



## BioE3 Policy and Biotechnology in India

**For Prelims:** BioE3 Policy, [Vigyan Dhara](#), [Net Zero Carbon Economy](#), [Circular bioeconomy](#), [Lifestyle for Environment](#), [Gene therapy](#), [Stem cell](#), [Golden Rice](#), [Bioremediation](#), [Carbon footprint](#), [National Biopharma Mission](#), [Biotech-KISAN Scheme](#), [Atal Jai Anusandhan Biotech Mission](#), [One Health Consortium](#)

**For Mains:** India's Biotechnology Sector, Significance of Biotechnology for India, Key Challenges Hindering the Growth of Biotechnology in India.

[Source: TH](#)

### Why in News?

Recently, the Union Cabinet approved the proposal '**BioE3 (Biotechnology for Economy, Environment and Employment) Policy for Fostering High-Performance Biomanufacturing**' of the [Department of Biotechnology](#).

- Alongside the **BioE3 Policy**, the Union Cabinet also merged three schemes of the Science & Technology Ministry into a single scheme, called [Vigyan Dhara](#), with a financial outlay of Rs 10,579 crore until 2025-26.

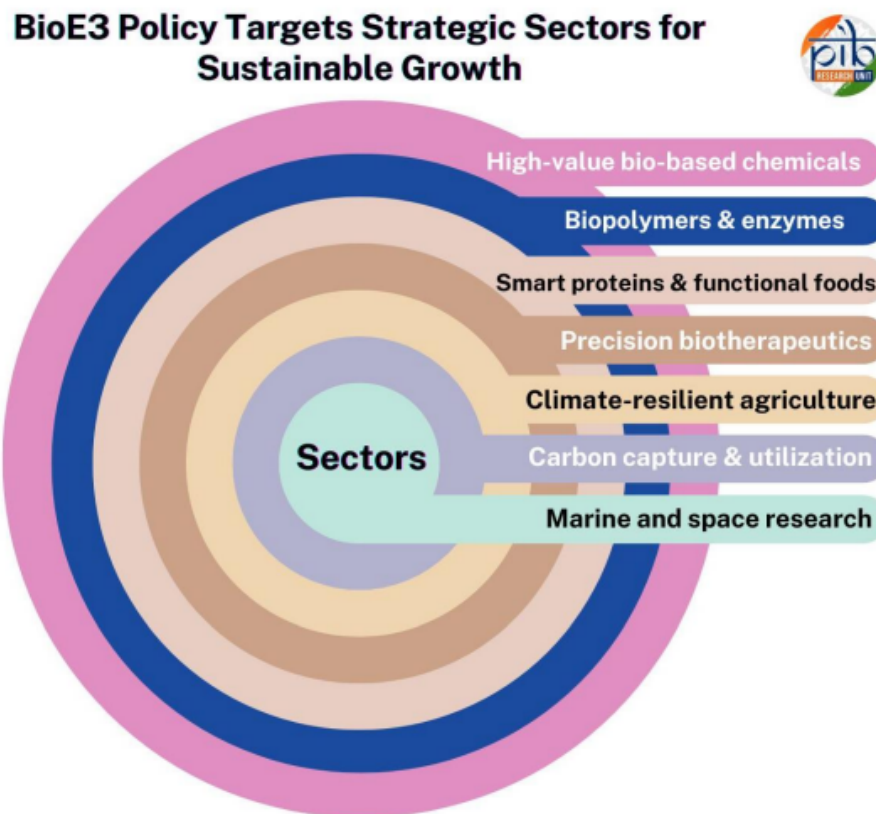
### What is BioE3 Policy?

- **About:** The BioE3 is aimed at fostering high-performance [biomanufacturing](#), which involves the production of **bio-based products across various sectors**.
  - The policy aligns with broader **national goals such as achieving a 'Net Zero' carbon economy** and promoting sustainable growth through a [circular bioeconomy](#).
- **Objectives:** The BioE3 policy emphasizes innovation in research and development (R&D) and entrepreneurship, establishes Biomanufacturing & Bio-AI hubs and Biofoundries, aims to expand India's skilled biotechnology workforce, aligns with '[Lifestyle for Environment](#)' programs, and targets the development of regenerative bioeconomy models.
  - The BioE3 Policy aims to **generate significant employment**, especially in **tier-II and tier-III cities** through the establishment of biomanufacturing hubs.
    - These hubs will utilise local [biomass](#), fostering regional economic growth and equitable development.
  - The policy also **emphasizes ethical biosafety and global regulatory alignment** to boost India's global competitiveness while ensuring responsible biotechnology development.
- **Core Themes of the BioE3 Policy:**
  - **Bio-Based Chemicals and Enzymes:** Development of advanced bio-based chemicals and enzymes to reduce environmental impact.
  - **Functional Foods and Smart Proteins:** Innovations in functional foods and smart proteins to enhance nutrition and food security.

- **Precision Biotherapeutics:** Advancing precision medicine and biotherapeutics to improve healthcare outcomes.
- **Climate Resilient Agriculture:** Promoting agricultural practices that are resilient to climate change, ensuring food security.
- **Carbon Capture and Utilization:** Fostering technologies for efficient carbon capture and its utilization in various industries.
- **Futuristic Marine and Space Research:** Expanding research in marine and space biotechnology to explore new frontiers in biomanufacturing.

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The policy's scope is broad and ambitious, encompassing several strategic sectors:



## What is the Vigyan Dhara Scheme?

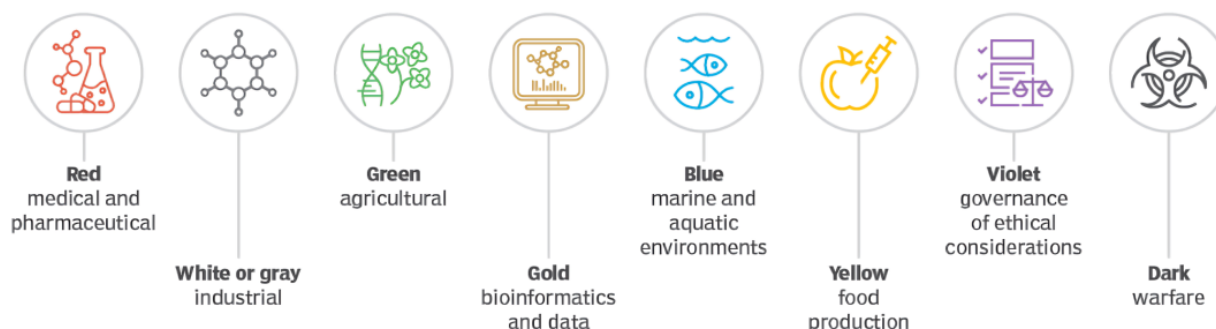
- **Background:** The [Department of Science & Technology \(DST\)](#) acts as the nodal department for organising, coordinating, and promoting science, technology, and innovation activities in the country.
  - The **three** (Science and Technology (S&T) Institutional and Human Capacity Building, R&D and Innovation, and Technology Development and Deployment) **central sector umbrella schemes implemented by DST** have been **merged** into the **unified scheme 'Vigyan Dhara'**.
- **Objectives and Goals:** The merging of the three schemes into Vigyan Dhara is designed to **improve fund utilisation and synchronisation** among various sub-schemes and programs.
  - Vigyan Dhara Scheme aims to expand the R&D base in the country and increase the Full-Time Equivalent (FTE) researcher count.
  - Focused interventions will enhance the **participation of women in Science, Technology, and Innovation (STI)** fields, with the goal of achieving gender parity.
  - All programs under Vigyan Dhara align with the 5-year goals of DST and are directed towards the larger vision of ["Viksit Bharat 2047" a developed India by 2047.](#)
- **Complementing the BioE3 Policy:** Enhancing S&T institutional infrastructure and developing a critical human resource pool.

- Promotes **basic and translational research in sustainable** energy, water, and other critical areas.
- Supports **innovations from school to industry levels and increases collaboration** between academia, government, and industries.

## What is Biotechnology?

- **About:** Biotechnology, a field that intertwines biology with technology, harnesses **cellular and biomolecular processes** to create products and technologies that enhance our lives and safeguard our planet.
- **Benefits:**
  - **Healthcare Advancements: Medical Biotechnology (Red Biotech)** enables the development of advanced drugs, vaccines, and therapies, including personalised medicine, [gene therapy](#), and [targeted cancer treatments](#).
    - It also facilitates rapid vaccine production, as seen during the [Covid-19 pandemic](#). [Stem cell](#) research and [tissue engineering](#) offer the potential to regenerate damaged tissues and organs, opening doors to treatments for previously untreatable conditions.
  - **Agricultural Improvements: Agricultural Biotechnology (Green Biotech)** involves [genetic modification](#) and engineering in plants that can produce crops that are more resistant to pests, diseases, and environmental stressors like drought, thus improving food security.
    - Biotech allows for the development of crops with enhanced nutritional profiles, such as [Golden Rice](#), which is fortified with vitamin A to combat [malnutrition](#).
  - **Environmental Sustainability: Biotechnology uses microorganisms to clean up pollutants (bioremediation)** like oil spills, heavy metals, and plastics, helping to restore ecosystems and reduce environmental damage.
    - **Industrial Biotechnology (White Biotech)** applies biotechnology to industrial processes, such as the production of [biofuels](#), [bioplastics](#), and biodegradable materials.
      - It focuses on **reducing environmental impact and promoting sustainability through** cleaner production methods.
      - Biotechnological innovations help recycle and upcycle waste materials, contributing to a **circular economy and reducing landfills**.
  - **Economic Growth:** The biotech industry drives economic growth by creating jobs in research, development, and manufacturing sectors.
    - Countries investing in biotechnology lead in cutting-edge innovations, giving them a competitive edge in global markets and trade.
  - **Climate Change Mitigation:** Certain biotechnologies can [capture and utilize carbon dioxide](#) from the atmosphere, helping to mitigate the effects of [climate change](#).
    - Biotechnology aids in the production of cleaner biofuels, reducing reliance on [fossil fuels](#) and decreasing [carbon footprints](#).
  - **Innovation in Materials:** Biotechnology enables the engineering of novel materials, including **bio-based fibers and high-performance bio-composites**, which have applications in industries ranging from fashion to aerospace.

# Types of biotechnology



## What is the Current State of Biotechnology in India?

- **Biotechnology Hub:** India ranks among the **top 12 biotechnology destinations** globally. The Covid-19 pandemic accelerated the growth of biotechnology in India, leading to advancements in vaccines, diagnostic tests, and medical devices.
  - In 2021, India saw a record number of biotech startup registrations, with 1,128 new entries, the highest since 2015. The total number of biotech startups reached 6,756 by 2022, with expectations to hit 10,000 by 2025.
- **Bioeconomy:** India's bioeconomy has seen a meteoric rise, from **USD 10 billion in 2014 to over USD 130 billion in 2024**, with projections to reach USD 300 billion by 2030.
  - **Biopharma remains the largest segment of India's bio-economy**, accounting for 49% of its total value, estimated at USD 39.4 billion. The vaccination market is projected to be worth Rs. 252 billion (USD 3.04 billion) by 2025.
- **Bioresources:** India's vast biodiversity, especially in the **Himalayas**, and the 7,500 km long coastline provide a significant advantage in biotechnology.
  - The [Deep Sea Mission](#) aims to explore the biodiversity beneath the seas.
- **Government Initiatives:**
  - [National Biotechnology Development Strategy 2020-25](#)
  - [National Biopharma Mission](#)
  - [Biotech-KISAN Scheme](#)
  - [Atal Jai Anusandhan Biotech Mission](#)
  - [One Health Consortium](#)
  - [Biotech Parks](#)
  - [Biotechnology Industry Research Assistance Council \(BIRAC\)](#)
  - [Genome India Project](#)
- **Recent R&D Achievements in Applied Biotechnology:**
  - **ADVIKA Chickpea Variety:** A drought-tolerant [chickpea variety](#) was developed with enhanced seed weight and yield under drought conditions.
  - **Accel Breed Facility:** A state-of-the-art speed breeding facility at Punjab Agricultural University (PAU), Ludhiana, accelerates crop improvement programs.
  - **Indigenous Vaccines:** India developed several pioneering vaccines, including the [quadrivalent Human Papilloma Virus \(qHPV\) vaccine](#), [ZyCoV-D \(DNA vaccine\)](#), and additionally, [GEMCOVAC-OM](#), an mRNA-based Omicron booster, was introduced.
  - **Gene Therapy:** [India's first gene therapy clinical trial for Hemophilia A received approval.](#)
  - **Novel Blood Bag Technology:** Researchers at **inStem, Bengaluru** created special sheets that **protect stored red blood cells from damage.**
    - This technology could help make better blood bags and reduce problems during transfusions.
- **Future Outlook:**
  - The biotechnology industry is set to reach **USD 150 billion by 2025** and has the potential to grow to USD 300 billion by 2030.

- The sector is expected to contribute around **3.3-3.5% of India's [Gross Domestic Product \(GDP\)](#)** by 2025.
- The market for diagnostic and medical devices is predicted to grow significantly, with the therapeutics sector expected to **generate USD 15 billion in bioeconomic activity by 2025.**
- The expansion of **biotech incubators and support for startups** is anticipated to drive further growth and innovation across various sectors, including health, agriculture, and industrial processes.



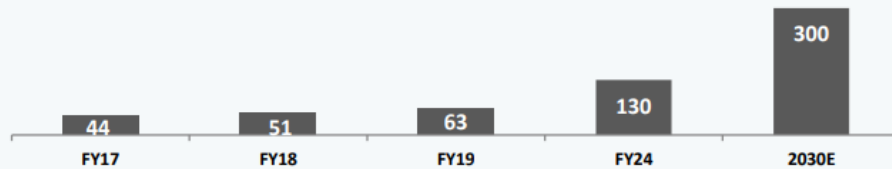


# BIOTECHNOLOGY



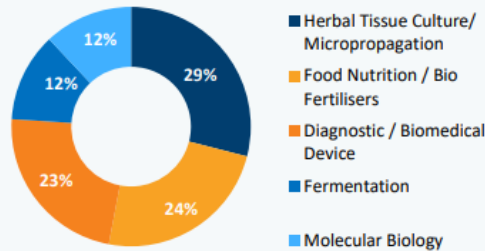
## MARKET SIZE

India Biotechnology industry valuation (US\$ billion)



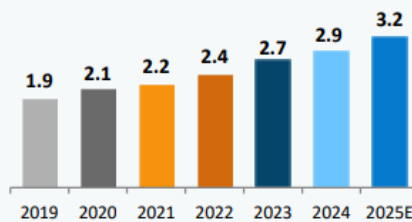
## SECTOR COMPOSITION

Vertical-wise distribution of start-ups, FY21 (%)

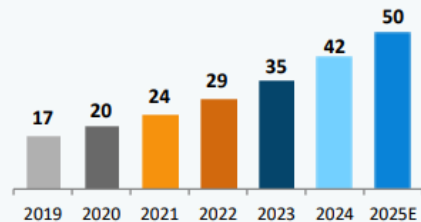


## KEY TRENDS

Clinical trials market in India (US\$ billion)



Medical device market in India (US\$ billion)



## GOVERNMENT INITIATIVES



Make in India



Biotech Parks



National Biopharma Mission



## ADVANTAGE INDIA

- **Skilled human capital:** With a total population of 1.4 billion, 47% being under the age of 25, India has a large pool of young and skilled workforce. India has a large reservoir of scientific human resources, including scientists and engineers.
- **Government Support:** Central and state governments have worked to set up several incubators and life science clusters across India. There are 9 DBT-supported biotech parks and 75 BIRAC-supported bio-incubators. In the Interim Budget 2024-25, the Department of Biotechnology (DBT) was allotted Rs. 2,251.52 crore (US\$ 271 million). National Biopharma Mission is supporting 101 projects including more than 150 organizations and 30 MSMEs. The National Biotechnology Development Strategy 2020-25, provides the government with a platform to strengthen skill development, resource and innovation.
- **FDI Policy:** 100% under automatic route for greenfield projects for pharmaceuticals; 100% under automatic route is allowed for the manufacturing of medical devices.
- **Epidemiological factors:** The patient pool is expected to increase over 20% in the next 10 years, mainly due to a rise in population.

## What are the Challenges for Biotechnology in India?

- **Strategic Roadmap Development:** There's a lack of a comprehensive strategic roadmap for biotechnology that outlines **competitive areas and industry-specific R&D needs**.
  - The biotechnology sector requires a revolution similar to the **Green and White Revolutions** to achieve significant advancements in crop improvement and therapeutics.
- **Bio-Networking:** Effective bio-networking is needed to enhance **interaction among biotechnology businesses**, address **intellectual property rights**, and ensure **biosafety and bioethics**.
- **Human Resources:** There is a need for more specialised human resources in biotechnology, particularly in remote regions.
- **Regulatory Burden:** **India's regulatory environment for biotechnology is complex and slow, particularly for genetically modified organisms (GMOs)**.
  - The approval process is cumbersome, with multiple agencies and the **Review Committee on Genetic Manipulation (RCGM)** leading to overlapping jurisdictions and delays.
- **Funding and Investment:** Although there is government funding for biotechnology projects, under the **Biotechnology Industry Partnership Programme (BIPP)**, further investment is needed to support high-risk, leading-edge research.
- **IT Integration and Data Management:** **Biotechnology research requires extensive IT support for data management, including challenges related to data integration and the establishment of technical standards.**

## Hyderabad as a Case Study for Biotechnology Development

- Hyderabad has secured over USD 700 million in investments and aims to reach USD 250 billion by 2030, reflecting significant financial backing for biotechnology.
- Major infrastructure projects such as **Genome Valley, Medtech Park, and Pharma City** are underway, enhancing Hyderabad's biotech ecosystem.
- The life sciences sector in Hyderabad has generated over **450,000 jobs in recent years, contributing to significant economic growth**.
- Telangana accounts for **1/3rd of global vaccine output** and Hyderabad is regarded as the **vaccine capital of the world**. Also, the State contributes to about **35% of India's pharmaceutical production**.
- Hyderabad offers **affordable human resources and lower real estate costs** compared to other global markets, attracting biotech firms.

## Way Forward

- Expand training programs such as the **Biotech Industrial Training Programme (BITP)** to develop a skilled workforce in biotechnology.
- Encourage **venture capital investment** in biotech startups and early-stage companies. Foster **public-private partnerships** to mobilise resources and accelerate innovation.
- Formulating and implementing supportive policies and incentives will be vital. Policies should focus on regulatory streamlining, tax benefits, and **subsidies to attract and retain biotech firms**.
  - Leverage initiatives like the **Production Linked Incentive (PLI)** scheme to enhance competitiveness. Focus on building global market presence and brand recognition through strategic partnerships and investments.
- Actively participate in global initiatives related to biotechnology, such as the **Global Alliance for Genomics and Health** and the **International Association of Plant Biotechnology (IAPB)**. Support the export of biotechnology products and services to global markets.

### Drishiti Mains Question:

**Q.** Discuss the BioE3 Policy, its alignment with India's national goals, and how biotechnology has evolved in India. Suggest potential solutions to address challenges.

## UPSC Civil Services Examination, Previous Year Question (PYQ)

### Prelims

**Q. Other than resistance to pests, what are the prospects for which genetically engineered plants have been created? (2012)**

1. To enable them to withstand drought
2. To increase the nutritive value of the produce
3. To enable them to grow and do photosynthesis in spaceships and space stations
4. To increase their shelf life

**Select the correct answer using the codes given below:**

- (a) 1 and 2 only
- (b) 3 and 4 only
- (c) 1, 2 and 4 only
- (d) 1, 2, 3 and 4

**Ans: (c)**

### Mains

**Q. What are the research and developmental achievements in applied biotechnology? How will these achievements help to uplift the poorer sections of the society? (2021)**

**Q. How can biotechnology help to improve the living standards of farmers? (2019)**

**Q. Why is there so much activity in the field of biotechnology in our country? How has this activity benefited the field of bio pharma? (2018)**