants of concerns.

Human Immune Monitoring and T-cell Immunoassay Platform (HIMTI)

» The HIMTI platform available at the National Institute of Immunology enables immuno-bridging and interchangeability trials, which are used to check the protection of vaccines as an alternative to efficacy trials.

Launch of Dare2eraD TB

DARE2ERAD TB:

Data-Driven Research to Eradicate TB- "Dare2eraD TB" was launched by Dr. Jitendra Singh, Hon'ble Union Minister of State (IC) Science & Technology on occasion of World TB Day, 2022.

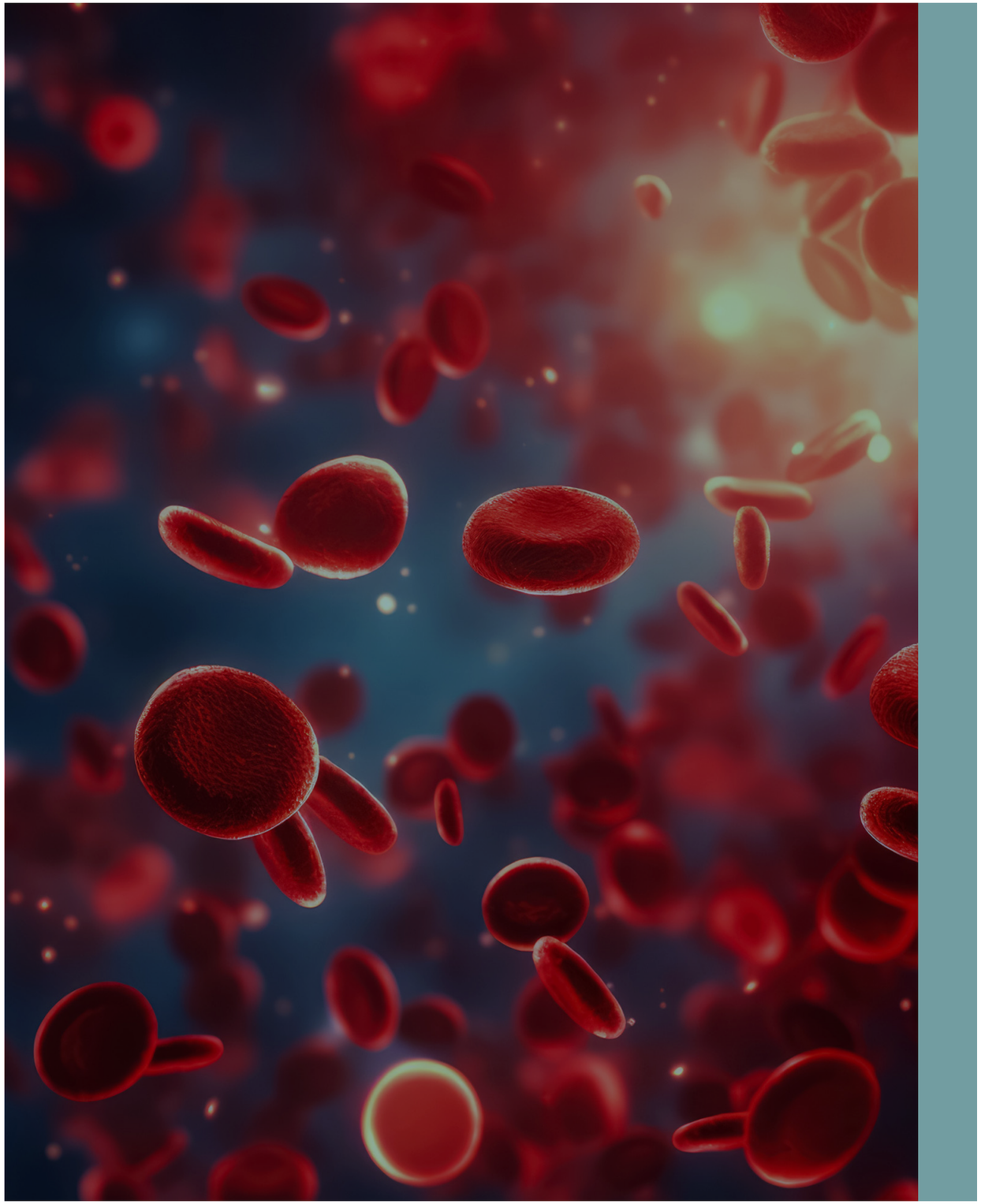
Whole Genome Sequencing (WGS) of 32,200 Mycobacterium Tuberculosis strains from active TB patients for formulating public health measures and appropriate control strategies for elimination of TB.


Tergene PCV Vial Line

National Biopharma Mission:

Under this Mission, Vaccine candidates (15) for Cholera, Influenza, Dengue, Chikungunya, Pneumococcal disease, COVID-19 (early development) and related technologies (4); Biosimilar products and related technologies (21) for Diabetes, Rheumatological and ophthalmic diseases, Cancer; Medical Devices & Diagnostics (29) have been supported so far.

SocioDent Private Limited



Therapeutic Interventions

Gene therapy for Hemophilia A:

» First gene therapy clinical trial in India for Hemophilia has been approved by the Central Drugs Standard Control Organisation (CDSCO).

» Lentiviral vector is being manufactured in a GMP facility supported by DBT at Centre for Stem Cell Research (CSCR) in CMC, Vellore, a translational unit of inStem.

Novel blood bag:

» Taurine and acridine containing electrospun-nanofibrous-sheets (Tau-AcrNFS) efficiently scavenged DAMPs from stored human and mice RBCs ex vivo.

» The technology has a potential for development of novel blood bags and medical device.

Novel Indian Blood Bag Technology

Sowing the Seeds of Progress

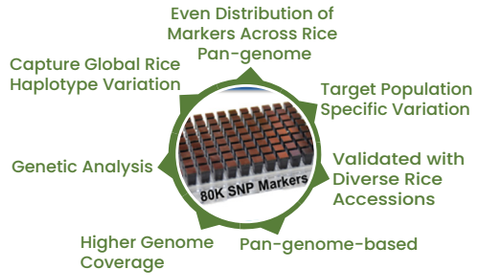
Interventions for Agriculture: Improved Production and Productivity

Improved varieties released since 2014

» DBT NGGF:

A 'single window service system' for advanced high throughput genomics and genotyping based solutions and consultancy in PPP mode is operational in NIPGR, New Delhi.

» Rice Pan-genome genotyping array:



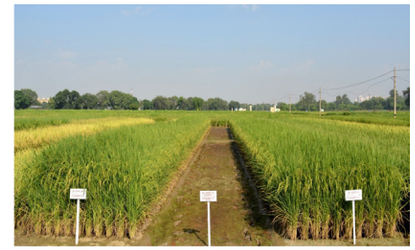
A 90K SNP genotyping array based on 3K rice pan-genome has been developed for genomics-assisted breeding and accelerated crop improvement useful for large-scale pan-genome based genotyping applications.

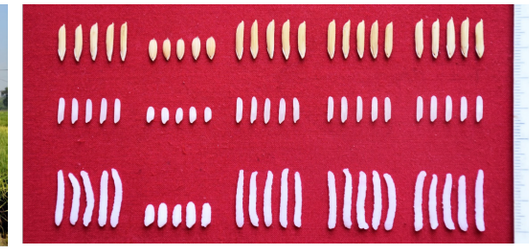
» Speed breeding facility:

- Speed breeding facility was established in IRRI, Varanasi.
- Facilitate faster genetic gains and transfer the superior haplotypes from landraces to elite backgrounds.
- Improved varieties of food crops and ornamental plants released during 2014-2023.

» Herbicide Tolerant Rice

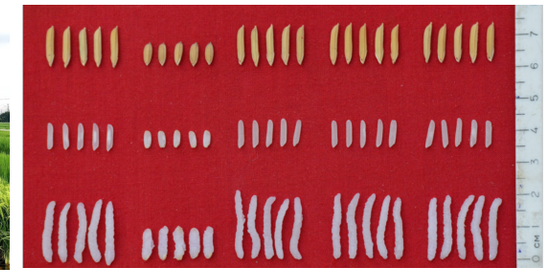
- **Pusa Basmati 1979:** A MAS derived herbicide tolerant NIL of Pusa
- Basmati 1121 tolerant to Imazethapyr.





PB 1121 Robin PB 1979-HT NILs

- **Pusa Basmati 1985:** A MAS derived herbicide tolerant NIL of Pusa Basmati 1509 tolerant to Imazethapyr.



PB 1509 Robin PB 1985-HT NILs

» Climate resilient varieties

CG-Barani Dhan-2 (R-RF-105, IET 24690) is moderately tolerant to white ear head, WBPH, leaf folder, plant hopper, neck blast and rice Tungro virus.

» Biotech-Kisan Hubs:

- » Hubs established in all 15 agro-climatic zones.
- » 55 interventions introduced to benefit farming community.
- » >3 lakh farmers have been benefited.

BiotechKisan Hub

Solar Panel

» Fruvetech - Fruits & Vegetables

- » An efficient cost effective and safer technology to enhance shelf-life of fruits and vegetables.
- » Start-up Fruvetech has been registered and recognized by Startup India (DIPP 91474).

ADVIKA

» Dr Jitendra Singh, Hon'ble Union Minister announced the release of 'ADVIKA', an improved drought tolerant variety NC7 which has been notified by Govt. of India for National release and cultivation and use by farmers to ensure sustainable pulse crop production.

ADVIKA: Superior Drought Tolerant, Climate Smart Chickpea Variety

Animal Biotechnology

» IndiGau: World's largest DNA chip for identification of purity of indigenous breed of cattle.

» Vaccine (Animal Biotech - TRPVB products and vaccine platforms).

» S19 Brucella vaccine: A novel delta S19 Brucella vaccine has been developed and the technology was transferred to M/s Hester Biosciences Pvt. Ltd. Indirect ELISA was developed for brucellosis with DIVA capability.

» Kit for detection of sub-clinical mastitis: Nano-based kit for screening of animals for mastitis.

Dr. Jitendra Singh, Hon'ble Union Minister of State (IC), Science and Technology releasing IndiGau

Charting a Green Course

An integrated approach towards promoting Circular Economy for Green, Clean and Prosperous India

Enzyme Cocktail for Lignocellulosic Ethanol

» Extensive bioprospecting of cellulolytic fungus Penicillium funiculosum yielded several novel enzymes and auxiliary proteins.

» Genetic Modification of this strain yielded DIBzyme-1 (Indian patent application no. 201711019184) which produces lignocellulosic ethanol.

2G Ethanol -DBT IOC Center

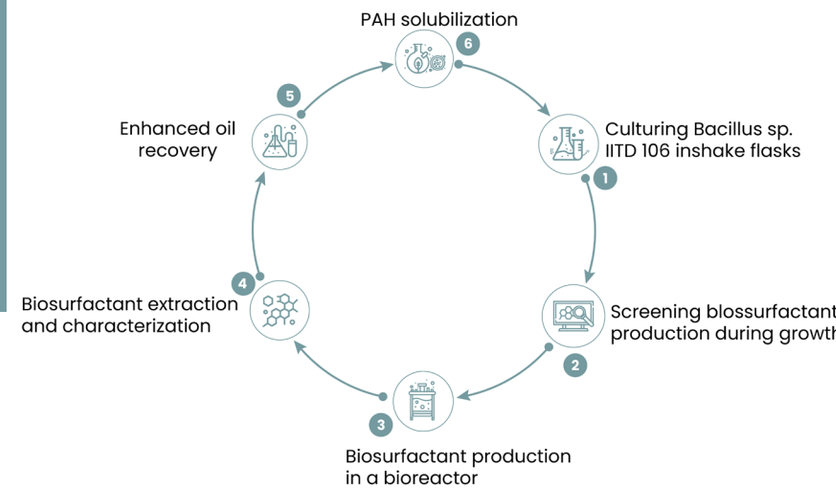
» Indigenous technology for conversion of Lignocellulosic biomass to 2G ethanol and optimized pretreatment process @ 250 kg/day pilot plant.

Algal Growth system - DBT-TERI Centre

» Marine algae cultivation in 1,00,000 L scale in outdoor (Mumbai coast) using a custom made sunlight-distributed (with improved productivity) algal growth system was demonstrated.

Marine Algal Production System (100,000 L, 220 sq m)

Biofermenter Lab, IIT Delhi



Process Flow for the Bioreactor Scale Production of the Surfactant in Laboratory

Microbial Production of a plant based surfactant

» A plant based surfactant discovered through microbial production showed immense potential in polyaromatic hydrocarbon solubilization and in enhancing the recovery of residual oil.

In-situ bioremediation technology for crude oil contamination

» A five member consortium was designed for field application including Pseudomonas putida, Alcaligens sp., Gordonia sp., Achromobacter xylosoxidans and Pseudomonas aeruginosa.

Empowering Human Resources in Biotechnology

Students benefitted

5,715
Skill- Vigyan Programme

11,328
PG Programme

31,000
Star College Scheme

Career Advancement Fellowship

7,395
DBT-JRF Programme

1,722
DBT-RA Programme

83
MK Bhan Young Fellowship Programme

279
Ramalingaswami Re-entry Fellowship

308
Biotechnology Career Advancement and Re-orientation Programme (BioCare)

A Conference on "Women Leading Change in Health and Science in India"

Beneficiaries from BioCARE Scheme

ESRF Access Programme:

» Indian investigators are given access to experimental stations for macromolecular crystallography, small angle X-ray scattering and Cryo-Electron Microscopy located in ESRF.

» More than 100 researchers, largely PhD students, have been trained in cutting-edge methods in Structural Biology.

Students Benefitted from Star College Program

North East Ventures

Advanced Animal Disease Diagnosis and Management Consortium (ADMaC)

» Evolved as a strong disease diagnosis network in the North Eastern Region.

Biotech HUBs

» Supported Infrastructure in universities/ colleges/ institutions and training in sophisticated technologies.

Centre for Bioresources and Sustainable Development in Arunachal Pradesh a Centre of Excellence (CoE)

» Facilitated development of more than 10 prospective innovative technologies.

Centre of Excellence on Fisheries and Aquaculture Biotechnology (CoE-FAB)

» Inventory of freshwater fish diversity of NER by molecular tools (DNA Bar coding) for improving the yield of fish production system in the NER.

North East Centre for Agriculture Biotechnology (NECAB), AAU, Jorhat

» Facilitating solutions against regional challenges in agriculture such as insect pests, drought, submergence and soil acidity.

Consortium programme on MDR-TB

» About 2000+ M. tuberculosis isolates collected from a diverse population of NER covering a total of 72 districts.

» Genome sequencing of around 400 isolates has been completed.

India’s Biotech Arsenal

Indian Biological Data Centre (IBDC):

- 1st National repository for life science data in India established at Regional Centre for Biotechnology (RCB), an autonomous institute of DBT at Faridabad.
- Data submitted to Indian Nucleotide Data Archive is actively synced with the International Nucleotide Sequence Database Collaboration (INSDC) repositories

Dr. Jitendra Singh, Hon'ble Union Minister of State (IC) Science and Technology dedicated to the nation, India’s first national repository for life science data-‘Indian Biological Data Center’ (IBDC)

Indian Biological Data Centre Team

Indian SARS-CoV-2 Genomics consortium (INSACOG)

Jointly established by MoHFW, DBT, CSIR and ICMR

INSACOG established with an aim to assess SARS-CoV-2 variants in India, and to correlate epidemiological data for public health interventions.

Consortium of 67 Indian Genome Sequencing Laboratories, 400+ Sentinel sites and Industry labs.

About ~3.33 lakhs SARS-CoV-2 Genome sequenced and analyzed by INSACOG labs (including their efforts under MoU with States).

Impact :

- Capacity for Pathogen Surveillance
- Sustained Genomics Infrastructure
- Virus Repository/ Culture
- Enhanced data sharing for streamlined national to international Public health decision making

INSACOG Team

Genome India - A DBT Initiative

Collaborating institutes (20 across 15 states)

Goals and Impact

- Create an exhaustive catalog of genetic variations in Indians and a reference haplotype for Indians by carrying out whole genome sequencing of 10000 samples from 100+ communities
- Design genome-wide and disease-specific genetic chips for low cost diagnostics and research.
- Develop a biobank of 20000 blood samples for genome analysis
- Make available genomic data for public access for research purposes (via IBDC)
- First step towards developing genome based precision medicine in India

Human Microbiome

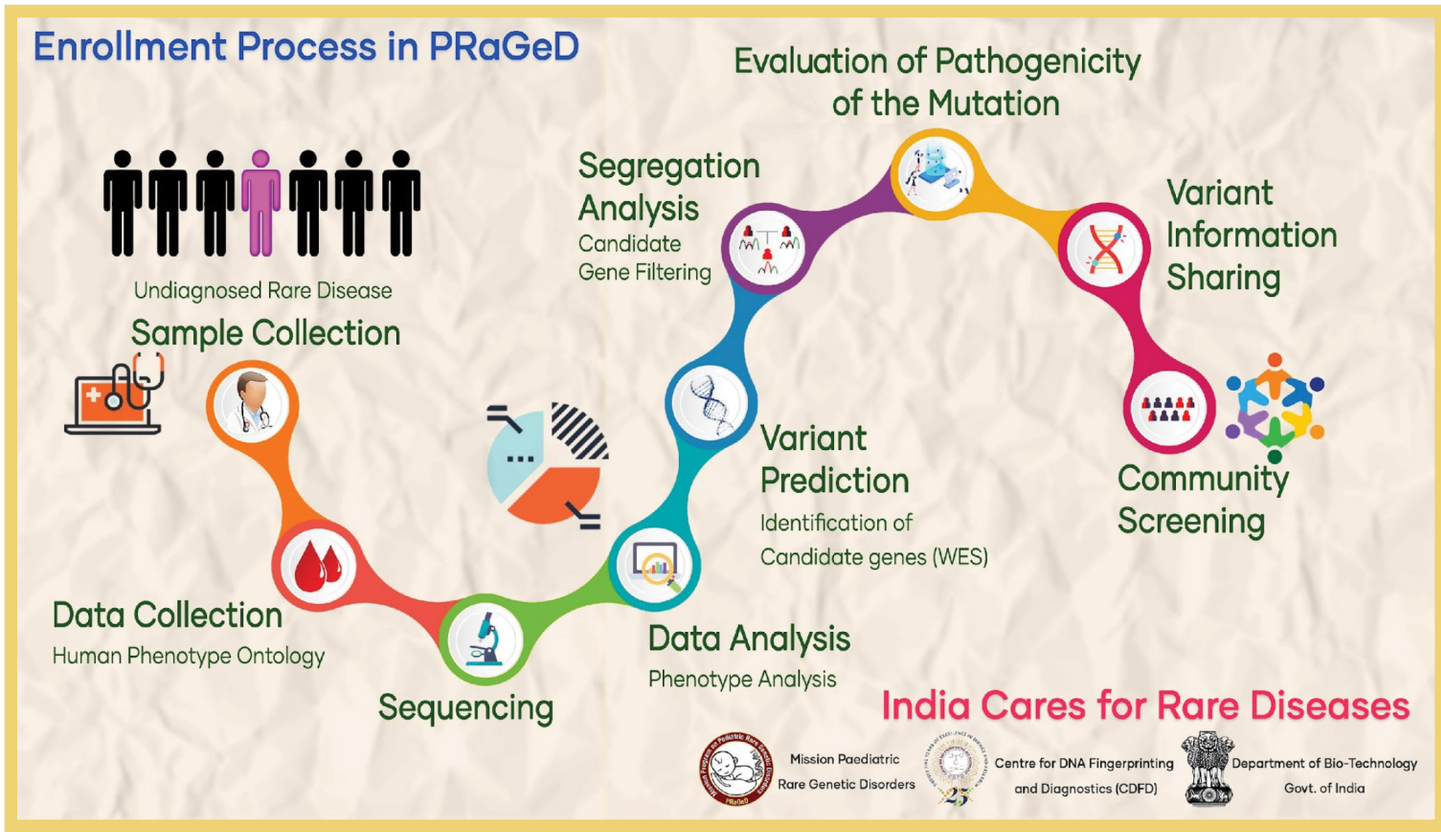
- Aims to map the reference microbiome of 3400 healthy individuals across 11 non-tribal and 6 tribal communities spread across the country and the microbiome variations with respect to Ayurvedic Prakriti.
- Expected to elucidate microbiome variation across the diverse biogeographic and dietary variations in India.

Achievements (till Nov 2023)

21805	18462	9942	7390	6308	>5547
Individuals contacted for recruitment	Participants enrolled including phenotyping	Individuals for whom GWAS done	Individuals for whom WGS done	WGS sequences analysed	Data Submitted in IBDC

Mission Program in Pediatric Rare Genetic Disorders

A consortium of 16 Institutions led by Centre for DNA Fingerprinting and Diagnostics, Hyderabad



- Recruitment of patients with rare genetic diseases
- Genomic analysis for diagnosis of rare genetic disorders
- Database development and analysis
- Functional validation of novel variants/novel genes
- Counseling of patients/families
- Awareness programme in rare genetic diseases

Zebra fish and mouse models being developed to study rare genetic diseases

Low Glucosinolate Brassica

Brassica genome edited lines for BjuGTR i.e low seed glucosinolate developed

Plasmodium vivax vaccine

- PvDBPII has been developed as a vaccine candidate against the blood-stage of P. vivax malaria.
- The process technology was transferred to the contract manufacturer, Syngene International Ltd., Bangalore, India.

National Centre for Microbial Resource (NCMR)

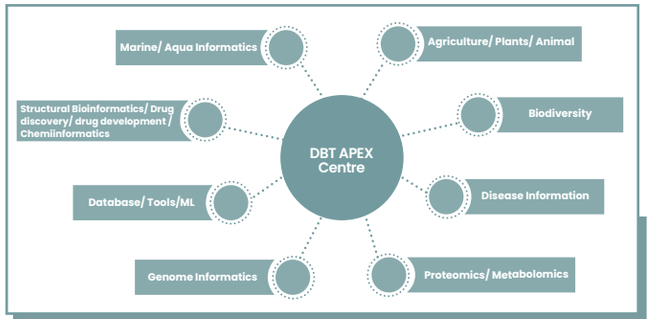
- NCMR established in NCCS Pune has been recognised as an International Depository Authority.
- NCMR holds more than 280 patent deposits across the globe.

Microbial Repository Center:

Established at Institute of Bioresources and Sustainable Development (IBSD) Imphal, 75000 microbial cultures collected and isolated from different unique ecological niches of NER of India.

Garbh-ini (Interdisciplinary Group for Advanced Research on Birth Outcomes—DBT India Initiative):

- Unique pregnancy cohort comprising >10000 women to study Pre-Term Birth (PTB).
- India-specific gestational age signatures through AI for pregnancy dating and prediction of adverse birth outcomes.



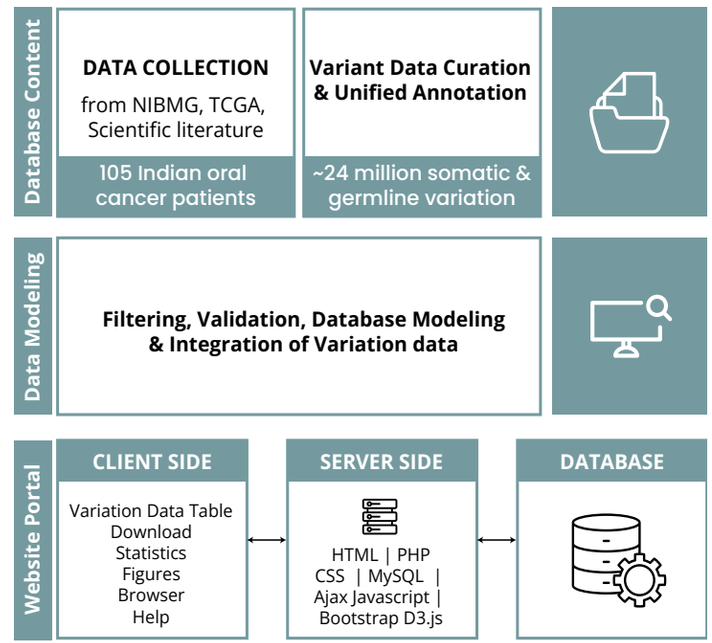
Revamping of BTIS Network:

- New set of centres of BTISNet are being funded in the frontier areas of Biotechnology.
- BTIS Network has developed 63 databases/software.

dbGENVOC

- The first open, web-accessible oral cancer database of the variants found significantly associated with Indian oral cancer patients, with a user-friendly interface to enable easy mining.

- Provides valuable insights to researchers on large-scale cancer genomic data at both population and at the individual patient level.



Empowering Entrepreneurship and State Partnerships

Biotechnology Industry Research Assistance Council (BIRAC)

>6000	74	>800	>4000 Crore
Startup supported	Incubators supported	Technology & products	Follow-on Funding raised by Startups

Biotech Startup Expo 2022:

- Hon'ble Prime Minister inaugurated First Biotech Startup Expo-2022 from June 9-10, 2022.
- More than 6,000 participants representing all the stakeholder segments of the biotech ecosystem.
- A large number of exhibitors including Startups, Incubation Centres, Research Institutions exhibited their products/ technologies and research leads in the event.

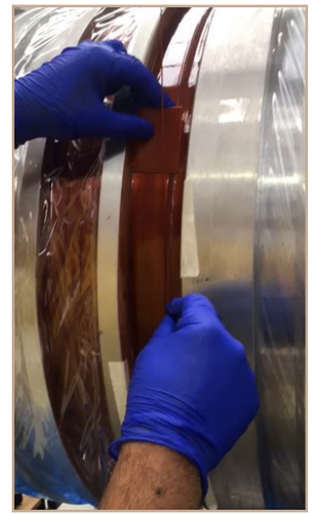
Biotech Expo

Biotech Park

- Industrial Biotech Park Kathua was Inaugurated by Hon'ble Union Minister of State (IC), Science and Technology Dr. Jitendra Singh & Hon'ble Lieutenant Governor, Manoj Sinha on 28th May 2022.
- Jointly Funded by Department of Biotechnology, Govt of India & Department of Science & Technology J & K UT.

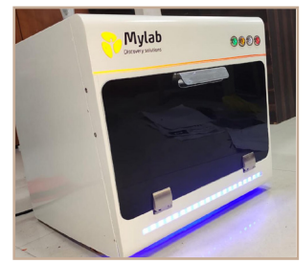
BIRAC IMPACT PRODUCTS

OmniBRX



MRI Magnet

Video Processor Scope



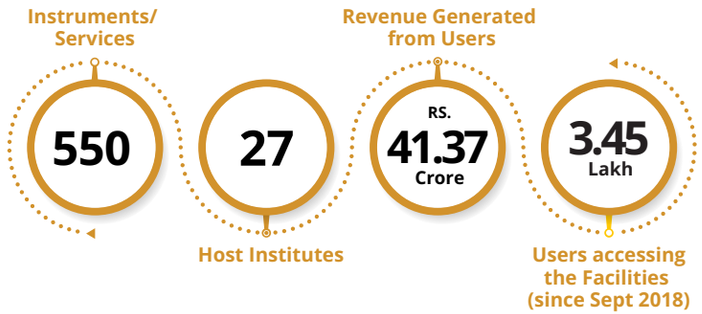
Compact DX 2

Elevating Research Infrastructure

» **DBT-SAHAJ:**
Scientific Infrastructure Access for Harnessing Academia University Research Joint Collaboration.

» **BUILDER:**
DBT-Boost to University Interdisciplinary Life science Departments for Education and Research programme.

SAHAJ: at a glance



Major infrastructure facilities supported

TACF - ICGEB, New Delhi

National Genomics Core - NIBMG, Kalyani




Lyophilisation Facility - IMTECH, Chandigarh

Navigating Change: Regulatory Reforms

Indian Biosafety Knowledge Portal (IBKP)

» A web based portal caters to researchers, industry and other stakeholders to provide latest scientific information and regulatory guidance related to authorization of GMOs/LMOs and products.

Biological Research Regulatory Approval Portal (BioRRAP):

» "One Nation, One Portal", BioRRAP is the 1st step in enabling ease of doing scientific research in India.

» BioRRAP caters to all those seeking regulatory approval required for biological research and development.

SoPs for regulatory review of Genome Edited Plants:

» Standard Operating Procedures (SOPs) for regulatory review of Genome Edited Plants under Site Directed Nuclease-1 (SDN-1) and SDN-2 categories for enabling regulatory streamlining of genome edited plants and resilient crops for future.

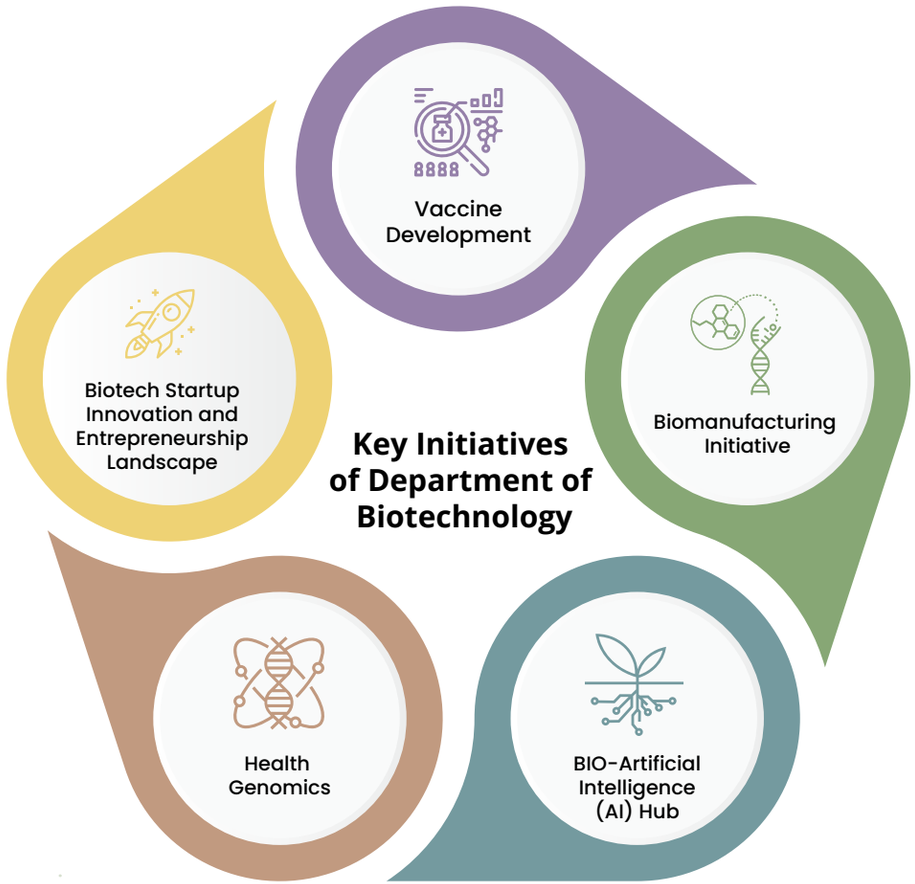
Response to COVID-19 situation:

» **March 20, 2020:**
Rapid response regulatory framework for COVID-19 for development of vaccines, diagnostics, prophylactic and therapeutics.

» **April 08, 2020:**
Interim guidance document on laboratory biosafety to handle COVID-19 specimens for R&D purpose.

» **May 26, 2020:**
Checklist for application to conduct pre-clinical toxicity (PCT) studies for recombinant vaccine for COVID-19.

The Roadmap for the Future



5 Years' Roadmap - Major Goals:

- Bio-economy Growth
- Global competitiveness
- Job Creation
- Catalyzing Entrepreneurship
- Attracting investments
- Accelerate lab to market innovations
- Promoting Cutting-edge technologies; Genomics, AI, Big data analysis

Fostering High Performance Biomanufacturing

Green, Clean and Prosperous India

Thematic Sectors of Biomanufacturing

Bio-based Chemicals & Enzymes
Catalyzing Greener Reactions

Functional Foods & Smart Proteins
Taste without Cruelty

Precision Biotherapeutics
Remedies that understand YOU

Climate Resilient Agriculture
Krishi that makes earth happy

Carbon Capture & Utilization
Recover to Prosper

Futuristic Marine & Space Research
Diving into Infinity

Catalyzing Accelerating Transformation with Bio-Enablers

Public Private Partnerships

Bio Artificial Intelligence Hubs

Biomanufacturing Hubs

Skilling and human resources

Regulatory enablement & inter-ministerial coordination

International Collaboration

DBT Blooming Through the Years

Biomanufacturing of Monoclonal Antibodies Group

Nutrition Biology Workshop
NABI Mohali

Startup Fruvetech- NIPGR, New Delhi

Bio AI Hub Group

Communication Workshop at the DBT Office

Biotech Regulation Team

DBT Chintan Shivir - NII New Delhi

NCCS FACS and SPR Facility Team

School Students Interacting with the DBT Team

Smart Protein Group

Joint Working Group of VAP